CHASING THE SMALLSAT BOOM
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Startup Rocket Lab’s Electron small-satellite launcher is scheduled to fly its first operational mission in April. Rocket Lab plans to launch six or seven operational missions this year and aims to fly every week by 2020. Cape Canaveral Bureau Chief Irene Klotz’s report on the burgeoning commercial satellite market begins on page 18. Rocket Lab photo.

Aviation Week publishes a digital edition every week. Read it at AviationWeek.com/awst

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FEEDBACK

UAS AS FIREFIGHTERS

In 2007, I was woken before dawn by a police car announcing I had 5 min. to evacuate ahead of the fast-moving Witch Creek Fire (six houses were burned down in the next block). If we have learned anything in California, it is that our firefighting service, Cal Fire Air, is inefficient.

This year much of Ventura County burned because Cal Fire does not fly at night, even though fires burn relentlessly. As a pilot, I understand that night flying can be dangerous, especially in proximity to a fire—but why not tap unmanned aerial systems (UAS) for the task? The U.S. Marines tested the K-Max autonomous helicopter in Afghanistan at altitude. At sea level, the K-Max can carry 750 gal. of water/fire retardant; the average fire truck carries about 500 gal. Wildfires are subdued only when the wind changes, comes off the ocean and drives the fire back to previously burned areas.

Our very courageous grounded firefighters are constrained to battling fire near roads. Unfortunately, fires are not that predictable, but UAVs can fly nearly anywhere at anytime.

In San Diego, wildfires are within about 10 mi. of a reservoir. A K-Max could make several roundtrips on just one tank of gas. Fires could be fought 24 instead of 12 hr. a day.

Another candidate is the Air Tractor, which has an amphibious firefighting model that could be made into a UAV. The Air Tractor and the K-Max sell for about $1 million and $8 million, respectively. Procuring 10 of each would cost less than $100 million. California wildfires in 2017 cost us more than $1 billion; fast math shows the advantage of UAS to fight wildfires round-the-clock.

The ironic fact is that were the government to engage in such a subterfuge we would not know it.

Roger Curtiss, Deer Harbor, Washington

UNFETTER SCIENTIFIC CURIOSITY

I am curious as to what is specifically being referred to. Though I suspect it might be a warning against “fake news,” I believe the admonition against all misinformation is a critical challenge that this next generation of young scientists has to confront.

Several subjects have existed in science that have been made taboo by the media and government agencies alike. Subjects like overunity (aka perpetual motion) systems, quantum vacuum engineering and unidentified aerial phenomena have been made unworthy of study by serious scientists and coverage by serious publications.

Coverage of these topics, if it happens at all, is often condescending or dismissive. Our young scientists must open their minds to the possibilities of the universe.

John J. Curcio, Eastchester, New York

KEEP THEM GUESSING

Recent Viewpoints addressed aspects of our nation’s current nuclear stance (Jan. 29-Feb. 11, p. 74 and Feb. 26-Mar. 11, p. 66). I contend that the Trump administration’s intention to spend unspecified billions of dollars in the upcoming defense budget to modernize and upgrade our nuclear capability in light of potential adversaries’ upgrades begs the question ‘Why?’ The stated intention of the U.S. is to use nuclear weapons only in response to provocation—not as a first strike. Therefore, if these weapons are limited to a response mode, how much improvement is needed? Are the warheads already fielded not robust enough to inflict horrific damage on a foe foolhardy enough to “push the button” first?

Billions of dollars could conceivably be saved by simply saying we are upgrading these weapons but not actually doing so. The threat of retaliation is what deters a rational enemy from engaging in a nuclear shootout. (An irrational enemy will not be persuaded regardless of what this country does.)

As long as the U.S. is perceived to have a devastating response capability, as a practical measure, it matters little how modernized that capability actually is. The money saved could be repurposed to other valuable programs.

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.

William Thayer, San Diego, California

CORRECTION:

The date of DARPA’s formation should have been stated as 1958 on page 16 of the March 12-25 issue.
Ted Fordyce has been promoted to Elbit Systems of America vice president for Washington operations, from vice president of government relations. He will serve as liaison to the White House, Congress and numerous defense-related entities.

Lockheed Martin has named Jeff Babione vice president and general manager of Skunk Works. He succeeds Rob Weiss, who will retire. Greg Ulmer succeeds Babione as vice president and general manager of the F-35 program.

Boeing has promoted Tim Keating to executive vice president of government operations from senior vice president.

Aerion Supersonic has named Tom Vice president and chief operating officer (COO). He had been president of Northrop Grumman’s Aerospace Systems sector. Aerion will be joining forces with GE Aviation and Lockheed Martin to develop the AS2 supersonic business jet, and Vice will help lead that development.

WestJet has named Ed Sims president/CEO and appointed him to the board. He succeeds Gregg Saretsky, who has abruptly stepped down. Sims has held senior positions with Air New Zealand and had been CEO of Airservices, New Zealand’s air navigation service provider.

Robert Sheybani has been appointed chief financial officer of Star Jets International, a private jet charter company. He has more than 30 years’ experience in finance and accounting, including at Societe Generale and Merrill Lynch.

Kraig Siracuse has joined Bell Helicopter as senior vice president for Washington operations. He had been a partner and managing director of Park Strategies.

U.S. Air Force Brig. Gen. Sean Farrell, has been named director of the Air Force Life Cycle Management Center’s Security Assistance and Cooperation Directorate, at Wright-Patterson AFB, Ohio. Farrell had been director of strategic plans, programs and requirements for the Air Force Special Operations Command at Hurlburt Field, Florida.

Thales and Safran have promoted Jean-Francois Delapau to chairman of the SoPadir Group from managing director. The group specializes in high-performance imaging technologies for aerospace, defense and commercial markets.

Kaman Aerosystems has appointed Darlene Smith vice president and general manager of Kaman’s air vehicles and maintenance, repair and overhaul (MRO) division.

Kollstrom Defense Aerospace Inc. has named Andy Trosper president of global distribution and supply chain in addition to his role as head of MRO for legacy defense aircraft.

AviaAM Financial Leasing China has promoted Tomas Sidlauskas to CEO, from vice president of sales. He has served as a director since 2014.

Global Eagle Entertainment Inc., provider of inflight entertainment, media content, technology and connectivity solutions to the airline industry, has promoted Jeff Leddy to executive chairman of the company and board chairman, from CEO. Josh Marks also moves up, to CEO from executive vice president of connectivity.

Gogo has named Oakleigh Thorne president/CEO. He succeeds Michael J. Small, who has left the company.

Michael Wilson has been appointed Unmanned Safety Institute (USI) director of operations. Most recently, he had been a USI master instructor and before that a Columbia Helicopters senior executive and U.S. naval aviator.

Raytheon has elected Adriane M. Brown as a director. A career science executive, her positions have included president/COO of Intellectual Ventures and Honeywell senior vice president of energy strategy.

Dallas Airmotive has hired Keith Moreland as rotorcraft regional engine manager for the Eastern U.S. He had worked for Rotorcraft Services Group, Uniflight and Airbus Helicopters.

Marie-Helene Emond has been named Esterline Avionics Systems’ marketing communications/public relations manager. She succeeds Janka Dvornik, who is retiring.

Romain Vasset has been hired as Air Partner freight charter sales manager within France, from Cologne, Germany. He had worked at Pro Sky AG and Evolution Jet International.

The Naval Aviation Museum Foundation has named Cindy McCalip vice president. She had been chief operations officer and executive vice president for the U.S. Navy Memorial Foundation.

UK Professional Pilots’ Union has elected Royal Air Force pilot Glen Beresford to its executive board.

Ian Wheeler has been named non-executive chairman of the board of Infares, an airfare data and analytics company.

Giuseppe Giordo, Aero Vodochody president/CEO, has been appointed by the Kingdom Public Investment Fund as a board member of Saudi Arabian Military Industries.

HONORS AND ELECTIONS

Tim Komberec, president/CEO of Empire Airlines Inc., has received the Executive of the Year award from the Pacific Northwest Aerospace Alliance, in recognition of his multifaceted contributions to the Pacific Northwest aerospace industry.

The Aeronautical Repair Station Association gave its 2018 Leo Weston Award to Jennifer Weinbrecht, who is retiring as vice president of compliance for Component Repair Technologies.
representing a green light for the acquisition of Rockwell Collins and the consolidation of two major aerospace suppliers.

Irish LCC Ryanair has agreed to take a 24.9% stake in Niki Lauda’s new Austrian carrier, Laudamotion, with a plan to grow ownership to 75%. The deal means Ryanair takes an ownership position in an airline that International Airlines Group and Lufthansa Group each tried, and failed, to acquire (page 15).

Delayed flight tests of General Electric’s GE9X turbofan for the Boeing 777X began on March 13 when the engine took to the air under the wing of GE Aviation’s modified 747-400 flying testbed.

United Technologies has signed an agreement with key customer Boeing representing a green light for the acquisition of Rockwell Collins and the consolidation of two major aerospace suppliers.

Israel Aerospace Industries plans to develop an electric short-haul commercial aircraft. Together with in-house developments, the company is considering potential collaboration with a start-up company.

Boeing’s 737-7, the third and smallest member of the MAX family, made its first flight on March 16. Deliveries are to begin in 2019. The first 737-9 variant was handed over to Thai Lion Air on March 21.

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European air taxi service WiJet has ordered 16 HondaJets, making it the launch airline customer for the light business jet. The order is valued at $78 million at list prices.

Voom, Airbus’ on-demand urban helicopter service, launched operations in Mexico City, its second market after Sao Paulo. More cities are to be added in 2018.

SPACE

Britain has enacted a Space Industry Bill, which will allow commercial space launch activities from the UK for the first time. Companies will be permitted to launch small satellites from British soil, as well as develop hypersonic flight and high-speed, point-to-point transport.

The U.S. Air Force has divided five launch deals between SpaceX and United Launch Alliance, awarding them more than $642 million for missions in late 2019 and 2020. SpaceX won $290 million to fly three GPS III satellites, while ULA was awarded $351 million for the AFSPC-8 and -12 missions.

Rocket Lab’s first commercial Electron launch, set for April, will include two spacecraft for Spire Global, which operates a constellation of cubesats for weather forecasting, ship tracking—and if the pending launch is successful—aircraft tracking (page 20).

Tokyo-based Sky Perfect JSAT Corp. and Thai startup MuSpaceTech have signed contracts with Blue Origin for launches on the New Glenn reusable orbital rocket expected to make its debut flight in 2020. Eutelsat and OneWeb signed the first New Glenn deals in 2017.

NASA issued a request for information on March 16 querying the U.S. private sector on scalable lunar lander concepts that could deliver large payloads and eventually astronauts to the Moon’s surface in the late 2020s.

Brexit Transition Deal Buys Time

Airlines and the aerospace industry have more time to adjust to Brexit now that the European Union and the UK have agreed on terms of a transition deal. The agreement includes a provision for trade relations to stay at the status quo for 21 months beyond the March 2019 effective date of Brexit, the UK’s move out of the EU. The transition period is not certain yet and hinges on a broader agreement outlining the conditions of the UK’s departure, which is expected before year-end. Airlines are extremely concerned about the loss of traffic rights, and the complex ownership structures of International Airlines Group subsidiary British Airways—as well as those of EasyJet and Ryanair—raise questions about their ability to continue operating as currently set up. In addition, Airbus could face trade restrictions for aircraft components that will have to be imported from the UK, most notably wings.

AviationWeek.com/avst
"TRADE WARS ARE GOOD AND easy to win." Thus tweeted President Donald Trump in early March. But for the jetliner industry, trade wars are a potentially toxic exogenous shock. Jetliners are uniquely vulnerable to retaliation, particularly from China.

First, the recent aluminum and steel tariffs are just the start of a much more aggressive Trump administration approach to trade. The administration also is imposing additional tariffs of $60 billion on annual Chinese imports. The goal is to cut the U.S.'s $375 billion trade deficit with China by $100 billion, which is basically impossible.

The Trump administration invoked national security as a rationale in the metals tariffs. That makes it immune from a World Trade Organization (WTO) protest. But this means anyone else can make the same claim and avoid a U.S. protest. As these security-based retaliations proceed, the WTO and other rules needed for world trade would be undermined.

Unfortunately, Boeing makes an easy target for anyone wishing to retaliate against the new U.S. trade measures. About 80% of Boeing's jetliners are exported, and the company is one of the most iconic U.S. manufacturers and global brands.

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Meanwhile, Boeing's defensive embrace of Trump—understandable, since the company was among the first subjects of his angry tweets—means that foreign governments now see Boeing as a Trump friend and ally, and therefore a good place to hit back at his policies.

For Boeing, retaliation is likely to take many unexpected forms. Canada's fighter competition process appears to penalize Boeing due to its International Trade Commission complaint against Bombardier's C Series. The Brazilian government is said to be rethinking its approval for a Boeing/Embraer tie-up. But in terms of overall retaliatory throw weight, China is by far the biggest risk for Boeing and the industry.

As the graph shows, China accounts for the majority of Boeing's jetliner delivery growth over the last five years. For Airbus and Boeing combined, China represented 22.8% of worldwide deliveries by unit in 2017. These numbers exclude scores of leased jets imported by China annually. China also plays a very large role in jetliner leasing and finance for carriers around the world.

Chinese retaliation against new tariffs would probably not take the form of a blunt embargo, or even anything that would jeopardize current Boeing orders. With air travel growing strongly in China, and global demand for the new Airbus and Boeing single-aisle jets still outstripping supply, canceling existing orders could be a self-inflicted wound.

Rather, the country would send a series of messages, ratcheting up the pressure on Trump. Today, China's airlines have almost exactly the same number of Airbus and Boeing jets—roughly 1,500 of each. For the past five years, China has favored Airbus, with a 60/40 ratio (although this is in units; since Boeing tends to do better with more expensive twin-aisle jets, the ratio in value would be somewhat more equal). A few large block orders for Airbus would send a strong message, particularly if China abstains from any Boeing orders for some time.

Perhaps in preparation for this, China has moved to increase Airbus in-country production capacity. In January, Airbus and its Chinese partners signed an agreement to ramp up the Tianjin assembly line to five aircraft per month by early 2019 and six per month by early 2020.

Beijing also would accelerate the country's jetliner development programs. These are still a long way from entering service and will be inferior to Western jets for decades to come. But then again, the swing toward protectionism will render that problem moot, with Chinese airlines increasingly compelled to accept Comac C919s and C929s, regardless of performance and product support concerns.

The Trump trade agenda may be justified or not, and Trump might be right, or not, about the winnability of a trade war. But the unfortunate reality about any war is that no matter who wins, the front line usually takes heavy losses.
It is with great pleasure that the IAF welcomes you to its upcoming event in the IAF Global Conferences series, the Global Space Applications Conference, GLAC 2018. GLAC 2018 is designed to encouraging the sharing of programmatic, technical and policy information, as well as collaborative solutions, challenges, lessons learnt, and paths forward among all nations with the desire to improve space applications and their usage. The GLAC 2018 will provide an excellent opportunity to review the state of the art of satellite-based applications, with a focus on: Farming and fishing, Integrated risk management, Climate, Natural resources, Mapping, Legal Aspects (Legal Regulations).
COMMENTARY

GOING CONCERNS

MICHAEL BRUNO

AEROSTRUCTURE PROVIDERS ARE USED TO being unloved.

They build to print, making aircraft subassemblies based on designs usually owned by others, so there isn’t much intellectual property or aftermarket revenue to be harvested later. In today’s push to own the life cycle, that is not a desirable place to start.

Worse yet, aerostructures makers must hold the assets and employees needed to make the aircraft sections—a capital-intensive position long discarded by leading airframers such as Airbus and Boeing as they spun off and outsourced the work to others. No wonder all of the biggest have either been restructured in recent years, or continue through that process.

“It’s not the most attractive part of the aerospace industry,” admits Spirit AeroSystems CEO and President Tom Gentile, whose Wichita company is the sector leader by sales.

But that picture could be about to change in a big way, although not necessarily for welcome reasons. A shakeout is coming in the aerostructures industry over the next 18 months, according to one major provider’s CEO, and his company and many others are positioning to be a buyer or seller.

Triumph Group CEO and President Dan Crowley says the aerostructures marketplace will see significant consolidation in the next 6-18 months, with maybe another go-around in 3-5 years.

“There is more capacity than demand,” he says. “There is a high need for investment. There are labor relations challenges in different plants. So that has to be sorted out because [OEMs] need structures they have to have. And so strategically, how our industry shakes out in that market, Triumph will be affected by that either as an acquiree or merger or potentially as a seller.”

Crowley came to this belief after talking with OEMs that used to own some of the structures businesses—and by looking at his own portfolio, which is being restructured and reduced. But he also points to the decision by the leadership of No. 2 aerostructures provider GKN to focus on aerospace.

GKN announced March 9 it would divest its other two major divisions, automotive and powder metallurgy, as well as several noncore business lines. The moves are part of an effort to stave off a hostile takeover by British turnaround company Melrose Industries. Shareholders have until the end of March to decide whom to side with.

Spirit has been widely discussed as a potential buyer of GKN Aerospace. Gentile appeared open to the possibility in an interview with Aviation Week on March 9 (see page 38).

Crowley told the JP Morgan Aviation, Transportation and Industrials Conference on March 13 the post-shakeout landscape will be geared toward being a “local, optimal solution” to OEMs, but it will take a lot of money to get there—money the OEMs are not spending.

“What is needed to make that happen is probably third-party money and private equity that comes in and says there’s a business there that maybe with the richest footprint or lower cost structure can improve margins, maybe put more automation in programs that can justify it,” he says.

“So it’s not a bad thing, but it has to happen, and I don’t think the OEMs and the companies that own the structures today can boot-strap it and afford to make those investments because the margins are not high enough.”

Why would anyone want to invest here? Despite potential overcapacity, the aerostructures marketplace is expected to grow in coming years, according to a 2017 forecast by MarketsandMarkets, from $52.17 billion in 2016 to $75.97 billion by 2022, at a compound annual growth rate (CAGR) of 6.47%.

“The growth of this market is mainly attributed to the rise in aircraft deliveries in the commercial and general aviation sectors,” the forecast states. “In addition, outsourcing of aerostructure manufacturing by major OEMs to Tier 1 and Tier 2 suppliers is further anticipated to drive the growth of the aerostructures market.”

The empennage segment is projected to grow at the highest CAGR, mainly due to increasing use of composite materials. North America is expected to be the leading region, the report says.

As the GKN drama shows, for financial and strategic sponsors, it appears decision points may be approaching sooner than previously thought. It behooves all to be ready. “The split of GKN has occurred much faster than we anticipated when we first suggested the Spirit/GKN Aero combination,” analysts Vertical Research Partners say. “This means that a potential deal could be complex—but given the projected accretion and strategic sense, we would not rule it out.”

Excess Capacity

The coming aerostructures shakeout

Spirit AeroSystems, which makes the pictured 737 section for Boeing, could be a buyer.
COMMENTARY

INSIDE BUSINESS AVIATION
WILLIAM GARVEY

DR. RICHARD MCGLAUGHLIN WAS once again heading for Haiti in his Cirrus SR22 as he had done regularly in the two years since the deadly and devastating 7.0-magnitude earthquake of 2010. This time his 25-year-old daughter, Elaine, was accompanying him on the medical supply mission.

About 45 min. after departing Miami and heading southeast over the ocean, the Birmingham, Alabama, pilot-physician noted that his aircraft’s engine oil pressure had dropped markedly. He decided he had best divert to the Bahamas’ Andros Island, and so informed air traffic control. Not long after, the engine started shaking heavily, then seized, and the flight turned eerily silent. The Cirrus had become a glider.

The pilot declared an emergency, trimmed to best glide speed and told his daughter to tighten her seat belt. Upon descending to 2,200 ft. and with Andros too distant, he reached overhead for a red handle and pulled down hard. With that, a rocket exploded from the aircraft, extracting a large orange-and-white parachute. Ninety-ft.-long risers hidden within the composite aircraft’s exterior ripped open from the fuselage to support the large, expanding canopy. The Cirrus slowed dramatically and then descended to the aqua blue waters below.

Once the aircraft splashed into the ocean, the McGlaughlins grabbed life vests, scrambled out the pilot-side door onto the wing, opened a life raft and got in, awaiting rescue (see photo). A U.S. Coast Guard HC-144 crew spotted the downed aircraft and raft and an MH-60 Jayhawk soon thereafter plucked them out of the sea and delivered them safely to Andros.

While the McGlaughlin aircraft was a total loss, the Cirrus Airframe Parachute System had done its job. Two people walked away thanks to it. Indeed, so have at least another 374. Mind you, not all those saved were in Cirrus aircraft. Versions of the system, made by BRS Aerospace, are fitted to a wide variety of mostly single-engine machines, including homebuilts, light sport aircraft and as after-market mods for Cessna 172 and 182 singles. Since the South St. Paul, Minnesota, company’s founding in 1980, its whole-aircraft parachutes have been installed on 35,000 flying machines—notably including the Airbus Perlan high-altitude glider.

However, at this time Cirrus is the only FAA-certified airframe manufacturer in which the parachute is standard equipment. Its models were designed from the start with a whole-aircraft parachute in mind. In fact, the system is part of their type certificates. So if the system is inoperable or out of date, the aircraft is technically unairworthy and cannot be flown.

BRS, which has 50 or so employees at its main facility and a secondary textile plant in North Carolina, reports talks are ongoing with other aircraft makers about equipping their new aircraft designs with its system. But it concedes that the time and expense of modifying existing production models with its system is probably not fiscally viable.

What’s coming, however, has piqued the company’s interest. Yes, it hopes to announce installation in other new owner-flown light aircraft—the sweet spot of its market so far—and maybe as soon as this year. But it is autonomous flying machines—tomorrow’s unmanned air taxis—that it covets.

“We are engaged with several VTOL and eVTOL [electric-vertical-take-off-and-landing] manufacturers,” CEO Enrique Dillon said recently. “It’s an incredible opportunity for BRS in providing a safety solution” for unmanned aircraft.

Accordingly, BRS is a member of the General Aviation Manufacturers Association’s Electric Propulsion and Innovation Committee, whose member companies are engaged in “the development, manufacture or advocacy of electric or hybrid-propulsion aircraft, technologies, systems, policies and standards primarily intended for general aviation.” Associate members on the committee include Uber Elevate, Airbus Group E-Fan, Terrafugia, Zee Aero and Evation, among others.

“Hundreds of millions [of dollars] are being poured into this [unmanned VTOL] industry,” Dillon says, to accelerate development, noting that “there are safety devices we are working on” to ensure good flight outcomes. Ultimately, he says, the technology “might be a combination of things with a parachute as well. And the parachute fits fairly well because the [UAVs’] rotors are in distributed proportion” rather than a single rotor as found on most helicopters, he adds.

And while each of those thousands of aircraft fitted with a BRS system leaves the ground piloted, once the parachute is deployed, everyone onboard is a passenger for the short ride that remains. Dr. McGlaughlin—now a board member of the Cirrus Owners and Pilots Association—along with 275 others, are living proof that Dillon’s premise is almost as sure as gravity itself. ☼

William Garvey is Editor-in-Chief of Business & Commercial Aviation
THE RESULTS OF EUROPEAN AIRLINE consolidation have been mixed at best. While the integration of several large players into International Airlines Group (IAG) can be viewed as a success, other mergers and takeovers such as the creation of the Air France-KLM conglomerate and parts of the Lufthansa Group have not fared as well. In the low-fare airline industry, EasyJet has been the most active in initiating takeovers in its short history, most recently through the acquisition of Air Berlin's Tegel Airport base, a move that provides a sizable operation in Europe's largest economy.

Ryanair's latest move, to buy first 24.9% and then 75% of Laudamotion, leaves observers puzzled. Why has Europe's largest low-cost carrier spent as much as €100 million ($123 million) to acquire an Austrian startup that has not even made its first flight? Laudamotion is the airline owned by former Formula 1 racing driver Niki Lauda and built on the remnants of bankrupt carrier Niki, another airline he once founded that was last controlled by Air Berlin. Laudamotion was going to operate independently against much bigger competitors but also wet-lease part of its fleet to Eurowings for the summer season.

It was a shaky setup seemingly bound to fail from the beginning, so Ryanair's decision to buy the carrier is great news for Lauda. His major shareholder has more than enough money to finance the start-up phase until profitability is reached in three years, according to the business plan.

Ryanair has never bought another airline. It once owned part of Aer Lingus and wanted to take full control, but it was forced to sell its stake by the British competition authorities. The Irish carrier expressed interest in purchasing former Air Berlin assets before but was never very serious in pursuing the idea. Lauda beat Ryanair in the final rounds of bidding for Niki, since he was prepared to pay a much higher price.

Now Ryanair is back in the picture. It is even wet-lease six of its aircraft to Laudamotion so the carrier can fly 21 aircraft in the summer season. On the other hand, it appears that Laudamotion's management will remain in place and continue its own strategy, which is different from Ryanair's. For example, the carrier plans to sell parts of its seat capacity to tour operators and fly several of its aircraft on behalf of Eurowings.

Benefits to Ryanair appear to be much more limited, but the case shows how much the company is changing. At least indirectly, the carrier gains better access to Germany and Austria, markets in which it has underperformed compared to its strongholds of Italy and Spain. It will also control a relatively low-cost platform that may be useful later. If Ryanair's ongoing conflicts with various European pilot unions continue, it could decide to grow it faster.

It's own pilot shortage is already a threat to its expansion plans—Ryanair had to cancel thousands of flights throughout 2018 to cope with the situation. Although Laudamotion opens up another growth path, it is not very substantial compared to Ryanair's huge operation. Ryanair also does not need the airline to deal with Brexit-related disruptions.

Laudamotion will operate an all-Airbus fleet, while Ryanair operates only Boeing 737s. CEO Michael O'Leary says the airline has wanted to gain experience with an Airbus fleet for some time. One can argue that it gives the carrier theoretically more leverage in future aircraft acquisition campaigns. But that is not really relevant, as it has large orders in place that will meet its requirements for many years.

Whichever way one looks at the transaction, the strategic rationale is not clear. But it will be an important test: Management has so far been extremely focused on maintaining the status quo and has adopted change very slowly. When Ryanair tried something new with its “Always Getting Better” initiative—introducing more customer-friendly features—it was a big success that returned the airline to a healthy growth trajectory.

Now Ryanair is combating new issues. First, O'Leary was forced to accept pilot unions across Europe and is in the process of negotiating collective-bargaining agreements in several countries—a difficult and painful learning process, he acknowledges. The next test will be whether O'Leary and his colleagues can integrate the new subsidiary and find synergies. If they succeed and make Laudamotion work, over time it could embolden them to purchase other carriers and strengthen Ryanair's case for abandoning its organic growth plan.

However, if the move fails, it will have been an expensive lesson for management that going off on strategic tangents is usually not a good idea. ⚠️
SOME SEE LOGISTICS AS THE “KILLER APP” FOR DRONES.
And not just in the commercial world; militaries are increasingly interested in using unmanned aircraft to rapidly and responsibly resupply troops in the field.

Multiple research and demonstration efforts are underway across a wide range of potential solutions, from disposable cargo gliders and swarms of package drones to optionally piloted rotorcraft.

For the commercial world, drone delivery means convenience. Goods ordered online could arrive within minutes, rather than days. For the military, it could mean survival, or at least relief for troops from the burden of carrying ammunition and supplies.

But combat resupply must be robust and reliable. If delivery of the latest iPhone to your doorstep is late, it is not life-threatening. For the military, the drones must get through.

Much of the testing now in progress is to understand how unmanned resupply aircraft can be used most effectively to support ground forces. One key is providing sustainment that can keep pace with dismounted infantry, so they do not end up isolated and unsupported.

The Marine Corps has experience with unmanned resupply. Two Lockheed Martin/Kaman K-Max unmanned external-lift helicopters operated in Afghanistan in 2011-14, delivering more than 2,250 tons of cargo to forward bases.

The capability was retired, but the Marines also participated in the Office of Naval Research’s Autonomous Aerial Cargo/Utility System (AACUS) program in which a manned helicopter was converted to unmanned operation using an autonomy kit.

A key to AACUS, which underwent its final demo in December at Quantico in Virginia, is the ability for a Marine with a tablet and minimal training to request resupply and manage the delivery without any need to understand the helicopter’s capabilities and limitations.

K-Max and AACUS have not led to programs, but they have influenced the Marine Corps’ requirements for a large ship-based unmanned aircraft, MUX. Resupply of Marine reconnaissance teams is one of the many missions envisioned for MUX, according to a request for information released on March 8.

MUX is not planned to enter service before 2025, and the Marines look likely to field a less ambitious unmanned resupply platform well before that. Rather than large platforms shuttling between bases, the focus is increasingly on a smaller, decentralized ability to organically support small, dispersed forces.

One capability could be the Yates Aerospace Silent Arrow, a disposable glider now in ground testing for the Marine Corps Warfighting Laboratory that could be air-launched from CH-53K helicopters, MV-22 tiltrotors or C-130 airlifters and fly up 50 mi. to deliver 700 lb. of cargo (page 41).

Another could be the Joint Tactical Autonomous Air Resupply System for which the Army and Marine Corps are developing requirements. As part of this, the services are testing the Joint Tactical Aerial Resupply Vehicle (pictured). This is a shrouded-rotor quadcopter developed by the UK’s Malloy Aeronautics with U.S. partner Service that is able to carry 50 lb. of cargo 20-25 mi. A larger version will carry 300 lb.

In early March, at Quantico, the Marines tested another resupply concept called Hive Final Mile. This relies on large numbers of drones to deliver small items such as water, food, ammunition or medical supplies to Marines in the field. The mobile hive stores, launches, recovers and recharges the drones.

A Marine submits an order via a tablet app, then hive software automatically decides which drone to send, plans, queues and deconflicts the flights, and sends information to a cloud-based platform to track inventory. In the concept demo, the drones delivered 2-3-lb. payloads over one-third of a mile in 2 min.

The hive is designed to house 18 drones and has been developed by Sentient Robotics along with the platform-agnostic software architecture. Drotek quadcopter and XCraft fixed-wing vertical-takeoff-and-landing UAVs were used in the demo. The next step is to scale up to more and larger drones carrying heavier payloads longer distances and to address issues such as automated loading and network security.

While the commercial world is working hard on drone delivery, the regulatory challenges around safety and airspace access mean the military could yet be first to routinely use unmanned aircraft for logistics.
Cubesats Conundrum

NASA’s Planetary Protection Office ponders how to deal with small satellites accompanying major missions beyond Earth orbit

Each of those cases where our responsibilities are,” says the space agency’s newly hired Planetary Protection Officer Lisa Pratt, formerly an astrobiologist and associate executive dean with Indiana University.

“There are going to be lots of changes, some an obvious change in the culture of how decision-making is done and how record-keeping is processed, to an overarching change in the framework from a scientific focus to a safety- and mission-assurance focus,” she says.

Among the first test cases for the revamped office are a pair of cubesats that will accompany the upcoming InSight mission to Mars. Equipped with a highly sensitive seismometer, InSight, which is set to launch in May from Vandenberg AFB, California, will be the first mission to probe the interior of Mars.

The cubesats, collectively known as Mars Cube One (MarCO), are a technology demonstration mission intended to relay data about InSight’s high-velocity entry into the Martian atmosphere, descent and landing in Elysium Planitia, just north of the equator. MarCO, built by NASA’s Jet Propulsion Lab in Pasadena, California, will be the agency’s first interplanetary cubesats. As such, MarCO is considered a test run for cubesats flying with the $2.1 billion Mars 2020 sample-caching mission and aboard the Exploration Mission-1 debut test flight of the Space Launch System rocket and Orion deep-space capsule.

“We’re all very excited about the possibility of cubesats as smaller, less expensive, innovative opportunities to do things that we just aren’t able to do with large, billion-dollar projects; but cubesats are often manufactured in very different kinds of facilities than large spacecraft components. In many cases, we’re pushing to make them with off-the-shelf materials,” Pratt said during a March 6 meeting of the National Academies Committee on Astrobiology Science Strategy for the Search for Life in the Universe.

“When that cubesat arrives and is added to a larger mission, right now it’s a big problem for planetary protection,” says Pratt. “We’re having some difficult conversations about what we know about the cleanliness of MarCO and what we know about how they will travel with the InSight spacecraft. We’re still learning about how those deployments will take place, and there is certainly the possibility that of the two, one may very well end up on the surface of Mars.”

In the future, the conundrum may be partly resolved by new sampling and assessment techniques, including sterilization technologies borrowed from the food, pharmaceutical and medical devices industries. “If we can figure out a way to make cubesats that are absolutely sterilized and encapsulated in a way that they don’t get recontaminated, those kinds of smaller, life-detection missions are really important for helping us move forward—particularly on Mars—in time to do it before we start to have humans in the vicinity,” says Pratt.

SpaceX, for example, intends to start launching cargo ships to Mars in 2022, followed by people in 2024, about a decade earlier than NASA’s current Mars exploration blueprint. “Clearly, as an agency we need to build trust and collaboration with the commercial space businesses because we need them to willingly partner with us . . . to take every opportunity to enable the science of astrobiology to happen in a place without inadvertent addition of either spores or organisms or just chemical compounds that could really confuse us,” says Pratt.

“These are scientists and engineers—they care deeply, too—and we need to convince them that we should all be playing by a well-established set of international rules,” she adds.
The birds are test articles for a joint venture with OneWeb, which plans to operate an initial constellation of 720 spacecraft in low Earth orbit (LEO) to provide worldwide high-speed internet and data services. The first 10 satellites are due to launch this year. The Airbus assembly line, as well as a second manufacturing facility in Florida that is set to open this spring, will be building satellites not just for OneWeb. Airbus already has sold the platform, which it calls Arrow, to the European Space Agency for an in-orbit technology test-bed slated to fly in 2020.

Airbus, which logged nearly $82 billion (€67 billion) in revenues last year, is not the only giant company taking an interest in small satellites. Lockheed Martin is now offering nanosat platforms and services via a partnership with Tyvak Nano-Satellite Systems. “We are looking for cool new space companies in order to incorporate them into some of our mission areas,” says Kay Sears, Lockheed vice president of strategy and business development. “We are not going to go create a nanosat platform—that is not what Lockheed does well. So we found a company called Tyvak, which is part of the Terran Orbital group, and we invested in them. They have a great small nanosat bus, and we have a bunch of payloads; so they are the bus provider and we are the payload provider.”

Small satellites, generally defined as weighing less than 1,300 lb., comprise a tiny but fast-growing share of a global space economy worth about $350 billion in 2017, according to a recent report by Washington-based consultancy Bryce Space and Technology. Morgan Stanley forecasts that global space industry revenues will reach $1.1 trillion or more by 2040. There was much arm-waving about that report at the Satellite 2018 conference in Washington March 12-15, but Bryce CEO Carissa Christensen notes that the industry already has been steadily growing at about 7% a year, which, if the trend continues, would put it within the Morgan Stanley ballpark. “It is basically saying if the industry continues along its present pace, and if we see in the future what we have seen in the past, we’ll get there,” Christensen says.

Two $100 billion markets currently dominate the industry—direct-to-home television and GPS navigation services—but what the future holds is anyone’s guess. Traditionally, manufacturers have measured market share by tallying how many geostationary orbit (GEO) communication satellites were sold in a calendar year, but that yardstick may already be an anachronism. “It is probably an old metric,” says Chris Johnson, vice president of Boeing Commercial Satellite Services. “Looking at traditional GEO awards is not the right metric to judge the healthiness of the industry. We all probably wish there were a few more GEOs.”

It would be easy to overlook a pair of small satellites that rolled off an assembly line at Airbus’ Toulouse manufacturing facility in March. For starters, they are pint-sized cousins of the flock of more than 200 satellites built by Airbus since 1961. Plus, they will never fly in space.

Small satellites, such as those deployed from the International Space Station, are the fastest-growing segment of the global satellite industry.

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Last year, satellite manufacturers competed in open markets for a near-record-low seven GEO contracts. Maxar Technologies CEO Howard Lance says its satellite manufacturing company SSL is seeing its fastest growth in LEO satellites for commercial and government markets. “We are also seeing double-digit growth in imagery, commercial customers, international [customers] and double-digit growth in the Radiant services business,” he says. “We see a big pipeline now in Canada. They have come out with their new budgets around defense and space, and we are very encouraged by that as well.”

In addition to rolling out new satellite platforms and operational orbits, companies are experimenting with new business structures and partnerships. Maxar, for example, wants to keep its four companies—MDA, SSL, DigitalGlobe and Radiant Solutions—separate and distinct.

In February, Lockheed published previously closely held technical data about payload interfaces for its LM 2100, LM 400 and LM 50 satellite platforms. “We didn't come to that decision lightly,” says Lockheed's Sears. “It was [something] like, ‘Oh, no. We are releasing the crown jewels.' But we wanted to stimulate the creative juices that we know are happening all around the space community; so that was our way of saying, ‘We will work with you.’”

Luxembourg-based SES, an early investor in O3b, an internet-via-satellite constellation, purchased the entire company in 2016, placed a seven-satellite order with Boeing to update the O3b network and now faces competition in medium Earth orbit (MEO) from, among others, Viasat, which provides broadband internet service only from GEO.

“We are not concerned about the dip in GEO orders,” says Sears. “There is still a lot of power in GEO, and we believe that orbit will continue to thrive for certain types of applications. But overall, we are convinced it is going to be a mix of orbits that will solve most of our customers’ needs, a blend of the agility and resiliency of LEO with the power and persistence of satellites in GEO.”

Nicolas Chamussy, head of Airbus Space Systems, adds: “The main reason for the drop is because [operators] are still scratching their heads, thinking, ‘Where am I going? Am I going to GEO? Am I going to LEO? Am I going to MEO? A combination of everything? Or am I simply not in the business anymore because of terrestrial operators?’ This is the main driver.”

To that end, manufacturers are trying to build as much flexibility as possible into their manufacturing processes and individual satellites. Lockheed and other satellite-makers are preparing for a future with fully digital, software-defined payloads that will be as customizable as a cell phone.

Johnson points out that Boeing has already produced generations of digital payloads, but the price needs to catch up with the technology. “As the affordability of digital payloads takes hold . . . you will start seeing that as the standard,” he says.  “Then you won’t have to pay the premium you would have had to in the past.”

One thing that is certain is more change. Hosted at the Satellite 2018 show this year were representatives from Ford, General Motors, Toyota, Tesla and Audi, as well as Amazon Web Services, a harbinger of potential future satellite applications driven by connected vehicles and data management.

“The mainstream trend in telecoms is wireless, and the good news is the satellite is wireless. We are a great wireless technology. We bring things to the table that are complementary to other wireless technologies: . . . ubiquity, reach, security, quality of service, point-to-multipoint services very efficiently, as well as broadcasting,” says Intelsat CEO Stephen Spengler. “On top of that, with the massive investment and innovation that we have seen in our industry in recent years, we have made tremendous strides in terms of performance and economics of our services. You look at all that, and it says we are ready to participate in the broader market.”

The harmonic convergence? Industry players think it will be fifth-generation wireless systems, with their promise of faster connectivity and no lag time. “We still have a lot of work to do in the standards area to make sure that we plug and play seamlessly in that future network,” says Spengler: “We have to work on our terminals and our antennas and devices to make them smaller, more cost-effective and easier to deploy, but we are heading in the right direction.”

The Boeing-built ViaSat-2, the world's highest-capacity commercial communications satellite, entered service in March with connectivity pricing competitive with terrestrial services.
Four years ago, when Peter Beck and his team at Rocket Lab were starting to build Electron, a low-cost, expendable, small-satellite launcher, Planet Labs was just beginning to experiment with custom-made cubesats for a planned 150-member constellation to take pictures of every location on Earth at least once a day.

There was talk of even bigger networks comprising hundreds or even thousands of small, inexpensive satellites to provide high-speed, cable-like internet and data services seamlessly throughout the globe.

Today, with about 200 birds in orbit, Planet Labs, now just called Planet, operates the world's biggest fleet of satellites. SpaceX has launched its first two prototypes for consumer websat services, and OneWeb aims to have its first 10 operational spacecraft in orbit by year-end. The three companies are among more than 180 angel- and venture-capital-backed space enterprises founded since 2000. In total, the start-ups have raised more than $18.4 billion in venture capital, including $2-3 billion per year for the last three years, excluding debt financing, Bryce Space and Technology, a Washington-based consultancy, writes in its 2018 “Start-Up Space” industry report.

About $150 million has flowed into Rocket Lab, which is based in New Zealand and Huntington Beach, California. The investors include Lockheed Martin, whose Skunk Works division along with DARPA previously partnered with Rocket Lab to develop advanced propulsion technologies such as high-density monopropellants, known as viscous liquid monopropellants. “We did some really cool stuff together,” says Beck.

These days, Rocket Lab depends more on Lockheed’s business chops than technical prowess. “Lockheed’s contribution is not so much on the technical aspect or facilities but more market intelligence and being able to collaborate on much larger projects,” says Beck. “They know within every country what is going on and who is building what. That has been really, really valuable to us.”

“Lockheed Martin pursues technology investments that help us keep pace with innovation across the industry,” says spokesman Matthew Kramer. “Rocket Lab’s work has application in a number of aerospace domains. . . . We are working with them to complement our overall efforts in small [satellite] lift.”

Lockheed declined to say how much it had invested in Rocket Lab but noted that Electron could allow for “low-cost flight-testing of our technologies.”

In January, Rocket Lab completed a two-flight test program of Electron, a 56-ft.-tall, two-stage, liquid-fuel, carbon-composite rocket designed to carry payloads of 220-496 lb. (100-225 kg). Launches cost $5-6 million per flight. In April, it intends to fly the first of six—and possibly seven—operational missions this year, a cadence of roughly one flight per month. “We are trying to squeeze another vehicle into the manifest this year. It really comes down to how well the production teams do,” says Beck.

Next year, the plan is to double the launch rate and fly every other week. In 2020, an Electron could launch every week, though that would require additional launchpads, says Beck. The company currently flies from New Zealand’s Mahia Peninsula, which has room for three or more pads. If the market warrants, Rocket Lab also would fly from Florida, Wallops Island, Virginia, or other sites geographically situated for low-inclination launches.

Rocket Lab did not wait until it finished the Electron flight tests before ramping up its manufacturing line. “We were very, very clear from Day
Blue Origin Shakes Up Its Short Game

> SUSPENDS PLANS FOR A BE-4 ENGINE TEST STAND AT CAPE CANAVERAL
> FILLS NEW SHEPARD 2018 PAYLOAD MANIFEST

Irene Klotz Washington and Cape Canaveral

Blue Origin is going for the long game, developing new tools, materials and manufacturing processes to operate fleets of suborbital and orbital rockets, in-space tugs and lunar landers capable of carrying 10,000 lb. (4,500 kg) to the surface of the Moon, about the capacity of an Apollo Lunar Excursion Module.

Toward that end, the Kent, Washington-based company, whose CEO is Honeywell’s former vice president and chief technology officer Bob Smith, sometimes scrambles the playbook, such as by delaying development of a BE-4 engine test stand in Florida and aiming to compete for U.S. national security space launch business, a decision that puts Blue in direct competition with one of its first industry partners, United Launch Alliance (ULA), a joint venture of Lockheed Martin and Boeing.

On Blue’s calendar this year are more than five flights of the reusable suborbital New Shepard vehicle, Smith said on the sidelines of the Satellite 2018 conference in Washington on March 15. Rack space aboard the New Shepard capsule, which sells for about $100,000 for a locker measuring 20.6 X 16.3 X 9.5 in. and as low as $8,000 for a student experiment, is sold out for 2018, says Clay Mowry, vice president of sales, marketing and customer experience.

The pilotless capsule, designed to carry six passengers and/or payloads, is boosted by a reusable, hydrogen-powered BE-3 engine to an altitude of 62 mi. (100 km). It separates and flies for 3-4 min. in microgravity, then makes a parachute descent near Blue’s West Texas launch site. The company has flown three versions of the booster and capsule, including one system that relaunched five times.

“We’re going to fly humans at some point, and we hope to do it this year,” says Smith.

Blue also plans to qualify the BE-4 rocket engine, which like New Shepard...
New Glenn launches, including two contracts announced during Satellite 2018. Their terms were not disclosed.

Initially, Blue is targeting about 12 launches per year, Meyerson said March 10 at an MIT Media Lab symposium in Cambridge, Massachusetts. “The early fights will be payloads, and we will evolve to flying people. Probably, it’s going to be seven or eight years down the road. We will have to increase our [launch] rate from Florida and multiple launch sites as well,” he notes.

Further on the horizon: a heavy-lift reusable launcher named New Armstrong, a lunar lander and a recently unveiled in-space orbital tug, all stemming from the technology developed for the BE-3. “Early on, we decided the BE-3 was going to be a family event,” says Meyerson. “The BE-3 always was envisioned as something that would be upgraded or upgradable for an upper-stage, high-performance rocket engine that we would use for deep-space exploration. We also envisioned clustering engines for powering an orbital vehicle,” he says. “The BE-3 has become the cornerstone of our development. It’s an engine we expect to be iterating on 50 years from now.”

Blue Origin plans more than five New Shepard fights in 2018. The newest capsule and booster took off for the first time on Dec. 12, 2017.
A vionics are available to provide the 15-min. routine, once-and-once-per-minute distress-tracking requirements the International Civil Aviation Organization (ICAO) will require for large aircraft in the coming years. But implementing ICAO’s Global Aeronautical Distress and Safety System (GADSS) presents other issues, satellite and tracking system providers say.

The utility of basic position reporting, bandwidth requirements and the need to coordinate distress responses with search-and-rescue (SAR) organizations were issues raised during an “aeronautical emergencies” panel discussion March 14 at the Satellite 2018 conference. Convened to discuss lessons learned from the Malaysia Airlines Flight 370 and Air France Flight 447 (AF447) searches, the panel focused on GADSS, the system ICAO developed to prevent future missing-aircraft events.

Satellite communications systems offered by Inmarsat and Iridium Communications already support the GADSS requirement that airlines track their aircraft weighing more than 27,000 kg (59,000 lb.) and carrying 19 or more passengers every 15 min. by November. And various suppliers advertise systems that provide the increased frequency needed for autonomous distress tracking. ICAO requires that large aircraft with certificates of airworthiness issued after January 2021 be capable of the once-per-minute distress-tracking standard.

The GADSS concept also calls for a means of recovering flight data recorder (FDR) information from an aircraft “in a timely manner” by 2021. While current or soon-to-be available systems such as the Aireon and FlightAware Global-Beacon offering will provide routine tracking at low cost using existing equipment, transmitting FDR parameters in a timely manner has cost and bandwidth implications.

Flight tracking tells where an aircraft is; flight-data streaming indicates what is happening on board, Iannuzzi argues. “We are talking about flight-data recovery. We are talking about a whole order of magnitude difference,” said Mary McMillan, Inmarsat vice president of safety and operational services, at the conference.

“Understanding where the aircraft is—that is critical, and to have better situational awareness around that is important,” said McMillan. “But to really understand what is happening with the aircraft takes a different level of data throughput that actually requires a lot more capable data link. In terms of being able to provide it, you have to have a directional antenna, you have to have a good size throughput in order to support that. You’re talking about streaming larger sets of data; obviously there is more cost associated with that.”

Airlines can already pull raw flight data from an aircraft once it has landed using a quick access recorder, but in-flight streaming of such information is at an early stage. The question then arose as to whether aviation-protected L-band spectrum will be sufficient to accommodate future flight-data streaming needs.

According to McMillan, Inmarsat is investing in its L-band network to support aviation surveillance, communications and flight-data streaming capabilities, and it has developed a “data fortress door” to segregate cockpit and cabin communications. She noted that Inmarsat also provides a high-throughput Ka-band service that airlines use for cabin entertainment and connectivity applications. “When we have an aircraft in trouble, I would like to see as much data as we can,” she added.

Brian Pemberton, Iridium Communications aviation general manager, says his company believes the L-band can accommodate future airline operational needs. Following the prolonged search for the FDRs from AF447, an Airbus A330 that crashed into the Atlantic Ocean in June 2009, France’s BEA accident investigation bureau “did an excellent job” of defining parameters for “triggered transmission” of flight data to the ground, he adds.

Data streaming may have helped locate the flight data recorder of Air France Flight 447, which took nearly two years to find.
Aeromexico's recent integration of its first Boeing 737 MAX-family aircraft into its domestic network marked the latest in a series of fleet changes for the Mexico City-based carrier. It is also arguably the least significant.

While the MAX brings efficiency compared to the airline's current-generation 737NGs, it also represents an element of continuity in a fleet that in early 2017 featured five distinct aircraft families. When the first of its 60 MAXs on firm order, a 737-8, began its Aeromexico service life March 9 on the carrier's Mexico City-Monterrey route, the fleet was down to three families.

Aeromexico's final Boeing 777 flight—Buenos Aires to Mexico City—was Feb. 26. The widebody twin's retirement, combined with last year's accelerated phaseout of 15 Embraer ERJ 145 regional jets, leaves the airline with Embraer 170s/190s, 737s and 787s. Having one model in the regional, narrow- and widebody segments maximizes Aeromexico's flexibility and "brings efficiencies, including training, maintenance, inventory and fleet productivity," says CEO Andres Conesa.

Fleet streamlining was one of Aeromexico's main goals for 2018. The primary one—leveraging the blossoming relationship with joint-venture partner Delta Air Lines—is a more involved, nuanced undertaking.

Aeromexico and Delta were granted U.S. and Mexican government approval for their joint venture in late 2016 and launched joint operations last May. The five-year approval allows the carriers to collaborate on transborder routes, fares and sales efforts. The agreement, which required the carriers to give up slots at capacity-constrained John F. Kennedy International Airport in New York and Mexico City's Benito Juarez International, to win regulators' approval, extended a partnership that began in 1994 with codeshare flights. In 2012, Delta made its first investment in Aeromexico parent Grupo Aeromexico—a stake that has since grown to 49%.

Executives with both carriers are convinced the joint venture holds great financial promise. They have identified $200 million in annual bottom-line benefits—$160 million in revenue boosts and $40 million in cost-saving opportunities through strategies such as combining operations at some airports. But, they caution, reaping those benefits is a caution, reaping those benefits is a caution.

"When we got the authorization in May, basically for the rest of the year, most of the network was already defined," Conesa told analysts in February. "You have less flexibility to adjust. For 2018, we have practically full flexibility. So we're fine-tuning all of our network."

One example: The recently announced nonstop service connecting two major automotive-industry regions—Detroit and Leon, Mexico—starting April 30. Aeromexico will operate the three-times-weekly route with 99-seat E190s.

Creating more feed into Delta's hubs has been an early focus of the airlines' cooperation. Among the network changes since the joint venture was approved: new Aeromexico routes between Mexico City and Seattle, Washington, and Portland, Oregon; Atlanta and Merida and Queretaro, Mexico; Leon, Mexico, and Los Angeles; and Guadalajara, Mexico, and Salt Lake City. The moves complement combined operations between Atlanta and both Guadalajara and Monterrey as well as frequency boosts on several other routes.

The goal is to capture a greater share of a transborder market that totaled 27.4 million passengers in 2016 and is growing at a double-digit rate. Aeromexico's figures show that American Airlines and United Airlines had the highest shares of Mexico-U.S. transborder air traffic during the first eight months of 2017, at 19% and 17%, respectively.

"When I look at that business, I see no reason over the next five years why those margins don't double," Conesa said. "And by the way, the Aeromexico team agrees with me."

Aeromexico plans to add five Boeing 737-8s in 2018.
W ith only a year to go until Britain is due to leave the European Union, airlines are still seeking clarity about what Brexit will mean for their schedules and operations—even as they acknowledge that some progress is being made.

Uncertainty about flying rights post-Brexit is the big concern once Britain leaves the EU in March 2019.

At the moment, British airlines owe their right to fly freely in the single EU aviation market to the fact that they are majority EU-owned—but soon they will no longer be. Solving this conundrum has been slow going; many airlines and others with a stake in the continuing smooth operation of aviation in the region after the break is official have been warning that flights could be grounded in the absence of an agreement.

Given that air transport contributes €300 billion ($369.6 billion), or 2.1% of European GDP, ensuring the sector continues to function smoothly is important for the region’s governments.

So for airports lobby group ACI Europe, the draft guidelines for a relationship following Brexit, which were released by the EU on March 7, are a “welcome step.” The pending guidance confirms that specific air transport and air safety agreements will be needed to safeguard air connectivity between the UK and EU.

“We call both on EU27 and UK negotiators to seek a future agreement that mirrors as closely as possible today’s arrangements,” ACI Europe says, noting that the draft EU guidelines do not consider the rights of UK airlines to keep flying within the 27 EU member states, nor vice versa. An end to these rights would cut operating flexibility and raise costs, resulting in a less competitive overall European aviation sector, the group says.

A transition period, which would allow the status quo to continue until the details can be worked out, is one option that seems to make sense to many operators.

Even Irish low-cost carrier Ryanair, which previously has been vocal in cautioning that Brexit could ground flights—and warned recently that it may have to add a caveat to its terms and conditions to allow for post-Brexit disruption—was acknowledging that some progress had been made before the latest steps toward a transition agreement.

Speaking in London as he unveiled Ryanair’s new environmental policy, Chief Marketing Officer Kenny Jacobs said recent comments by UK Prime Minister Theresa May that the UK would continue to have close relations with the European Aviation Safety Agency (EASA) indicate that negotiations regarding the aviation sector appear to be heading in the right direction.

“What happens after January 2021 is more uncertain,” Jacobs said. “The signals there are more negative than we would like. Market access is not guaranteed.”

At the same event in Brussels, Willie Walsh, CEO of British Airways parent IAG, remains sanguine about U.S./UK talks.

Lufthansa Group CEO Carsten Spohr pointed out that airlines are a valuable bargaining tool in the Brexit negotiations. “Aviation itself is not really the issue, but the importance of aviation for the government negotiations is very high,” he said.

The questions extend beyond British carriers’ rights to fly to EU destinations.

The U.S. and UK are crafting a new air services accord to take effect when the UK is no longer part of the U.S.-EU Open Skies agreement. Industry sources close to the situation are “optimistic” the two sides will reach an agreement that takes into account majority European ownership of British Airways, Virgin Atlantic and Norwegian Air UK.

That echoes comments by International Airlines Group (IAG) CEO Willie Walsh, who told the A4E Aviation Summit he was “completely relaxed” about the negotiations on the new bilateral air services agreement.

In the first rounds of these semi-informal talks, the U.S. and UK representatives agreed to aim at a standard U.S. open skies deal similar to what the UK has been using, but not a comprehensive EU/U.S. agreement, which includes a joint committee and language on environmental and competition issues.

Hints that the U.S.-UK negotiations were collapsing are “utter nonsense,” Walsh told attendees, adding that he believed a comprehensive air service agreement would be reached before April 2019.

Some aspects of a new treaty still need to be hammered out, the key one being ownership and control regulation. Going into the talks, the U.S. proposed a traditional ownership-and-control clause that would require British carriers to be majority UK-owned and controlled to be allowed to fly to the U.S. That clause was to be waived in a side letter. However, UK negotiators indicated they would strongly prefer to have rights straight away in a new air services agreement that replaced European with British ownership, the sources said. The U.S. may ultimately agree to this, one expert predicts, mainly because it does not change anything in comparison to the
status quo with the UK still inside the EU. Also, the U.S. has agreed to European rather than national clauses in its air services agreements with the EU and Switzerland. A change to the Swiss bilateral was needed when Lufthansa took over full control of Swiss International Air Lines.

Another issue to be resolved is the U.S.’ wish to get seventh-freedom rights—the right to carry cargo between two points in foreign countries without a link to a service originating in one’s own country. In the EU/U.S. agreement, seventh-freedom rights were retained from the old bilateral deals, but no additional rights were granted.

### Boeing Begins 777 EcoDemonstrator Tests

#### ECODEMONSTRATORS HAVE SO FAR TESTED MORE THAN 80 TECHNOLOGIES

#### THE COMPACT THRUST REVERSER IS FITTED TO THE RIGHT-HAND GE90-115B ENGINE

Guy Norris Los Angeles

Tested of a raft of new flight deck systems, alternative fuels, materials and a shorter thrust reverser has begun in Seattle on a modified Boeing 777-200F as part of the company’s ongoing EcoDemonstrator program.

The latest EcoDemonstrator—a FedEx-owned technology originally delivered late last year and loaned back to Boeing for the test program—is the fifth in the series since the initiative began with evaluation of several new technologies on a 737-800 in 2012. Previous EcoDemonstrators have included a 757, 787-8 and most recently an Embraer E170 that evaluated a set of airframe and systems advances in conjunction with the aircraft’s Brazilian manufacturer.

In all, Boeing says more than 80 technologies have undergone evaluation using the first four EcoDemonstrator flying testbeds.

The latest phase, which is scheduled to run through late April, includes tests of another 35 discrete technologies, after which the 777 will be returned to FedEx. Early testing has evaluated flying with 100% biofuel as well as the merits of the compact thrust reverser and approaches using an experimental synthetic instrument landing system (SILS)—a Boeing-developed precision approach system that could enable older aircraft to use satellite-based approaches using ILS-like guidance.

Although commercial airliners have previously flown with a blend of conventional kerosene jet fuel and alternative biofuels, Boeing says these tests will represent the first time a large widebody aircraft has flown exclusively using a paraffinic unconventional jet fuel. Regulations now limit biofuel blends to a maximum of 50%, but new specifications could permit 100% biofuel flights in the future.

The latest EcoDemonstrator tests come as the use of biofuels is on the rise. In January, a Qantas-operated 787-9 powered with a blended fuel that was 10% derived from brassica carinata, an industrial type of mustard seed, flew the first biofuel flight between Australia and the U.S. Qantas says the use of the biofuel reduced carbon emissions by 7% compared with the usual emissions over the same Los Angeles-Melbourne route. Carinata biofuel reduces emissions by 80% over the fuel’s life cycle compared to a standard pound of jet fuel. Qantas aims to use a form of renewable fuel for all Los Angeles-based flights by 2020.

The 777F also will be used to test an advanced Doppler LIDAR clear air turbulence detector developed by JAXA, the Japan Aerospace Exploration Agency. The laser-based system, one of several Lidar devices Boeing plans to test on the EcoDemonstrator, receives scattered light reflected back by aerosol particles such as water drops and dust, which are suspended in the air. A processor analyzes variations in light wavelength caused by the Doppler effect to determine airflow motion ahead of the aircraft. Changes in these wavelengths therefore make it possible to detect clear air turbulence that conventional weather radars fail to identify.

Although similar technologies have been developed and tested in the past, the resulting LIDAR systems have often proved too large and heavy for practical use. This is partly because a more powerful laser is required to detect backscatter from the lower density of aerosols at high altitudes over 10 km (6 mi.), where passenger aircraft typically cruise. The LIDAR under test on the 777F is a lighter, more compact version of a system JAXA developed in 2011. The initial 1-Hz laser device, which weighed 150 kg (330 lb.), used twin lasers and showed in flight tests it could detect turbulence about 9 km ahead at an altitude of 12,000 m (7.5 mi.). JAXA says the ultimate target of the LIDAR program is to help cut by half the number of turbulence-induced aircraft accidents.

The aircraft’s No. 2 (right-hand) General Electric GE90-115B engine has also been fitted with a compact thrust reverser design that incorporates thermoplastic blocker doors. Developed by Boeing, the concept is designed to help reduce the overall weight and drag of future nacelles and propulsion systems, which continue to grow in size as bypass ratios increase and cores shrink. The new reverser is designed to help offset potential pressure loss in
The UK and the U.S. also need to find a way to incorporate British Overseas Territories, which still fall within the old Bermuda II bilateral. Unlike the French overseas territories, they are not part of the EU/U.S. deal. The 14 territories include Bermuda, the Cayman and British Virgin Islands, the Turks and Caicos Islands, the Falklands and Gibraltar, among others.

Since the Brexit vote, attention has mostly focused on the impact on the major European airlines, many of which have made high-profile contingency plans of their own, including setting up new subsidiaries or applying for new air operator’s certificates to ensure they can keep flying. But smaller operators are in search of answers to allow them to prepare for potential upheaval, too.

The European Regions Airline Association (ERA) published advice to its members on Feb. 28 setting out the likely impact on different categories of airlines including scheduled, charter and cargo operators and discussing the risks related to issues such as data protection and EASA oversight.

It concludes: “A contingency planning checklist is vital to the survival of a business operating at EU and UK cross-border level, and a framework must be in place to support the operation that is specific to that network design. The solutions for ERA-member airlines are not ‘one-size-fits-all,’” it states.

The industry must work to “protect the established pillars of European aviation,” the ERA added.

“It is paramount that aviation integrity remains intact, irrespective of the political tactics of decision-makers. The European aviation industry must not suffer the brunt of political inadequacies,” the ERA document states.

Flight tests also include evaluation of the Aircraft Collision Avoidance System for NextGen (ACAS X), the next-generation replacement for the traffic alert and collision avoidance (TCAS) system, which has been mandatory in most U.S. airliners since 1993. The FAA plans to replace the current TCAS to allow use of automatic dependent surveillance-broadcast (ADS-B) and to provide collision-avoidance protection during NextGen procedures with reduced separation, such as closely spaced parallel operations. The system will be required to protect against collisions with unmanned aircraft, too.

ACAS X uses transponder interrogations as well as ADS-B signals to detect and track nearby aircraft, and will use the same antenna and displays as the current TCAS II system. However, unlike current TCAS II technology, which uses rule-based logic to model a spectrum of pilot responses, ACAS X’s alerting logic uses probabilistic models to represent various sources of uncertainty. These models rely on computer-optimized logic lookup tables that capture each possible state in the probabilistic-state distribution.

Boeing also plans to evaluate SOCAS (Surface Operations Collision Avoidance System), a device that scans the ground during taxiing to warn pilots of obstacles. Tests of the SO-CAS ground-scanning system are scheduled to take place in late April at Glasgow, Montana, but may be moved to Moses Lake, Washington, where Boeing focuses much of its remote flight-test activity. In the nearer term, the company expects the LIDAR testing to be underway by the end of March.
In the increasingly crowded electric vertical-takeoff-and-landing (eVTOL) market, credibility is in scarce supply. But the early leaders are separating themselves from the rest of the field by flying full-scale, people-carrying aircraft.

Kitty Hawk, owned by Google co-founder Larry Page, has joined the leader board by flying a two-seat eVTOL, called Cora, in New Zealand and the U.S. The company joins Joby Aviation and Airbus in flying full-scale prototypes of air taxis that transition to wingborne forward flight to increase efficiency, speed and range.

Cora is a follow-on to the ZP-1 and ZP-2 prototypes flight-tested by the former Zee.Aero team. For vertical flight, the aircraft has 12 rotors mounted in fore/aft pairs on booms under the wing. In forward flight, the rotors stop, aligned with the booms, and a pusher propeller provides propulsion.

Joby, which in February raised $100 million in investment from companies including JetBlue and Toyota, is flight-testing the S4, the prototype of a five-seat eVTOL with six tilting propellers mounted on the wing and tail. The new investment will be used to certify the aircraft.

The Zee.Aero team began hover flights of the unmanned, proof-of-concept Z-P1 in December 2011, conducting the first transition flights in February 2014. These were followed in August 2017 by the first manned flights of the single-seat Z-P2, which introduced the configuration used for Cora.

Cora has experimental certification and began unmanned flight tests in New Zealand in October 2017 in partnership with the country’s Transport Ministry and Civil Aviation Authority. Transition flights followed in November in the U.S.

In New Zealand, the aircraft is operated by Zephyr Airworks, a company formed in December 2016 by Kitty Hawk and led by CEO Fred Reid, former president of Lufthansa Airlines and Delta Air Lines and founding CEO of Virgin America.

Kitty Hawk is led by CEO Sebastian Thrun, founder of the Google X advanced research laboratory where he led development of self-driving cars. The company is also developing the Flyer, a single-seat eVTOL designed for recreational flying over water only.

Kitty Hawk and Joby are on a list of eVTOL leaders that includes Germany’s Volocopter and China’s Ehang, both of which are flight-testing full-size eVTOLs that resemble scaled-up multicopter drones. Volocopter in 2017 secured $30 million in financing from investors including Daimler.

Airbus’ Silicon Valley incubator A³ began unmanned flight tests of its Vahana single-seat tiltwing eVTOL in February, and Germany’s Lilium has flown an unmanned prototype of its tiltfan eVTOL and is now working on a larger five-seat aircraft with $90 million of investment raised in 2017.

Michael Hirschberg, executive director of AHS International, the vertical flight technical society, considers Joby and Kitty Hawk to be two of the leaders in the new industry because they have conducted manned flights of transitional eVTOLs with distributed electric propulsion.

VTOL aircraft that transition to wingborne flight and use multiple, redundant electric propellers offer greater efficiency and safety. Uber, which is developing its Elevate air taxi network, says only faster transitional eVTOLs can provide the high utilization required to make the service economically viable.

Cora has a wingspan of 36 ft., speed of about 110 mph and a range initially of 62 mi. In addition to the 12 independent rotors for vertical flight, the aircraft has a triple-redundant flight control system and an airframe parachute (see page 14). The aircraft is designed to be self-piloted, with human oversight, according to Kitty Hawk.

The aircraft is intended for use as a rideshare transportation service such as Uber Elevate. “We are not putting time frames around when Cora will be available for public flight,” the company says. “We have a lot of work to do, and we are working constructively with regulatory authorities.”

Cora prototypes have flown in New Zealand and made transition flights in California.
Tail Rotor Electrification Could Pave Way for Rotary-Wing Hybridization

> LEONARDO HAS COMPLETED 10 HR. OF ELECTRIC TAIL ROTOR TESTS
> ZF SAYS 1,000-KW MOTOR NEEDED FOR LIGHT TWIN-ENGINE HELICOPTER ANTI-TORQUE SYSTEM

Tony Osborne Las Vegas

Despite the rush toward electric vertical-takeoff-and-landing (eVTOL) air systems and urban air mobility, helicopter manufacturers and their suppliers are continuing to explore the potential electrification of anti-torque systems on conventional helicopters.

The approach is regarded as a possible first step toward the hybridization of rotorcraft and could bring about key ancillary benefits in terms of performance, safety and environmental aircraft.

Leonardo has been studying the potential of the technology in conjunction with the UK’s University of Bristol through the European Union’s Clean Sky 1 initiative, ground testing an air-cooled electric tail rotor on the tail boom of an AW139 medium-twin-engine aircraft for 10 hr. in the company’s whirl tower facilities in Cascina Costa near Milan.

“This is not a technology ready for implementation, but there is a lot of potential,” says Roberto Garavaglia, Leonardo’s president of strategy and business development.

On a conventional helicopter, the tail rotor runs by using a shaft connected to the main gearbox via the tail boom to a gearbox that synchronizes the tail rotor’s movement with that of the main rotor. Introducing an electric anti-torque system could immediately dispense with the complex network of shafts and gearboxes, eliminating the need for heavy maintenance on those components. Such a system would probably derive its power from a generator driven by the turbine, an approach likely to be used in distributed hybrid-powered eVTOL air vehicles being envisioned by some manufacturers.

In addition to reducing maintenance costs, the electric tail rotor can be decoupled from the conventional main rotor. On the ground for example, this would allow the tail rotor to be shut down entirely, making the on- and offloading of passengers safer while the main rotors keep running. In the emergency medical service mission, where stretcher-bound patients are often loaded on board via clam-shell doors in the rear fuselage of light helicopters, shutting down the tail rotor would eliminate the safety risk posed by running rotors.

“In the cruise, most of the stability in forward flight is provided by the vertical and horizontal stabilizers,” Garavaglia says. But reducing the speed of the electric tail rotor or optimizing it in conjunction with that of the main rotors—particularly during cruise—could help reduce fuel consumption as well as the noise levels that result from the main and tail rotors’ interactions, he notes.

A helicopter company test pilot tells Aviation Week that another benefit could be to link tail rotor performance to density altitude so that performance could be improved in low-density situations such as those associated with hot and high conditions. An electric tail rotor also could compensate for the loss of tail rotor thrust and improve aircraft control, especially for smaller helicopters during severe turbulence.

Leonardo’s work on an electric rotor paved the way for the technology to reach a technology readiness level of four—component validation in a laboratory environment. In 2017, Italy bestowed the National Award for Innovation to the company for this work.

An electric tail rotor would make it easier to design a folding tail boom, too, allowing the aircraft to take up less space in a hangar or perhaps on a ship, if applied to a naval aircraft. Weight savings are likely to be neutral, however, because while the electric tail rotor necessitates the removal of the heavy tail rotor gearbox and shaft, it still requires the generator, motor and extra wiring.

At Heli-Expo, Germany’s ZF, a specialist in producing aviation gearboxes, displayed a mockup of an electric tail rotor it plans to demonstrate this year. Initially, the use of a 1,000-kW motor is being explored, but company officials note that the technology is scalable across the spectrum of helicopter sizes and takeoff weights. ZF expects such a motor will be needed to support the tail rotor of a light-twin helicopter model up to around a 4-metric-ton maximum gross weight.

The company also plans to look at the potential of an electric shrouded anti-torque system, such as Airbus’ fenestron system, to see if the technology could be applied there.

“We do not believe this is a technology that can be applied retroactively because of the challenges associated with certification and testing. Instead, it would be better used on a new-build helicopter,” says Lars Mitter, head of customer services at ZF Aviation Technology.
GE Sees Catalyst as Engine for Change in Turbo Push

> ATP REBRANDED AS CATALYST
> CERTIFICATION TESTS START IN 2018, FLIGHT TESTS ON CESSNA DENALI IN 2019

Guy Norris Prague

General Electric is upping the ante in its decade-long campaign to challenge Pratt & Whitney Canada’s turboprop dominance by stepping up new developments of its H-series engines and preparing for certification tests of the all-new Advanced Turboprop (ATP), now rebranded the Catalyst.

“It’s been quite a journey,” says Brad Mottier, vice president and general manager of GE Aviation’s Business and General Aviation (BGA) and Integrated Systems organization. From initially acquiring Czech-based Walter Engines in 2008 to shipping the first flight-test Catalyst turboprop to Textron later this year for the prototype single-engine Cessna Denali, the European-based venture has grown to include 22 GE Aviation facilities and more than 1,800 engineers.

At the heart of the initiative, GE has also invested $400 million in developing Prague into its new turboprop center of excellence, where more than 500 jobs will be generated as production of the Catalyst and H-series engines begins to grow. “Our mission was to build a team and a business from virtually nothing,” says Mottier. The challenge also included transitioning the entire former Walter facility from Jinonice to its new location at Letnany, a nearby suburb northeast of Prague. “We did this while retaining our [European Aviation Safety Agency (EASA)] repair, certification and production certificate. To do that, we mapped out each manufacturing area and rebuilt that large Jinonice facility within these four walls,” he says.

Although GE’s initial focus was on improving the Walter-developed M601 by producing the H80 derivative, which was introduced in 2010, the long-term vision was the genesis of the ATP. “We started analyzing our competitor’s product and in 2014 came up with the idea for a clean-design engine. We were working on that when Cessna had a competition for the Denali, for which we were selected,” says Mottier.

Although so far launched only for the new Cessna single, the Catalyst makes extensive use of additive manufacturing technology. Parts such as heat exchangers, exhaust case, and vane were produced using 3D printing. The engine is also the first in its class to introduce two stages of variable stator vanes (VSV) and cooled high-pressure turbine blades and vanes. The design also incorporates a compressor design partly leveraging the CT7, which generates an overall pressure ratio of 16:1. Compared to current engines in the 900–1,700-shp range, GE expects the 1,300-shp-rated Catalyst to deliver up to 20% lower fuel burn. Much of this is due to the use of the cooled turbines, which allow operating temperatures approximately 300°F-plus higher than standard for a turboprop of this category.

Thanks largely to an integrated full-authority digital engine/propeller control (Fadepc), VSVs and a three-stage, counter-rotating low-pressure turbine, the engine is also expected to generate up to 10% higher cruise power. “The Fadepc makes sense, even for a product this size,” says Gordie Follin, ATP engineering lead. “Compared to an engine that generates similar power at sea level, our lapse rate and power at altitude will be much better because we can maintain peak efficiency at off-design conditions.”

The Fadepc is also key to enabling the pilot to control the engine with a single throttle lever, significantly reducing workload. “In a conventional turboprop aircraft, the pilot is trying to independently manage and optimize the propeller and gas turbine based on noise and gauges, but with the Fadepc you can have closed-loop optimization on takeoff power, or noise, or noise at cruise, or specific fuel consumption at cruise,” says Follin. The system is designed to change engine scheduling depending on aircraft operating conditions. “So if you have the icing system on, or environmental control on, the reference torque and propeller rpm changes,” adds Paul Corkery, senior executive and turboprop leader.

Fadepc data is also an enabler to GE’s digital engine plan for the Catalyst. Test cells will be used to collect individual performance data from engines as they come off the production line, along with data on key tolerances and characteristics. This information will form the basis for creating a physics-based model, or digital twin, of the engine against which actual in-service performance and maintenance needs will be assessed using operating data collected by the digital engine controller.

As with other new engines across GE Aviation’s portfolio, the Catalyst makes extensive use of additive manufacturing technology. Parts such as heat exchangers, exhaust case,
GE Sees Catalyst as Engine Propulsion to work on other improvements; it’s a catalyst for new change,” he says. It is a catalyst for the competition and a business from growing. “Our mission is to deliver up to 20% lower fuel burn. Much of this is due to the newer sibling, says Michele D’Ercole, president of GE Aviation Czech. Beginning in 2009, when GE launched the H80 based on the M601, the company added a new compressor, blisks, blades and new stators to enhance power by 20% and boost efficiency by 10%. “From an architecture standpoint, it is simple and durable, but relatively modern from a technology-infusion perspective,” says D’Ercole. In late 2016, the Electronic Engine and Propeller Control (EEPC) system on the H-series received type certification from EASA, becoming the first business and general aviation turboprop to combine engine and propeller operations into a single system and marking a key steppingstone toward the Fadepc on the Catalyst.

Nextant Aerospace’s G90XT, a remanufactured King Air C90, was the first application of the EEPC-configured engine and will be followed this year by certification on the Thrush 510G crop duster aircraft. The system will also equip the H75-powered Diamond Dart 550, a military trainer that is due to make its first flight within the coming weeks. Tests to clear the engine for aerobatic flight are underway in a specially developed rig in Prague.

The H80 does not have a hot section. “That’s one of the main advantages of the design. We don’t need a hot section inspection, so the next goal is to extend time between overhauls as much as possible,” says D’Ercole. Upcoming improvements derived from the Catalyst include the addition of super-polished compressor blades and abradable coatings. EASA certification for the super-polish finish, which improves efficiency, is expected by the third quarter of this year, while the abradable change is already being introduced into production engines.

The engine ran in Prague for the first time on Dec. 22, 2017, marking a program development pace 30% faster than previous new GE projects. This tempo will continue, says Jen Pinson, turboprop manufacturing programs leader. “The whole development program has 10 engines, plus we have several rebuilds. In all, we will have 33 engine tests, 17 of which are certification tests, and that does not include a flying testbed or other rig tests. All that will happen over the next two years using four test cells in the Czech Republic as well as altitude tests in Canada that will be running this summer.”

Although no dedicated flying testbed campaign is planned or required for certification, GE says a King Air 350 being modified in Germany for use by the Czech Technical University’s (CVUT) Center of Aerospace and Space Technology may play a role in safety of flight clearance work early in 2019, prior to flight tests on the Denali. The first Catalyst engine, which has so far accumulated only 39 min. of run time, has meanwhile been seconded to CVUT for tests under a collaborative research agreement aimed at developing new methodologies for designing preventative health-monitoring systems for modern turboprops.

As the launch platform for the Catalyst, the H-series turboprop is poised to benefit from advances introduced with the newer sibling, says Michele D’Ercole, president of GE Aviation Czech. Beginning in 2009, when GE launched the H80 based on the M601, the company added a new compressor, blisks, blades and new stators to enhance power by 20% and boost efficiency by 10%. “From an architecture standpoint, it is simple and durable, but relatively modern from a technology-infusion perspective,” says D’Ercole. In late 2016, the Electronic Engine and Propeller Control (EEPC) system on the H-series received type certification from EASA, becoming the first business and general aviation turboprop to combine engine and propeller operations into a single system and marking a key steppingstone toward the Fadepc on the Catalyst.

Production of H80-series turboprops is stepping up in Prague where a newly assembled engine is seen undergoing predelivery tests.
The one-month average delay in the delivery of Leap 1A engines for the Airbus A320neo family can be described as a challenge, but CFM International’s performance also can be seen as remarkably close to the target schedule, given the scale of the production ramp-up. Nevertheless, Safran and General Electric (partners in the CFM joint venture) and their suppliers are looking for ways to clear the bottlenecks that are holding up deliveries.

Every engine manufacturer in commercial aviation has recently experienced some sort of manufacturing difficulty, affecting the related aircraft’s delivery schedule. Airbus CEO Tom Enders criticized CFM in February for shipping engines late. Safran has at least warned that increasing Leap production would be a daunting task. “In just four years, we will achieve a Leap production rate higher than the current rate for the CFM56—a rate that took us 35 years to reach,” Safran Aircraft Engines CEO Olivier Andries reiterated last year. Safran’s final assembly line (FAL) in Melun Villaroche, near Paris, handles all Leap 1As and some Leap 1Bs for the Boeing 737 MAX.

The engine-maker revamped its preparation work, creating a “manufacturing readiness level” metric comparable to the well-known “technology readiness level” in research and development. As early as 2012, four years before the first delivery of a Leap-powered A320neo, Safran and Albany (a specialist in 3D woven composites based on carbon fiber) were fine-tuning the fan blade’s production process. They increased the monthly fan-blade production rate to 100 from 50, although none were destined to be fitted to an engine.

The Melun Villaroche FAL has benefited from numerous improvements. Some work instructions are available in augmented reality, and automation was enhanced for fan assembly.

It is fair to say that Safran was well prepared, but it could not control every step in the supply chain. Leap engine deliveries for Airbus are still 4-5 weeks behind schedule, Safran CEO Philippe Petitcolin confirmed in late February. Already in the middle of a fast production ramp-up, the company is dogged by a delay that began in early in 2017. A quality issue with a low-pressure turbine disk has been resolved, but the time lost cannot be recovered. GE, Safran’s partner on the Leap, also encountered problems with a turbine disk that has set its schedule back.

To further accelerate manufacturing, Safran and its suppliers need more parts-machining capacity. However, the purchasing cycle for some of the required machine-tools—Petitcolin specifically noted broaching machines—takes two years.

As a result, the FAL in Melun Villaroche is not running at full rate. The assembly cycle takes just a few weeks, “but some [workers] do not have a lot to do on some days because the parts are not coming in,” Petitcolin says.

The engine-maker anticipates that Leap production will be back on track by midyear. In 2017, CFM handed over a combined 459 Leap engines for the A320neo and the 737 MAX, up from 77 in 2016 (China’s Comac C919 represents a negligible proportion of the total). This year, it plans to deliver 1,100 Leaps. The ramp-up phase is thus said to be on target. The total number of Leap deliveries by Safran and GE is projected to exceed 2,000 by 2020.

Amboise, France-based Mecachrome is a major supplier for the Leap program, signed in 2014 by Safran to produce titanium-aluminide blades for the Leap’s low-pressure turbine. Mecachrome’s purpose-built production line at its Sable-sur-Sarthe site features a high degree of automation. Other Leap parts—such as titanium shrouds—are produced at its facility in Evora, Portugal.

 Asked about deliveries for the Leap, Mecachrome CEO Arnaud de Ponnat says the situation used to be “very tense” but is now easing. He points to increasing production rates in Evora. “We are coming back on schedule,” he says, noting that delays are “three times shorter” than they used to be. He cites Mecachrome’s expertise in automation—acquired in the automotive sector—as one of the reasons the company expects to get back on track during the ramp-up phase.

However, Mecachrome’s improvement plans are sometimes disturbed by additional requests from Safran. These stem from adjustments in the engine-maker’s policy of double-sourcing. On a given part, Mecachrome can be asked to increase its share of the production to 100% from its original assignment of one-third, “to compensate for another supplier,” de Ponnat explains. Meetings with Safran take place weekly.

With regard to the A320neo ramp-up, de Ponnat notes that producing aerostructures is easier: “There is less change, and the number of manufacturing processes is typically three, instead of 20 for an engine part.”

De Ponnat says Mecachrome’s Leap turbine blades have been consistently on time. This year’s rate is planned to be 120,000-130,000 units, up from 50,000 in 2017.
AIR TRAFFIC MANAGEMENT

How To Streamline Europe’s Air Traffic

> OPERATORS WILL BE ABLE TO PRIORITIZE FLIGHTS
> AIRSPACE WILL BE BETTER SHARED BETWEEN AIRLINES AND MILITARY

Thierry Dubois Lyon, France

The joint undertaking responsible for Europe's technology project in air traffic management (ATM) modernization is highlighting the benefits of future changes as seen from a carrier's operations control center in an effort to gain momentum with airlines.

Support from operators may help propel such ideas as more efficient flight planning and better use of airspace. As is often the case with ATM programs in Europe, progress has been slow. They generally move at the speed of the slowest member state or wait for another organization to advance.

In the framework of the Single European Sky ATM Research (SESAR) joint undertaking, an Airbus-led consortium that includes Lufthansa Systems and Sabre Airline Solutions, has worked out several potential improvements.

The hope is that an extended flight plan (EFPL) will optimize agreed-upon—as opposed to requested—trajectories. When an operations control center (OCC) submits a flight plan, it is received by the network manager at the ATM organization Eurocontrol. The network manager is responsible for validating and distributing it to the concerned air traffic control centers, such as an en route control center. Both the network manager and the control center recalculate a 4D (three spatial dimensions plus time) flight profile for their individual needs. Air traffic control, for instance, recalculates the flight plan to prevent conflicts.

But the involved parties are not using the same data. “For instance, the airspace user has very accurate aircraft performance information, while the others use standard engineering data,” says Franck Ballerini, SESAR's head of network research. This results in misaligned trajectories, which can cause a flight plan to be wrongly accepted or rejected.

In the latter instance, the trajectory is refined to be eventually accepted by both parties. But the flight plan then released to the crews in some cases does not provide the optimum vertical profile. An otherwise avoidable step climb or extension of the beginning of descent may appear.

The EFPL includes much more information than the conventional flight plan—position, altitude, time at every waypoint and additional information such as aircraft mass and speeds, temperature and wind at every waypoint. “The airspace user will provide the 4D trajectory, including information on aircraft performance, thus ensuring a more accurate view of the flight intent,” Ballerini says. The misalignments should therefore gradually disappear.

Despite all the benefits of the evolution, the EFPL still has to be implemented. A validation phase involved 14 airlines and, in 2016, operational maturity was deemed sufficient. However, a standardization activity had been started at the International Civil Aviation Organization (ICAO) level. So it was decided to wait for the ICAO standard that is now being finalized, Ballerini says.

The updated target calls for completing deployment of the EFPL by 2020-21. In terms of system upgrade, at least, deployment is said to be “well on track” in several countries such as Poland, Spain and the UK.

“EFPL is a very strategic project because it is the first step toward the concept of [a] business trajectory,” an Airbus spokesperson says. The business trajectory management concept is a new planning system for 4D trajectory operations, using an “iterative refinement process” until the aircraft departs.

Another source of frustration for carriers has been the military preemption of airspace blocks. Often, this space goes unused, even though civil operators are banned from entering it, or the military uses only a fraction of the blocked space. The practice prevents civil operators from flying their preferred optimum flightpath.

The “advanced flexible use of airspace” concept aims to provide a more flexible management of airspace reservations. The airspace the military “books” as a large block is divided into smaller modules. The layout allows the military to reserve modules instead of the entire block, providing they do not need more. An airspace status change is shared in real time.

The estimated bottom line in fuel efficiency is a 1.5% improvement. Full deployment is scheduled for the end of 2021. Paradoxically, although the system upgrade is in full swing, most countries do not plan to exchange information between civil and military users until 2021, according to Cristian Pradera, SESAR's planning senior expert. Belgium, Bulgaria, Hungary, Portugal and Romania are the few exceptions to have already begun such information sharing.

The third enhancement, to be deployed by 2022-23, is already in service in a simplified version. The current tool allows for the swapping of slots within a single airline—an incentive to cancel a slot, in case of delay, as soon as possible. In a more sophisticated form, the “user-driven prioritization process” will enable the operator to allocate priority numbers to its flights if congestion causes delays. One flight may be favored over others, which will be pushed back at the end of a given period.

The Airbus-led consortium predicts the total cost of delays can be cut by up to 10-15%.
All aircraft must be identifiable,” Acting Administrator Dan Elwell told the FAA UAS Symposium in Baltimore March 6. “If you want to fly in the system, you have to be identifiable and observe the rules . . . One malicious act could put a stop to all the good work we have done.”

The FAA is close to releasing a notice of proposed rulemaking (NPRM) on remote identification. “We are committed to moving quickly to establish requirements,” said Elwell. At the same time, the White House and Congress are working on legislation to enable government agencies to detect and counter drones.

The challenge is becoming acute. The number of drone users registered with the FAA passed the 1 million mark in January, and the 75,000 commercial UAS within that total are expected to increase fivefold over the next five years. “The potential for misuse presents unique challenges,” says Michael Kratsios, deputy assistant to the president at the White House Office of Science and Technology Policy.

Remote ID is an issue that has divided the UAS community. Hobbyists want to continue flying model aircraft without regulation; commercial operators want today’s confining Part 107 drone regulations to be expanded to permit flight over people and beyond visual line of sight (BVLOS).

Finding ways to identify and counter malicious drones is critical to allaying security concerns that have stalled rulemaking sought by commercial operators. Flight over people and BVLOS are viewed by industry as essential to unlocking the full commercial potential of UAS, including for drone delivery services.

The next 12-18 months will be “critically important” to integration, said Elwell. The requirement for hobbyists to register their drones has been reinstated by Congress and, to address security, lawmakers are expected to modify the ban on regulating model aircraft when reauthorizing the FAA.

The Defense and Energy departments have been given limited authority to detect and mitigate UAS threats to critical infrastructure. Legislation to enable the Homeland Security and Justice departments to detect, and in some cases counter, drones is expected “in the coming months,” says Kratsios.

The Remote ID NPRM is with the White House Office of Management and Budget for approval, says Earl Lawrence, executive director of the FAA UAS Integration Office. The proposed rule will be performance-based, he says, and will not prescribe equipment.

“It could be a line of code,” says Lawrence, adding that the FAA is looking for a network solution where drone and operator ID are broadcast to the internet. “We will not dictate how the signal gets to us, just that it gets there within a performance-based requirement and not every 3 hr.,” he says.

The security “dialog has flourished over the past year,” says Angela Stubblefield, the FAA’s deputy associate administrator for security. When it comes to operating drones, registration, identification and mitigation are all needed to address “the clueless, the careless and the criminal,” she says.

The biggest concern is weaponized drones. Another is UAS bypassing ground security to gather information at corporate and government sites. Drones disrupting and harassing law-enforcement and public-safety operations is another key worry, as is UAS flying contraband across borders or into prisons.

The issue expands to safety. The public will react differently if a drone is anonymous and its behavior unexpected, says Lawrence. A drone popping up over a parade will evoke a different reaction if its intent and operator are unknown.

“Anonymous operations in the system are not consistent with moving forward with integration and expansion of operations,” says Stubblefield. The
A drone on a delivery run will create fewer safety concerns with the public if its identity is known, says the FAA.

ability to identify UAS operators also will play a key role in threat detection and mitigation.

The FAA has evaluated drone detection systems at several airports and will submit a report to Congress this year. “There are systems out there that can detect drones, but if we cannot ID them we are at a disadvantage,” she says. “We can detect all day long and not know much about the threat they pose.”

“If we can identify the drone, we may not have to take steps to counter it,” says Tim Arel, deputy chief operating officer for the FAA Air Traffic Organization (ATO). If a drone is preventing public-safety helicopter operations, Remote ID will allow them to contact the operator and tell them to get out of the way.

“With manned aircraft, we can see the tail number and know who owns it, who’s on board, what its intent is. With drones, we might not need to mitigate if we have an ID,” says Stubblefield.

The focus for Remote ID is on operations below 400 ft. “We want a different system down low,” says Lawrence, because the surveillance system now used for normal ATC operations at higher altitudes “is not appropriate for high-volume, low-altitude operations.”

Last December, an aviation rulemaking committee—chartered by the FAA to make recommendations on UAS identification and tracking—delivered a sharply divided report to the agency. “The most contentious topic was who needs to ID and where,” he says.

Lawrence suggests starting with “anybody who has to be registered; because if you are registered, you are not anonymous.” As for where, he suggests airspace covered by LAANC, the FAA’s new Low-Altitude Authorization and Notification Capability.

LAANC is an automated system enabling Part 107 operators to gain access to controlled airspace near airports. A prototype was deployed at several airports in November. Beginning April 30, the FAA will expand the system to 500 air traffic facilities, to cover approximately 500 airports by Sept. 13.

Methods of complying with the Remote ID rule will have to address a wide range of needs, says Lawrence. Categories include locations such as drone races, when the UAS lack any ID equipment, but the site could gain a permit, as is now done with air shows, says Lawrence. This approach also could be used for fields where aeromodelers operate under a community-based safety system, he says. For more toy-like drones that fly in back yards, control station ID could be used if manufacturers build in a mechanism that prevents the UAS from flying more than 400 ft. from its operator. Lawrence suggests “some kind of industry-consensus consumer standard” for a tamper-proof ID protocol.

The base station would connect to the internet and broadcast its location. For other operations, within visual line of sight over a wider area or under a BVLOS waiver to Part 107, Remote ID could require the location of both aircraft and operator to be transmitted on the network.

BVLOS operations will require backups: a network as well as a relatively inexpensive on-aircraft transmitter that can be accessed by law enforcement and public-safety helicopter operators. The onboard transmitter also would support detect-and-avoid requirements by identifying the UAS to other aircraft.

Despite the importance of Remote ID to enabling BVLOS operations, the FAA is keeping the rulemaking separate. “It is logical to make them separate rules,” says Lawrence. “This is an ID rule for any aircraft operating at low altitude. It is about separating ATC into two systems.”

Automatic dependent surveillance-broadcast (ADS-B) could be used for BVLOS operations, but Remote ID could saturate the 1030-/1090-MHz frequencies used by ATC, warns Jay Merkle, deputy vice president of the FAA ATO program management office. “We can’t afford to have drones on those frequencies in areas where we are not providing them with [instrument flight rules] services,” he says, particularly where multipath problems already cause tracking issues.

Another frequency, 1104 MHz, could provide ADS-B-standard Remote ID. “That’s the back-side DME frequency,” says Merkle. “It appears to be deconflicted with regard to spectrum, but it needs to be tested to demonstrate that it really works. If it does, it could be part of a performance-based rule.”

The FAA sees Remote ID as another software app built using the same design models as LAANC and derived from the UAS Traffic Management (UTM) construct under development by NASA. The FAA portrays LAANC as the initial element of UTM, which is being designed to automate management of high-volume operations in low-altitude airspace. NASA plans to complete UTM development in 2019.

LAANC is a service provided to drone operators by private-sector companies, not the FAA. There are five now, with more to be added from mid-April as the FAA prepares to expand LAANC nationwide. Traditionally, the FAA would have built the system, then operated it, but the intent is to relinquish control of low-altitude airspace to private-sector partners who will invest in building up UTM capability.

Identification and tracking is viewed similarly to LAANC, as a UTM function to be performed by private-sector UAS service suppliers, or USS. “The FAA can’t collect tracks for the whole country. It has got to be federated,” says Lawrence. USS would keep IDs in a database, and law enforcement would go to them as the track owners to identify a drone and its operator.

As a result, the FAA has no intention of putting in a ground infrastructure to track drone IDs, as it has done with ADS-B. “The FAA is not going to put in independent sensors to listen in because of the cost of the infrastructure,” says Lawrence. “We want to keep it light and do it faster and cheaper.”

Leading drone maker DJI has proposed a drone-tracking system, Aerospace, using the existing command link.
As Counter-UAS Gains Ground, Swarm Threat Looms

> GUN-STYLE JAMMERS ARE INCREASINGLY BEING DEPLOYED TO COUNTER SINGLE DRONES

> EMERGING DRONE SWARMS WILL CHALLENGE COUNTER-UAS TECHNOLOGIES

The emerging market for solutions to counter small unmanned aircraft systems (UAS) is booming, to meet security concerns ranging from airport intrusions to battlefield threats such as quadcopters modified to drop grenades.

A new report by the Center for the Study of the Drone at Bard College lists more than 235 counter-UAS (C-UAS) products on offer or under development by 155 manufacturers in 33 countries. This contrasts with the 10 dedicated counterdrone systems identified by a market survey conducted as recently as 2015 by Sandia National Laboratories, the report’s author says.

“The growth of C-UAS technology is directly tied to mounting concerns about the threat that drones pose both in civilian and wartime environments,” says Arthur Holland Michel, co-director of the Bard center. “The expansion of the sector in the roughly five years since counterdrone systems first appeared on the market has been stratospheric,” he adds.

So long as risk persists, the anti-drone market is expected to thrive. But today’s counterdrone tools are unlikely to be much use against the most novel drone threat expected in the near future—large swarms of autonomous, small UAS.

A new report for the U.S. Army by the National Academies of Sciences, Engineering and Medicine warns that small UAS swarms could be used much sooner than the service anticipates. And while U.S. forces are fielding systems to counter single drones, the report finds little is being done to defend against organized groups of autonomous UAS.

It is no surprise that counterdrone technologies lag those of UAS themselves, just as the weaponization of drones has lagged the rapid growth of small UAS in the commercial and recreational arena. Counterdrone systems available today are more likely...
to be tools for defense forces and law enforcement purposes—meant to mitigate nefarious use of consumer drones—rather than military systems geared to counter military systems.

Several counterdrone solutions are becoming available, only some of which have been tested, their effectiveness verified and systems deployed operationally. A lack of common standards in the C-UAS industry “means there is a wide variance in the effectiveness and reliability of systems,” says Holland Michel.

“We have volumes of marketing copy large customers get when they issue requests for proposals . . . but we have no data relating to tests in the field,” Holland Michel says. Companies say they are willing to do demonstrations, but customers say most systems do not live up to their promises, he notes.

Compounding this uncertainty are the varied rules of engagement (and civil laws) that pertain to how drones can be countered. Kinetic countermeasures are restricted outside of combat zones for obvious reasons. Disabling a drone with a machine gun is clearly not viable for defending a sports arena.

And even on patrol, rules of engagement may frown on lethal force against inanimate objects that risks injuring bystanders. Jamming tools, which seek to stop drones via radio-frequency (RF) interference, can often be a brute-force measure that disables other communications systems, from cellphones to Wi-Fi to walkie-talkies. So jamming, too, is hardly a one-size-fts-all answer.

And all of these measures—from nets to bullets to lasers to jamming—are much less effective against swarms.

“When these [small UAS] are combined in groups or swarms, their threat is signifcantly enhanced,” says Albert Scarretta, president of CNS Technologies and chairman of the committee that conducted the National Academies study.

Counter-UAS systems use a variety of technologies to detect and interdict drones. Of the systems listed in the Bard report, 88 (37%) are capable of detection only, 79 (34%) interdiction only and 65 (28%) both detection and interdiction. The main detection and tracking methods are radar; RF detection and location of the drone’s communication links, electro-optical and IR cameras and acoustic sensors. Two-thirds of systems are single-sensor; but 10% combine four or five.

DroneShield, an Australian company, offers a portable counterdrone device as well as static installations. The company’s DroneGun will be used by the Queensland Police Service during the Commonwealth Games in April, in Sydney. SteelRock, a UK defense contractor that itself sells an armed multirotor drone, also offers a form of anti-drone radio shotgun.

Fortem Technologies, a U.S. startup that has attracted backing from Boeing, has developed DroneHunter, an unmanned aircraft that autonomously patrols drone no-fly zones to detect any rogue drone using radar, capture it with a net gun and tow it away. And Department 18, another Australian company, has teamed with Raytheon to market Mesmer, a drone redirection tool.

“A lot of militaries are looking for a portable countermeasure, as opposed to a site countermeasure—a product for a dismounted soldier to be used in many situations,” says DroneShield CEO Oleg Vornik. “A lot of jammers are not designed for deployment. They tend to be big boxes you cannot pick up or smaller boxes with antennas that are not practical to carry.”

SteelRock’s NightFighter is a shotgun-shaped combination of antennas and software that is wielded like a gun. “If you are looking to acquire a target with a quasi-ffrearm, you need to be able to see it, and the ergonomic way to do that is with a rifle. The way the technology works is more akin to a shotgun in terms of short-range engagement,” says CEO Rupert English.

Like NightFighter, DroneGun can be transported by one person and is designed to jam one UAS at a time. “Drones know where they are, and where they came from, so their response to jamming is to stop and land. We are using the protocols as they are meant to operate when the drone gets lost,” says Vornik.

These types of directional systems can mitigate but not eliminate the collateral inconvenience of jamming other systems, which is why their use is restricted to government agencies with regulatory approval. “You have an RF going out in a cone,” English says. “We’ve worked on narrowing down that cone to a point where it can be used by a trained operator in a complex environment. But in the same way a shotgun blast will dissipate, as you get down-range the signal will get wider.”

Products such as NightFighter and DroneGun provide a defense against one drone at a time, which matches the current threat. But they may not be the solution to swarms. “Shooting a narrow jamming beam so as not to interfere with a wide area doesn’t work if you’re dealing with more than one UAS,” says Holland Michel. “The same thing goes for net-based systems. Most are one-shot solutions.”

“One of the unique attributes of Mesmer is we don’t need to stay targeted on the drone itself. All we need is to detect it, identify it and then send a bit of code, which takes microseconds, and go on to the next target,” says Department 13 CEO Jonathan Hunter.

“If you have five to ten drones coming at you, and you’re using a jamming capability, you have to keep that signal on one drone until it does what you want it to do,” Hunter says. “And it can take up to 60 sec. to affect that drone in a positive way, as all the others are still flying toward you.”

Mesmer takes control of a single UAS via its radio and sends either a command to land, fy to a safe area and land or return to where it took off. There is no limit on how many UAS the system can counter at a time, says Hunter, except for the time it takes to send the code to each targeted drone.

The detection component of Mesmer extracts information from the drones and gives each a unique identifer. This way, it can counter only specifc UAS. “You could have 10 [DJJI Phantom 4s flying in an area],” says Hunter, “and we will target the one we want to come down, and the rest will still fy.”

Drone swarms are not a distant worry. “Current and near-term (by 2025) capabilities will enable the employment of multiple small UAS in coordinated groups, swarms, and collaborative groups,” the National Academies report says. The Army’s planning time frames are “too drawn out to address the rapid advancements in small UAS performance capabilities and anticipated threat uses,” it warns.
It took 51 years to deliver the first 10,000 Boeing 737 fuselages. You predict it will take just 15 years to produce the next 10,000. Where is Spirit headed on narrowbody production? We're just at 52 737s per month, and Boeing has announced we will go to 57 per month next year. We already have the equipment in place or on its way. Last year, the book-to-bill rate on narrowbodies was 1.6, so the backlogs grew. There is definitely upward pressure on rates.

How high could you go? Could you produce 70 fuselages a month? We can go above 57. It would require more capital, but we have the space and infrastructure to do it. We're going to consolidate 500,000 ft.² of warehouse space into a new 160,000-ft.² warehouse with a lot of automation. That will free up even more space.

With Boeing and Airbus increasing narrowbody rates and production of Bombardier’s C Series starting to ramp up, are you worried about the supply chain? These unprecedented rates are a strain for everybody. There are so many pieces to it: the infrastructure, capital, tooling, people, training and warehousing facilities. It has been a struggle for parts of the supply chain to keep up, and that has created some disruption in our line and for Boeing. We’re maintaining the schedule, but it’s a stretch. Of course, it’s not just the structures. Some of the engine companies are hard-pressed as well. It takes a huge amount of expertise and program management.

Where is the challenge? Is it a lack of materials, or lack of talent in the labor pool? It’s a little bit of both. Our line works extremely well when it has all the parts it needs. Getting the material on time and in the right quantities is incredibly important. We’ve had some disruptions we’ve had to work through. The other challenge is talent. We’ve hired more than 3,000 people in Wichita in the last three years and will hire at least 1,200 more this year. We can get science, technology, engineers and mathematics talent, but a big challenge is hiring front-line mechanics. It’s starting to get difficult to hire the number of front-line people we need.

How does automation play into your growth plans? We couldn’t be at the rates we are today without automation. For example, we have about 450,000 fasteners in every 737 fuselage, and about 60% of those are automated—automatic drilling and filling. But at least 40% of the fasteners are still manually inserted. There are some places you just can’t automate because they are very difficult to access. So it’s a balance. You need both.

Is Boeing helping you with automation? Boeing is very open to sharing their best practices. We exchange ideas literally every day. It’s not just with the 737. For example, we build the forward fuselage on the 787 and they build the aft fuselage. We are exchanging ideas all the time—every-
thing from comparing metrics on how we are laying down the carbon fiber to inspections, materials, techniques and tools. It benefits Boeing if we can become more productive.

**How big a role will additive manufacturing/3D printing play at Spirit?** One of seven distinctive capabilities we’ve defined is lean metallic structures, because we will be building metallic structures long into the future. In 3D printing, we’re working with Norsk Titanium. Our structures are very large, so powder bed 3D printing isn’t very interesting to us because it would take too long to print up our parts. Norsk does something called rapid plasma deposition, where they can layer—in this case titanium—into very big structures pretty quickly. They lay it in big beads to create a near-net shape, and then we can machine it. We save 70% of the material because instead of starting with a block as big as a conference table, we start with a near-net shape and then just do the final machining.

We’ve got our first four parts, which are fairly advanced. Boeing has also been working with us on that.

**Do you see additive manufacturing being used for aluminum as well?** Eventually, but our initial focus has been on titanium, because of its unique characteristics and the expense. When I look at some of the forgings we have in aluminum, where we start off with a 1,500-lb. block and end up with a 47-lb. part, I see plenty of opportunity. But aluminum is not something we’re working on now.

**What about composites?** We’re working on advanced composites. How do we get more lightweight, reduce the number of fasteners, streamline the manufacturing process? If you look at our composite aircraft today, the architecture is remarkably similar to metallic. It’s all carbon fiber, but you have skins, stringers, frames, brackets and lots of fasteners. You needed that for aluminum, but with composites the opportunity exists to create a monolithic structure where all that goes away. It’s not just carbon fiber; there is lots of work going on now with other types of material, like thermoplastics.

**Spirit still counts on Boeing for 82% of its sales, with about 15% coming from Airbus and the rest from defense.** We would like to be more diversified, but we don’t want to reduce the amount of work we have with Boeing; we want to grow it. We just want the other parts of the business to grow faster. We think defense can be 10-15% of our business in five years, and I’m hoping toward the upper end of that range. We already have work packages on the KC-46 tanker, CH-56K, P-8, the V-280 and the B-21 [next-generation bomber]. One big program we’re not on and would like to get on is the F-35.

**Airbus is half the [commercial] market, so we want to continue to grow that relationship.** We also want to grow our fabrication business. We make 38,000 detail parts. You’ve heard a lot of indications that Boeing and Airbus are looking to insource different things. If they decide to insource some Tier 1 structures, we want to make sure we have Tier 2 detail parts that we can supply to them and others.

**GKN Aerospace, a competitor of yours, is selling off non-core businesses and refocusing on aerospace. Do you want to acquire GKN?** We obviously are aware of what’s going on, but we wouldn’t never discuss a specific situation. The 3-5% growth we’re targeting is organic, but we’re also looking to grow inorganically. We have a lot of cash on our balance sheet. We have a lot of firepower. So, if the right opportunity existed, we could execute on it. [An acquisition] would have to meet our strategic criteria. It has to be more Airbus content, more military content and more low-cost-country footprint.

**Investors seem to be pressuring conglomerates to break up.** The conglomerate premium does not seem to be as strong as it used to be. That’s one thing I like about Spirit: We are aerospace structures. It’s not the most attractive part of the aerospace industry. We don’t have a lot of aftermarket, our margins tend to be lower and we trade at a lower multiple, but that’s fine. Aerostructures is at least a $55 billion-a-year market, and we’re the largest commercial aerostructures business.

**Do urban air taxis intrigue you?** Aerospace Industries Association CEO Eric Fanning recently said it could be a $30 billion-a-year industry employing 60,000 people in the next 20 years. If there are that many drones, they are going to need a lot of structures.

**What about supersonic business jets?** We’ve talked to Aeron and Boom. I’m very interested in both, particularly Aeron, because they’re probably a bit further ahead. They’re at the cutting edge of technology, so they require the most sophisticated structures. That’s a great challenge and a learning opportunity for us.

**Do you expect Spirit to have a role on Boeing’s proposed new midmarket airplane [NMA]?** That’s something we would have to compete and win work on. We’re investing more in R&D to develop ideas that would be attractive for Boeing to consider. We haven’t really engaged with them yet on NMA. I know they’ve been talking with a lot of their customers to determine the business case for it. We’ll wait for them to reach those conclusions. We have plenty of time to talk.
CARGO AIRCRAFT

Strong Cargo Demand Puts Atlas Air in Growth Mode

> E-COMMERCE BOOSTS CURRENT CYCLE
> AAW MAY ADD SMALLER WIDEBODIES IF LARGER ONES ARE UNAVAILABLE

Sean Broderick Washington

It does not take much digging into Atlas Air Worldwide Holdings (AAW) to unearth a complex clutch of businesses. The parent company owns an aircraft lessor as well as at least part of three airlines that fly both cargo and passengers under for-hire agreements. In some cases, it flies customers’ aircraft; in others, it flies its own. It even leases aircraft to some customers that turn around and contract one of the AAW airlines to pilot, maintain and insure them.

But beneath the complexity is a simple truth: If AAW is doing well, then the global air cargo market probably is, too. On both counts, business is booming—and recent moves by AAW underpin the company’s confidence that the good times will continue to roll.

AAW has quietly lined up six used Boeing 747-400 freighters to meet both current and anticipated demand, CEO William Flynn revealed on a recent earnings call. Two entered service in September and October 2017, and the other four will fly this year. AAW has customers for all six, though Flynn declined to name them. AAW said in a Securities and Exchange Commission (SEC) filing that it put 747-400Fs in service for two customers in the September-October 2017 timeframe: DHL Global Forwarding and Hong Kong Express.

“We have identified a number of aircraft and leased them in,” Flynn says. “We think that was a prudent thing to do, as we think about growing demand over the next couple of years and our ability to service that.”

The new additions will operate both under charter and ACMI (aircraft, crew, maintenance and insurance), or wet-lease, arrangements, and Flynn says they could move between the two types of flying. About 70% of AAW’s 2017 flying, as measured in block hours, occurred under ACMI contracts, and the company expects the percentage to be a bit higher this year.

Adding the six widebody aircraft boosts AAW’s fleet size to 30 747-400s. It operated 73 aircraft as of Dec. 31 and has since added one 777F purchased this year from LATAM Airlines and put into service at DHL Express.

The fleet additions come amid a notable surge in the air cargo specialist’s business. AAW’s block-hour volume grew 20% in 2017, and the company is projecting a 19% bump this year. Some of last year’s growth, which included a 17% increase in revenue to a record $2.2 billion, can be attributed to incorporating a full year of results from Southern Air, the cargo airline AAW purchased in April 2016. The ramp-up of work for Amazon is another source of new business: The e-commerce giant is leasing 20 Boeing 767s from Titan, AAW’s dry-leasing arm, and contracting AAW to operate them under CMI deals. Twelve were in service as of Jan. 1, with the rest being added this year.

But even without those one-offs, Flynn says, the cargo market’s fundamentals are strong, creating opportunity for AAW.

“The market really infected all the way back around July/August of 2016,” he says. “And we’ve seen just continued solid growth, month-over-month, and certainly a very good peak in 2017 and a very strong outlook for 2018 and beyond.”

International Air Transport Association (IATA) figures show that air freight traffic, as measured in freight-ton kilometers, grew 9% in 2017—the biggest one-year climb since 2010. While much new belly capacity is being introduced via widebody passenger aircraft, demand for freighters is rising. Widebody freighter use is approaching 11 hr./day, a level not seen since 2012, according to IATA figures. This has operators and lessors seeing used freighters in a new light.

“There is not a lot of excess capacity in the market,” Flynn says, adding that only a handful of the still-available 747-400s are worth considering, and even those would require substantial investment to get flying again. Aviation Week’s Fleet Discovery shows 16 747-400Fs in storage, including five that are at least 25 years old.

If the market keeps surging, ordering new 747-8s to go with the 10 AAW has in service is a possibility, Flynn says. The biggest problem: getting them anytime soon. Lackluster demand means Boeing is building 747s at a rate of just six per year, and a February order from UPS pushed the backlog up to 25.

“There are no -8s available in the near term,” Flynn says. “The -400, particularly in the fuel environment we’re in . . . delivers a great cost-per-kilo [performance] in terms of operations.”

While sourcing more 747 lift may be difficult, Flynn says there are opportunities to add smaller widebodies. AAW long ago identified the 20 767s it needed to fulfill its commitment to Amazon, and Flynn says the company is “anxious to see” how the Airbus A330-300 passenger-to-freighter conversion (P2F) that recently entered service with DHL performs.

“We’re continuing to study that as a potential next-freighter opportunity for us, but that’s couple of years out,” Flynn says.

Thanks to the e-commerce boom, air freight’s growth cycle may stretch out to meet down-the-road opportunities such as more 747-8 and A330-300P2F orders. Amazon, which has lined up 40 767s—20 from Air Transport Services Group and 20 from AAW—is the most visible example of a company using e-commerce to influence air freight’s role in supply-chain logistics. But there are many more.

When it comes to e-commerce, no matter what industry companies are in, Flynn says, “all are looking to further gain efficiencies and time-definite outcomes in their supply chains—all of which favors air [cargo]. There is a new or a growing ingredient in the calculation around future growth, and I think this cycle could well be extended and continue to grow as a result.”

Atlas Air is leasing six 747-400 freighters to meet demand.
Electric Record Holder Enters Market With Inexpensive Cargo Drone

> UNPOWERED SILENT ARROW DELIVERS 700 LB. AND COSTS LESS THAN $10,000

> DEVELOPMENT OF ELECTRIC-POWERED REUSABLE VARIANT BEGINS

Graham Warwick Washington

Chip Yates is best known for breaking speed records with an electric-powered motorcycle and aircraft. It is ironic, therefore, that the first product from his company, Yates Electrospace, should be an unmanned cargo glider.

Yates has exceeded 200 mph on electric power on the ground and in the air. He is currently rebuilding his Long-ESA electric aircraft in a bid to set more records. He is also working on a new aircraft, coded VFP—for Very Fast Plane—with which he plans to push the speed record on electric power beyond 400 mph.

Yates Electrospace also has done consulting work with several companies developing electric aircraft, including with startup Wright Electric on its plans to develop a battery-powered short-haul airliner. But the company's focus for now is on taking the Silent Arrow cargo delivery UAV into large-scale production.

Under development since 2014, the GD-700 Silent Arrow is an inexpensive, disposable glider that can deliver up to 700 lb. of cargo from a standoff distance of 23-49 mi. when air-launched from a helicopter or air-lifter at an altitude of 12,000-25,000 ft., respectively.

The Los Angeles-based company is working under a contract from the U.S. Marine Corps Warfighting Laboratory (MCWL) to produce 10 full-scale flying aircraft. The first lot of six have been built and are now undergoing wing-deployment testing leading to flight characterization.

"Silent Arrow is designed to deliver cargo at an unprecedented low price: a sub-$10,000 aircraft carrying 700 lb. of cargo. There is nothing else like it," says Yates. "I told our engineering team that if any component looks like it belongs on an aircraft, it’s way too expensive."

Acting as its own transport crate, the Silent Arrow cargo glider is designed for air launch from the CH-53K, MV-22 or C-130.

Silent Arrow is its own delivery crate. The articulated wings are attached to the lid and folded up for storage inside the box-like fuselage. To assemble the UAV, the lid is flipped over and folding panels attached to create simple aerodynamic fairings at the nose and rear.

Testing is underway at Inyokern Airport in California, where Yates Electrospace has a flight-test facility, and the nearby China Lake naval weapons test center. To comply with FAA regulations, the unmanned aircraft are being tow-tested. "We are getting the data we need without launching out of a C-130 in this phase," says Yates.

“We can do lift-to-drag measurements and control-surface gains by towing it behind a [Chevrolet] Camaro at up to 130 kt.,” he says. The tow car is equipped with a roll cage, winch and tow line and a display of video and streaming telemetry from the UAV as it flies behind the vehicle.

The program is now in its second phase, which ends in September. “MCWL is then looking to do a fast-turn Phase 3: to order two to four aircraft incorporating all we learn in Phase 2, then drop them out of an MV-22 [tiltrotor] at Yuma,” says Yates.

Yates plans to launch a funding round within the next six months to raise the investment required to scale up to full-rate production of Silent Arrow. "We are getting requests for quotations in the thousands of units and have just quoted for 2,000," he says.

Silent Arrow was originally designed under company independent R&D funding with electric propulsion, and an "electric reusable" ER-700 version is planned. “Our first product is unpowered, aimed at affordable tactical cargo delivery and disaster relief,” he says. “But we have responded to several requests for information with our ER-700 autonomous aircraft.”

Yates Electrospace recently received its eighth patent in the field, this one for a drone delivery system in which a pilot-ed mothership, possibly electric-powered, would launch cargo drones that would then fly laterally and down to their delivery points. This would be more efficient than using drones that have to take off and land from a fixed warehouse, Yates says.

Continuing the pursuit of electric aviation records, Yates plans to have the fuselage for the new VFP completed by September. The single-seat aircraft—“It looks like a bullet,” he says—will have a megawatt-class electric propulsion system with four motors from UQM Technologies driving propellers from Catto.

The custom 250-kW motors have been delivered by UQM, which also developed the 193-kW motor powering Yates’ record-setting Long-ESA and electric motorcycle. Two of the four motors have already been run on a custom test stand, driving a contra-rotating propeller arrangement with good results.

“The VFP electric aircraft is half legitimate test platform for government programs and half to enable our engineering team to stretch their legs and do something ridiculous with,” says Yates. “We were the first to 200 mph, and now we would love to be the first team to reach 300, 400, 500 mph and maybe even to break the sound barrier on electric propulsion.”

AviationWeek.com/awst
MANNED/UNMANNED TEAM IN CONTESTED AIRSPACE

SOFTWARE DISTRIBUTES PLANNING AND CONTROL TO ENABLE MISSIONS TO CONTINUE DESPITE JAMMING

Graham Warwick Washington

AFTER YEARS OF OPERATING IN PERSIMMON ENVIRONMENTS, U.S. FORCES FACE THE POSSIBILITY OF FUTURE PEER CONFLICTS WHERE COMMUNICATION AND COORDINATION WILL BE FAR FROM CERTAIN BECAUSE OF SOPHISTICATED JAMMING. THIS IS PARTICULARLY CONCERNING FOR MANNED/UNMANNED TEAMING.

In contested airspace, instead of communicating continuously, a group of aircraft collaborating to complete a mission might stay silent to avoid detection or be jammed intentionally and unable to exchange mission updates.

“The hard part will be how to get everybody the right information at the right time to execute the mission when we can’t guarantee they can talk,” says Jarrod Kallberg, BAE Systems’ technology development manager for DARPA’s Distributed Battle Management (DBM) program.

Under DBM, BAE is developing and testing two key capabilities for operations in contested environments: Software that builds a common operating picture shared between cooperating aircraft; and a distributed, adaptive mission planning and control system for manned/unmanned teams.

BAE is in the second and final phase of the DBM program, which runs to July 2019, and conducted the first live flight tests in September 2017 with DARPA and the U.S. Air Force Research Laboratory. These involved real and simulated aircraft all running two software components: the Anti-Access Real-time Mission Management System (ARMS) and Contested Network Environment Situational Understanding System (Consensus).

“Everybody starts a mission with a data load that tells them what to expect, the rules of engagement, what everyone has to do,” says Kallberg. “But things change, and we have to provide effective ways to exchange information [in a contested environment] so we don’t have to scrub the mission.”

Consensus builds the common operating picture shared by everyone, which ARMS then uses to generate appropriate tasking and routing for all the aircraft within the team. The software is able to build a representation of the network state to estimate the availability of communications between aircraft and then decides what information has the highest priority when links are restored.

“Using the network state and inferring which aircraft has what information, the system decides what needs to go where,” says Kallberg. Rather than pass all the data between all the aircraft, the software decides what messages need to be sent, their value to the mission and their priority, and then it compresses the information using different schemes for transmission over existing data links.

“The system tries to keep track of what it believes the other aircraft have, makes inferences about what they know and don’t know, and chooses what to send them,” he says. “If one aircraft has a piece of information that is important to another aircraft which it believes does not have it, then it bundles that information up and sends it as a priority.”

ARMS is designed “to distribute planning and control tasks so each player can continue to do their part if they are not able to talk; to act on what they understand of the mission status until they can recover communications, synchronize with the common operating picture and get back on plan,” says Kallberg.

The goal is to treat the unmanned aircraft within a team more like wingmen. “We want to make the coordination a little more natural. We want to give the unmanned aircraft objectives, versus programming them with specific routes and tasks,” he says.

BAE’s DBM software shares an operational picture and distributes mission planning among all manned and unmanned aircraft within a team.

“We start with an objective that is intuitive to a pilot, such as search an area. Then under the hood, there is technology to decompose that objective into parts that each vehicle needs to accomplish: which task, which route, which sensor, where to look, what to report back,” Kallberg says.

The DBM software is platform-agnostic and runs on mission computers in the aircraft involved. “All the aircraft share the common operational picture, all have the same starting point, the same software and same algorithms,” says Kallberg. The software “decomposes the objective in a consistent way,” so each aircraft knows what the others will do when communications are interrupted. Planning and control is distributed throughout the team, so it is not lost.

The September tests involved seven live flights of a Calspan Learjet acting as a surrogate unmanned aircraft and operating with simulated aircraft flown by human pilots. “The pilot of a simulated aircraft introduced a mission objective, it was broken apart by the software, and a part was assigned to the unmanned aircraft on the test range,” he says.

“We were able to show that, when communications get cut off, the mission was able to go forward within the expected parameters of the test,” Kallberg says. The aircraft was able to continue its mission “for a few minutes” without coordination, he says. “It worked pretty well. We were able to demonstrate the framework and get feedback that the approach we are taking is a good one,” he adds.

The September tests involved an air-to-air mission. The next major event, a simulation exercise planned for July, will likely involve an air-to-ground mission.
Boeing’s Next-Gen Super Hornet Will Be (Sort Of) Stealthy

> BLOCK III SUPER HORNET WILL GET ENHANCED STEALTH COATING

> NEW AIRCRAFT WILL BEGIN ROLLING OFF THE PRODUCTION LINE IN 2020

Lara Seligman Washington

President Donald Trump was ridiculed on Twitter after pronouncing during a visit to Boeing’s St. Louis facility that the company’s new F/A-18 Super Hornet will be equipped with the “latest and the greatest stealth, and a lot of things on that plane that people don’t even know about.”

But it turns out Trump was on to something. Boeing is about to kick off an exhaustive effort to transition the U.S. Navy’s carrier air wing to the “Block III” Super Hornet, a next-generation version of the strike fighter complete with new sensors, extended range, a more powerful computer and, yes, enhanced stealth coating.

These changes will allow the Super Hornet to fly alongside the Lockheed Martin F-35C carrier variant as the backbone of the Navy’s carrier air wing into the 2040s and beyond, says Dan Gillian, Boeing F/A-18 and EA-18 program manager.

Trump previewed the new and improved fighter during a March 14 visit to the St. Louis facility, which has been building F/A-18s, first the A-D Hornet and later the E/F Super Hornet, since 1978.

Gillian confirms that an improved low-observable (LO) coating will be one of five key characteristics of the Block III Super Hornet. The fighter is already “a very stealth airplane today”—he says, declining to elaborate—but there are new coatings engineers can apply on different surfaces of the aircraft to make it even more survivable, he says.

The F/A-18 was not designed specifically to be stealthy and lacks many of the fundamental stealth characteristics baked into Lockheed Martin’s F-35 and F-22 airframes. But there are other ways to enhance stealth, such as adding LO coating and radar-absorbent material improvements in certain locations on the airframe. A few simple changes “can buy us just a little bit of performance that’s low-cost and easy to go do,” Gillian says.

The souped-up aircraft the Navy has agreed to buy looks very different from Boeing’s original 2013 proposal for an “Advanced Super Hornet,” which focused on stealth. Boeing engineers found they needed to make design compromises to significantly reduce the aircraft’s radar cross section—for instance, by restricting payload, Gillian told Aviation Week in 2017 (AW&ST Feb. 20-March 5, 2017, p. 17).

This drove Boeing to drop certain features of the 2013 proposal, such as an enclosed weapons pod and internal infrared search-and-track (IRST) sensor, from the newest package.

The Navy will begin procuring the Block III Super Hornet in fiscal 2019 with a 24-aircraft buy, the first of which will come off the production line in 2020. Over the next five years, the Navy proposes buying 110 additional Super Hornets, including a three-year multiyear procurement, which is a significant boost from last year’s budget request. Meanwhile, the Navy will accelerate divestiture of the legacy Hornets, with the last active component squadron transitioning to the Super Hornet in 2018. The service plans to send the last F/A-18 A-D to the boneyard no later than the fiscal 2030 timeframe.

Boeing aims to deliver one Block III squadron per carrier air wing by 2024, two squadrons of Block IIIIs per carrier air wing by 2027, Gillian says.

Boeing will achieve this goal both by building new Super Hornets and by upgrading the older Block II aircraft to the Block III configuration in depot. Boeing intends to start service life modification (SLM) work on the Block II aircraft in St. Louis in April.

The SLM’s initial focus will be extending airframe life to 9,000 hr. from 6,000, Gillian says. Later, SLM will incorporate efforts to make the aircraft more “maintainable”—for example, grooming wire, fixing corrosion and replacing ducts. Boeing is also working with the Navy on a “reset” of the Super Hornet’s environmental control system following a spike in hypoxia-like physiological episodes in the fleet.

SLM will expand to include the full Block II-to-Block III conversion in the early 2020s, Gillian says. This means LO improvements; an advanced cockpit system with a large-area display for improved user interface, a more powerful computer called the distributed targeting processor network, a bigger data pipe for passing information called Tactical Targeting Network Technology and conformal fuel tanks (CFT).

The CFTs will extend the range of the aircraft by 100-120 nm. They are designed to replace the extra fuel tanks the Super Hornet currently slings under its wings, reducing weight and drag and enabling additional payload.

Boeing in February received a potential $219.6 million order to design, develop, test and integrate the CFTs. This work will manifest both in the new-build aircraft that will roll off the line in 2020 and the aircraft being converted from Block II to Block III, Gillian says.

Finally, the Block III upgrade also will include a long-range IRST sensor that will allow the Super Hornet to detect and track advanced threats from a distance.

Gillian expects SLM will take 18 months per aircraft at first, but he wants to drive that time down to 12 months. ☛
The KC-390 has enjoyed a fairly smooth upbringing. From the initial studies unveiled in 2007, Latin America’s largest-ever aircraft has progressed rapidly from artist’s impression to reality, rolling out in 2014. Only the Brazilian economy has held the aircraft back—a delay to service entry of 18 months—after the government slowed funding for it, in part protecting it from potential cuts that have befallen numerous other Brazilian defense programs.

There was also a setback last October, when an inflight incident during stall tests led to the grounding of one of the flight-test aircraft.

But developing the airlifter has been a strategic imperative for Brazil—in the coming months.

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But developing the airlifter has been a strategic imperative for Brazil—in the coming months.

The KC-390 faces plenty of competition on the international market, from the Lockheed C-130J Hercules, Antonov An-178 and Airbus A400M, the Embraer airlifter already appears to be nearing deals.

Portugal’s government is planning to order five aircraft and has options for a sixth to replace its H-model C-130s. And then there is Skytech, the Portugal-based company that envisions dry-leasing KC-390s to military customers to cut the cost of expensive procurement programs. (see page 47).

The KC-390 is also competing in New Zealand and is known to have attracted significant interest from a number of Middle Eastern countries, which it visited during a world tour in 2016 and again in 2017.

The aircraft’s appearance at the FIDAE air show in April should be an opportunity for some of Brazil’s neighbors to finally see the aircraft up close. It is due to perform in the flying display says Paulo Gastao, KC-390 program vice president. Several Latin American countries, including host Chile, have signed letters of intent to purchase the aircraft but have yet to sign contracts.

The Brazilian government believes as many as 300 KC-390s could be exported over the next 20 years, bringing $20 billion into the national economy. The government has streamlined methods of international financing to help make purchases more attractive.

But the KC-390’s export success will likely hang on the success of initial operations by the Brazilian Air Force. It is expected to put its first two aircraft into service this summer—perhaps as early as June, air force officials announced earlier in March.

“For a new aircraft like ours, it is normal that potential customers like to wait for the domestic air force to start to operate the aircraft,” says Gastao. “They can be sure that we have really achieved the milestones, and that the customer is happy. . . . We do expect more interest from the market once we deliver the first aircraft to the Brazilian Air Force.”

The country is buying 28 KC-390s to replace its aging fleet of C-130 and KC-130 Hercules, which, despite upgrades, are proving costly to maintain and suffer from low dispatch rates and availability, air force officials tell Aviation Week.

The declaration of an initial operating capability last December allows the air force to begin cargo transport and passenger flights with the KC-390 as well as undertake some limited special operations. The KC-390’s cargo compartment is 18.54 m long, 3.45 m wide and 2.95 m high (61 X 11 X 10 ft.), and can accommodate large equipment, artillery pieces and partly dismantled helicopters. A key attribute for Brazil is its ability to carry the Guarani armored personnel carrier. Alternatively, it can carry 80 fully equipped soldiers or 64 paratroopers.

With a maximum takeoff weight of 87 metric tons, the IAE V2500-turbofan-powered airlifter is able to carry distributed loads of up to 23 tons or a concentrated load, depending on the center of gravity, of 26 tons.
The aircraft’s abilities will be widened significantly with the sign-off of a full operational capability (FOC) expected later this year, paving the way for the aircraft to perform aerial refueling, airdropping of both equipment and troops, as well as firefighting and landing at austere runways. Testing for all these tasks is scheduled to be largely completed in time for the FOC.

Meanwhile, the first production aircraft will be used to support the ANAC civil certification trials, negating the need for Embraer to remove flight-test instrumentation from one of the prototypes.

Of these trials, it is perhaps the aerial refueling that is the most significant. Brazilian Air Force Northrop F-5 Tiger fighters performed dry hookups to the wing-mounted hose-and-drogue refueling systems early in 2017, but wet tests involving the passing of fuel are due to begin in the coming weeks. Other receivers for the KC-390 will include the A-1 AMX light attack aircraft and the KC-390 itself. In the future, the KC-390 will also refuel Brazil’s new Saab JAS-39/F-39 Gripen fighter jets being developed in conjunction with Sweden, due to be delivered starting in 2021.

Another capability likely to attract attention will be the KC-390’s ability to refuel helicopters. While yet to be tested in actuality, simulations have shown the low-speed flight profiles for helicopter refueling are well within the KC-390’s flight envelope. Currently, the KC-130 is the only operational airlifter able to perform the task, but Airbus is developing the capability for both its C295 and A400M airlifters. Brazil also wants to be able to refuel its H-36 Caracal helicopters.

“The only physical difference when refueling helicopters will be the basket; you have a bigger basket for low-speed operations,” says Gastao. “But the refueling system can be used to refuel both fast jets and helicopters.”

The aircraft’s firefighting capability will be one of the last things to be tested. The KC-390 will use the Modular Airborne FireFighting System (MAFFS) II system that, as on the C-130, uses a series of tanks fitted into cargo holds containing water or fire retardant. Crews will discharge the retardant over the fire through a pipe fitted through the port-side para-troop door. This allows the aircraft to remain pressurized during the drop. Previous versions of MAFFS used on C-130s discharged off the rear ramp, reducing performance.

The Brazilian Air Force also foresees a need to use the KC-390 for search-and-rescue missions. Brazil is responsible for rescue across 22 million km² (8.4 million mi²) of the Atlantic, as well as the nation’s vast interior. The prime sensor for the mission will be the KC-390’s Leonardo Gabbiano T20 radar.

The air force is also planning to equip the KC-390 with the Litening laser designator pod, adding to the aircraft’s intelligence, surveillance and reconnaissance capability. This will be fitted onto a pylon on the port side near the nose.

Other tasks envisaged for the KC-390 include supporting Brazil’s Antarctic research programs.

The air force is paving the way for the KC-390’s service entry. It has been closely involved in the flight testing of the aircraft, but since 2016, a special unit called Kilo Group has been compiling operational documentation and writing the tactics and doctrine for the aircraft. In March, personnel from Kilo Group moved to Anapolis air base near Brasilia to prepare for arrival of the first aircraft. Anapolis will be the first of two bases to receive the aircraft, as well as the first to receive the F-39 Gripen. A second unit will later be stood up at Rio de Janeiro’s Galeao International Airport, the current main operating base for the air force’s Hercules fleet.

Brazil will receive two aircraft each in 2018 and 2019 and then three per year until 2023, when 10 aircraft will be delivered during 2024 and 2025, according to the Brazilian Air Force. The build rate takes into consideration slots for export orders, says Gastao.

“[The air force is] excited this aircraft is a game changer, a new world for them, a fully multirole-capable aircraft,” he says.

Embraer will test more of the tactical capabilities of the KC-390 in 2018, with the aim of achieving full operating capability by year-end.
Embraer’s KC-390 military airlifter achieved initial operational capability, including provisional type certification, at the end of 2017. Development formally began in 2009, building on Embraer’s experience developing the E-Jet airliners, and the first production aircraft are scheduled to enter service with the Brazilian Air Force this year.

**Anatomy of the Embraer KC-390**

**1 | Flight Deck**
- Rockwell Collins Pro Line Fusion Integrated avionics
- Full-authority digital flight controls with sidesticks
- Dual headup displays with enhanced vision system
- Optional third crew station for aerial refueling and search-and-rescue missions

**2 | Engines**
- International Aero Engines V2500-E5 Turbofans
- 31,300-lb. takeoff thrust

**3 | Refueling**
- Fixed- and rotary-wing aircraft can be refueled at speeds from 120-300 kt.
- Two underwing Cobham 912E hose-and-drogue pods
- Pods can transfer up to 400 gal./min. of fuel
- Removable auxiliary tanks in the fuselage increase fuel offload or range

**4 | Cargo**
- Maximum capacity 26,000 kg (57,300 lb.):
  - Seven 436L pallets
  - 80 troops or 66 paratroops; 74 stretchers and eight attendants
  - One Stryker armored vehicle or UH-60 Blackhawk helicopter
  - Can airdrop up to 41,900 lb.

**5 | Landing Gear**
- Four-wheel bogie allows operation from semi-prepared and unpaved airfields
- Carbon brakes with brake-by-wire and steer-by-wire control systems
- Hydraulic struts deploy to stabilize the aircraft during loading and unloading

**6 | Radar**
- Leonardo Gabbiano T20 tactical radar
- Spotlight synthetic aperture radar
- Weather, navigation, air-to-air and air-to-surface surveillance modes
- Removable Rafale Litening II electro-optical/infrared target pod mounted under the forward fuselage

**Specifications**
- Wingspan: 115 ft.
- Length: 115.4 ft.
- Height: 38.8 ft.
- Cargo Hold: Volume: 5,970 ft.³
- Load Envelope: 11.3 ft. wide x 9.7 ft. high
- Length (incl. ramp): 60.7 ft.
- Max. Payload: 26 metric tons
- Max. Cruise: Mach 0.80
- Ceiling: 36,000 ft.
- Range: 1,520 nm (23 metric tons)
- Takeoff Distance: 5,000 ft. (23 metric tons)
  - 3,820 ft. (16 metric tons)
- Landing Distance: 3,280 ft. (16 metric tons)

**Source:** Embraer
International Militaries Are Becoming Targets for Lessors

Portugal's Skytech Signs Letter of Intent for Six Embraer KC-390s

The order could test the market in military-aircraft leasing

Tony Osborne London

A Portuguese company's plans to purchase Embraer KC-390 airlifters has shone a light on the leasing world's new target: providing aircraft to the world's militaries.

Lisbon-based Skytech signed a letter of intent to purchase six KC-390s at the Singapore Airshow in February, in a move the company says will help to address international shortfalls in tactical aerial refueling and airlift.

Skytech aims to offer medium- and long-term leases for the KC-390s, and potentially other platforms and services, to government customers. Unlike in the commercial world, in which vast swathes of the airliner fleet are leased, most military aircraft are wholly owned by their respective governments. Leasing such aircraft is still in its infancy.

There are some exceptions, however. In the UK, for example, the Royal Air Force's Airbus A330 Multi-RoleTanker-Transports (MRTT) are operated by a private company—AirTanker—through a private finance initiative. To generate additional income, some of the AirTanker aircraft are leased to airlines in a commercial configuration. Several fleets of British training aircraft are also privately owned, and France has adopted a similar model.

Irish lessor Stellwagen became the first to test the potential market at last year's Paris Air Show, when it announced it was purchasing 12 Airbus C295 twin-turboprop transports, which it hopes to lease to specialist operators. The C295 is primarily a military aircraft with limited commercial certification. Four of the 12 have been placed with Canadian and Kenyan humanitarian operator DAC Aviation International.

"The potential is huge," says Mal Sandford, a Skytech senior vice president. "Everyone operating a [Lockheed Martin] C-130 is a potential customer [for the KC-390], particularly the earlier E and H models," he says.

Air forces, particularly those in Europe, are still facing significant shortfalls in air transport and air-to-air refueling capability, he says. Defense budgets may be increasing across the continent, but they are focused on front-line capabilities such as combat aircraft. Europe has also been roundly criticized for its lack of aerial refueling capability. Operations over Libya in 2011, for example, had to be backed up by U.S. tanker assets. This prompted the formation of the Dutch-led Multinational Multi-Role Tanker Transport Fleet, equipped with the A330 MRTT.

By leasing an aircraft, governments could get around the often eye-watering initial acquisition costs associated with purchasing it. Under Skytech's model, the aircraft would be offered on a medium- or long-term dry lease, and the aircraft would then be operated within the customer's national military airworthiness standards and with their own trained crews, but it would remain the company's property. A service provision arrangement would be entertained if a government required it, however.

"We are already talking with several air forces, . . . effectively offering governments an easier approach to procurement," says Sandford. Skytech was formed in 2016 as a joint venture between Australia's Adagold Aviation and Portuguese charter carrier Hi Fly, which operates a number of Airbus airliners. Adagold had been using Hi Fly aircraft to support an Australian defense force contract to fly personnel to the Middle East. Hi Fly also provides transport aircraft for the Belgian Air Component and has flown South Atlantic air bridge flights to the Falkland Islands for the UK Defense Ministry.

The KC-390 deal is the company's first big move into a market that Sandford believes could become highly contested in the coming years, despite what he calls its "high barriers of entry."

Deliveries of Skytech's KC-390s could begin as early as 2020. With six aircraft, Sandford envisages supporting two or three customers, but market interest could drive more orders. He says Embraer is enthusiastic about the business plan, and the companies have agreed on a potential strategic collaboration to jointly explore new training and services business opportunities.

Skytech's plan is to take delivery of the aircraft wired for multimission capability to broaden its market appeal. In addition to tactical transport and aerial refueling, the KC-390 could perform maritime patrol, search-and-rescue and even firefighting missions.

"The KC-390 is a fantastic aircraft," Sandford says. "It is a reliable aircraft, a commercial aircraft for military activities."
The Air Force is laying the groundwork to procure the new type as soon as 2019, Lt. Gen. Arnold Bunch, Jr., the military deputy in the service’s acquisition, tells Aviation Week. Bunch has directed a team to develop an acquisition strategy for nondevelopmental light attack aircraft, complete with a plan for manning, sustaining and basing the new platform. He has already held one “extended” meeting with the team and is planning a second for this month.

If Bunch is satisfied with the strategy the team devises, he says he may ask the chief of staff and secretary of the Air Force to approve a reprogramming request to buy the aircraft in fiscal 2019—at least a full year ahead of schedule. Currently, the Air Force has budgeted procurement funding starting in fiscal 2020 to buy the new fleet, Bunch says.

Senior service leaders believe there is growing support among the top ranks of the Pentagon and Congress to accelerate the light attack buy because it aligns “directly” with Defense Secretary James Mattis’ National Defense Strategy. The new policy, unveiled in February, calls on the U.S. armed services to find more cost-effective ways to conduct counterterrorism operations in the Middle East while pivoting to “great-power” conflict.

“This is directly in response to the National Defense Strategy that told us to fight violent extremism at lower levels of effort and rely more on allies and partners,” Air Force Secretary Heather Wilson said during a recent event in Washington. “We should not be using an F-22 to destroy a narcotics factory in Afghanistan.”

Within the service, support for a light attack aircraft is the strongest it has been since the concept was born in 2007, says Rebecca Grant, president of consulting group IRIS Independent Research. “As they look at the innovation they need to do, the logic of a lower-cost light attack platform stands out,” she says. And as the Air Force looks to growing threats from Russia and China, “there is even more of a desire to come up with a good, affordable light attack solution so that the Air Force can focus on the urgent high-end fight,” she notes.

Other benefits of a light attack fleet are pilot seasoning and opportunities for experimentation, two important areas of focus for the Air Force right now, Grant says.

For the new aircraft, the Air Force most likely will go with either Sier-
ra Nevada/Embraer’s A-29 Super Tucano, which the Afghan Air Force is already using to fight terrorists, or Textron’s AT-6 Wolverine. The service plans to conduct a second experiment with the two aircraft this summer, this time focused on logistics and maintenance support requirements, outstanding weapons and sensor issues, training syllabus validity, networking and future interoperability with partner forces, and other areas not addressed in the first event.

Depending on the acquisition strategy, however, other manufacturers could compete for the work. Textron’s Scorpion and L3/Air Tractor’s AT-802L Longsword participated in the first experiment but were not selected to move on to the second. They could compete again, as could the newly announced “Bronco II,” the U.S. version of the Mwari multmission aircraft from South Africa’s Paramount Group.

Analysts agree that buying sooner rather than later is essential, both to maximize affordability and to stay ahead of the threat. The rapid proliferation of advanced anti-aircraft weapons means that nonstealthy, slower-moving aircraft are becoming more vulnerable by the day.

“If there is resistance to light attack, the concern is that by the time the planes are fielded, there won’t be any enemies that don’t have at least shoulder-fired weapons,” says Loren Thompson, chief operating officer of the Lexington Institute.

And if speed is key, the most attractive acquisition strategy for the Air Force likely will involve new contracting authorities designed for rapid acquisition, called Other Transaction Authorities (OTA). The advantage of these, which the Air Force used for the first light attack experiment, is that they theoretically allow the service to transition into a follow-on production contract without further competition.

But OTA are a relatively new, untested practice, and using them for a light attack program could invite bid protests if the Air Force’s case is not airtight. That is one reason the Air Force might opt for a more traditional contracting approach, but that would likely add years to the time line for fielding.

The Air Force is not limiting its options, Bunch says. “The challenge I’ve given [the team] is: I’m not going to specify how you do this. I want you to tell me the best option for how to go do it, given that . . . I want this as quickly as [possible],” he says. “The sky is the limit.”

For now, Wilson says the Air Force has included a $2.5 billion “wedge” in the five-year budget plan as a placeholder for the light attack buy.

The number of aircraft the Air Force eventually purchases will depend not just on the concept of operations but also the interest of U.S. allies, according to Wilson. The light attack program “has to be coalition at the core,” with an emphasis on common training and equipment as well as “a network that shares,” she notes.

The office of the deputy undersecretary for international affairs has already built an “engagement plan” to gauge international interest in the program, Bunch says. But another important aspect is developing a variant of the aircraft that can be sold abroad, which involves Congress and the U.S. State Department, he says.

“What I don’t want to do is go buy airplanes and have them sitting on the ramp, so we’ve got to sync everything up,” Bunch stresses. “I can’t just flip a switch and go buy the airplanes. We’ve really got to understand the concept of operations.”

Textron’s AT-6 turboprop was one of four aircraft that participated in the U.S. Air Force’s first light attack experiment in 2017 at Holloman AFB, New Mexico.

### Sierra Nevada Corp./Embraer A-29

**Dimensions [ft. (m)]**
- Wingspan: 36.6 (11.2)
- Length: 37.1 (11.3)
- Height: 13.02 (4)
- Engine: 1,600 shp/1,177 kW

**Weights [lb. (kg)]**
- Max. Takeoff: 11,904 (5,400)
- Internal Fuel: 1,121 (509)
- External Fuel: up to 1,606 (729)

*Source: Sierra Nevada Corp. and Embraer*

### Textron AT-6

**Dimensions [ft. (m)]**
- Wingspan: 34.25 (10.4)
- Length: 33.33 (10.16)
- Height: 10.66 (3.25)
- Engine: 1,600 shp/1,177 kW

**Weights [lb. (kg)]**
- Max. Takeoff: 10,000 (4,536)
- Internal Fuel: 1,200 (544)
- Max. Usable Fuel With 4 Tanks: 2,908 (1,319)

*Source: Textron Aviation*
Taiwan Considers F-35 Buy and Upgrades F-CK-1s

Taiwan is moving to strengthen its fighter force, raising with Washington the possibility of acquiring Lockheed Martin F-35 Lightnings while also scheduling modernization for more Aerospace Industrial Development Corp. (AIDC) F-CK-1 fighters. Further, the island is considering purchasing Boeing KC-135 tankers, apparently for a long-range strike capability, to hold Chinese targets at risk.

In another program, upgrades of Taiwanese F-16s are turning out to be harder than expected, says an industry source; that work is probably running behind schedule.

Taiwan is evidently interested in the F-35B version of the Lockheed Martin fighter, since National Defense Minister Yen Teh-fa referred to the Lightning’s vertical-take-off-and-landing capability, which only the F-35B version has.

As asked in parliament whether the air force wanted to buy F-35s and KC-135s, Yen said: “The F-35 has the ability to take off and land vertically. It suits the requirements of the air force command. Indeed this matter has been raised with the U.S. . . . As for KC-135 airborne tankers, this is still being assessed.”

Operationally, F-35Bs take off with a short ground run, not vertically. Still, they would be especially useful for Taiwan because China can rain air-to-surface, cruise and short-range ballistic missiles on the island’s runways. The U.S. think tank Rand calculates that no more than 155 Chinese ballistic missiles would be needed to cut all Taiwan’s runways and taxiways into segments shorter than the 1,500 m (5,000 ft.) needed for fighter operations. Clearly, China would have to expend many more missiles if Taiwan had fighters that, thanks to vertical-lift gear, could operate using only a few hundred meters of concrete.

But fighters are neither cheap nor the only way to deny control of Taiwanese airspace to China: Additional surface-to-air missile systems are an alternative. But surface-to-air systems, unlike F-35s, would not bring a greater ability to strike Chinese surface targets, which Taiwan is evidently interested in.

There are no tankers in Taiwan’s fleet. Yen did not discuss the possible mission of KC-135s, but presumably it would be supporting penetrating attacks on China. That task would be much less challenging if performed with F-35s rather than F-CK-1s, F-16s and Mirage 2000s, the aircraft that form almost all of the current Taiwanese fighter force. KC-135s would be bought secondhand from the U.S. Air Force, which is replacing the type.

The head of the parliament’s foreign and national defense committee, Wang Ting-ru, said last year that Taiwan hoped to acquire F-35s. But since supplying 150 F-16A/B Block 20 fighters in the 1990s, the U.S. has been unwilling even to sell more aircraft of that type to the Republic of China Air Force, as the Taiwanese air arm is formally called.

The U.S. is supporting modernization of the F-16A/Bs, however; 139 are left, according to Aviation Week Intelligence Network data. Lockheed Martin is providing kits with which AIDC is upgrading them to the F-16V standard. That includes installing the Northrop Grumman APG-83 radar.

It turns out that the F-16s need more work than the government banked on when it agreed with the U.S. in 2012 to go ahead with the program (at that time for 145 units). When disassembled for the modernization, the F-16s, now up to 21 years old, have been found to be in worse condition than expected, says the industry source, who is close to the program. Their faults are being fixed, but doing so considerably increases the required amount of skilled labor.

This has almost certainly forced a reorganization of the schedule, perhaps including a delay in completion, though the source would not comment on that militarily sensitive point.

AIDC said in 2016 the work would begin in 2017 and end in 2022; the steady delivery rate would be 24 aircraft a year, implying that production had to ramp up almost instantaneous-ly. If the scheduling was that tight to begin with, it is unlikely to have survived the appearance of unexpected tasks. But deliveries could still finish on time if a higher rate is adopted after resources are mustered to do the extra work.

The air force already has 49 of its F-CK-1s modernized to the F-CK-1C/D standard. That leaves 95 in the original F-CK-1A/B condition. The service says all F-CK-1A/Bs in its third wing will go through the upgrade; it is unclear how many aircraft that involves.

Avionics, including the radar, are improved in the upgraded version. The F-CK-1C/D can also carry the Wan Chien, a standoff missile like the Raytheon AGM-154.

The air force hints that this batch of F-CK-1s will be upgraded to a higher standard: It says the work will help lay a foundation for a new indigenous fighter program. The program could not do so unless some development work were involved.

A new fighter program has been proposed but not funded. Officials appear to have penciled in the mid-2020s for the beginning of full-scale development (AW&ST Sept. 4-17, 2017, p. 33).
A follow-on order for the Eurofighter Typhoon from Saudi Arabia could extend production of the fighter well into the mid-2020s and give the UK more breathing room as it considers industrial options for a future combat aircraft.

Britain and Saudi Arabia have begun negotiating a potential order for 48 Typhoons. The Royal Saudi Air Force (RSAF) already operates 72 of the jets. In December, the UK secured a 24-strong order for the aircraft from Qatar, and it is making sales pushes in Belgium and Finland. Germany is considering Typhoons to replace its Panavia Tornados by 2030, although American types including the Lockheed Martin F-35 are also on the table.

A follow-on order from Saudi Arabia was long expected in part because it has been operating the Typhoons in its cam-
DEFENSE

Could F-16s in Battle Talk via Commercial Internet?

> U.S. MILITARY HEEDS SMALLSAT REVOLUTION

> AFRL TO EXPERIMENT WITH AIRCRAFT ANTENNAS

Lara Seligman Washington

What if warfighters could install an antenna on their F-16s, much like homeowners do on their roofs, and establish a commercial internet connection, allowing them to send critical battlefield information rapidly to the rest of the force? The U.S. Air Force Research Laboratory (AFRL) is about to find out.

The Air Force is finally catching on to a revolution in the commercial small satellite world. Feb. 22 SpaceX launched a Falcon 9 rocket carrying two experimental satellites from Vandenberg AFB, California, to test out technologies for a megaconstellation of small satellites that would provide high-speed internet and other communications services directly to consumers, businesses and other subscribers. And SpaceX is just one of many commercial firms that are starting to experiment with such a service. OneWeb is scheduled to begin launching its 720-satellite broadband constellation later this year.

This revolution could have wide-ranging implications for an increasingly connected battlefield if the U.S. military can leverage the emerging capability. A commercial space-based internet comprising dozens if not hundreds of small satellites could potentially provide much wider bandwidth for information-sharing between platforms. And as potential adversaries develop increasingly sophisticated anti-satellite capabilities, it is also a more resilient solution than the current mix of large, dedicated military spacecraft.

“I think we’ve heard pretty clearly from all of the senior leadership that information is the next stage of warfare. Whoever dominates the information flow and the ability to make decisions quickly is likely to win future wars,” says Brian Beal, program manager of a new AFRL effort to experiment with leveraging the commercial space internet for military purposes.

Building a modern communications network to support the warfighter all over the world would require at least a few hundred or as many as a thousand satellites orbiting the Earth, Beal says, which quickly becomes unaffordable if the Defense Department uses traditional methods.

Instead of the traditional approach—developing purely Pentagon-owned, purpose-built spacecraft to do the job independently—what if the warfighter could simply lease that commercial bandwidth?

To explore what is possible, AFRL plans to contract with at least one commercial internet provider for a set of antennas that can be mounted onto Air Force test aircraft, Beal says. The team will then fly the aircraft, a Beechcraft C-12J based at Holloman AFB, New Mexico, directly under the associated satellites and establish a communications path.

AFRL plans to measure the quality of the connection—data latency, throughput and error rate, among other factors—and experiment with sending encrypted messages across the commercial network, Beal says.

AFRL wants to harness a revolution in the commercial small satellite world to provide a battlefield internet connection.

A key piece of the puzzle will be figuring out how to send critical threat information securely over a commercial network. To help ensure cyberresiliency, AFRL will likely contract with companies that have a good history of providing cybersecurity to current terrestrial networks, says Greg Spanjers, chief scientist at the Air Force’s Strategic Development Planning Experimentation office.

This capability could one day be used to pass information securely between stealth fighters, although that is beyond the scope of this particular program, Spanjers says. Using space-based commercial internet to connect advanced stealth platforms is much harder technically because the solution would likely involve modifying the antennas and radios currently on those aircraft, he says.

AFRL is moving full speed ahead with the experiment. The team conducted an industry day in August, attended by all of the major players, Spanjers says. AFRL put out a solicitation in October, and at the end of February issued the first contract offers to industry. The service is in the final stages of negotiating the contracts and will soon release the names of the chosen contractors.

In order to contract with nontraditional as well as traditional companies, the Air Force intends to use new experimentation mechanisms such as Other Transaction Authorities, similar to the contracting strategy the service used to conduct a light attack aircraft experiment at Holloman last summer, Spanjers says. The goal is to bolster the emerging commercial space internet industry, rather than be an “anchor tenant.” Ideally, the contractors chosen will have “a strong business case that is not solely dependent on the government,” Spanjers says.

“The key tenet of this entire approach is that we want to be a customer of this global utility that’s standing up. We don’t want to be—and can’t afford to be—the sole tenant of constellations of this size,” Beal says.

Spanjers expects the capability could be fielded in the early 2020s, but the time line depends on how quickly the commercial space internet itself evolves. Cost is also uncertain, but Spanjers believes the Air Force could save a lot of money compared to traditional ways of doing business.

In the end, AFRL hopes the experiment will help the Air Force build a broad battlefield network enabling warfighters in the air and on the ground to pass information seamlessly.

“They tend to be stovepiped systems, so the more stuff that we can get connected into this communications backbone architecture, the more we can accommodate the data sharing,” Beal says. “This is a change, a very large change in the amount of information that [the Defense Department] and any user of these constellations can move globally. So that’s really at the heart of it: moving information.”

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FCC Probing Unauthorized Launch of Nanosats

SWARM TECHNOLOGIES PROTOTYPES FLEW ON INDIAN ROCKET

LAUNCH SERVICE BROKER TO STEP UP OVERSIGHT

Irene Klotz Washington

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ast December, the FCC denied a request by Silicon Valley startup Swarm Technologies to operate four prototype satellites for a planned machine-to-machine internet communications system because the birds were too small to be readily tracked by the U.S. Space Surveillance Network.

Nevertheless, a month later, SpaceBEE I-4 rode into orbit as secondary payloads aboard an Indian PSLV rocket, says Curt Blake, president of Seattle-based Spacelight, which arranged for the ride. “We launched the four small satellites,” says Blake. “The FCC is looking into the matter. It’s for them to deal with.”

While it is incumbent upon a satellite operator to obtain FCC authorization to fly, Blake says that as a launch-services broker, his company will now voluntarily step up oversight to ensure future customers are compliant. “I don’t want to really be an auditor. That’s not what we’re designed for, but if that’s what it takes,” he said on the sidelines of the Satellite 2018 conference in Washington March 12-15.

“We do our due diligence, but I’ve always assumed people wouldn’t launch something if they couldn’t [operate it] because satellites are expensive, launch is expensive, and it’s not like you’re going to continue to be able to use this if it turns out you’re not licensed. I thought that would be sort of a self-regulating function. . . . It just seems logical to me,” said Blake, adding that the company is changing its processes to ensure future customers are compliant.

He declined to discuss how the Swarm satellites managed to be launched without proper FCC authorization. Swarm did not respond to a request for comment.

The FCC on Dec. 12 informed Swarm co-founder and CEO Sara Spangelo that the company’s application for experimental authorization had been denied. “The application proposed to deploy and operate four spacecraft that are smaller than 10 cm [4 in.] in one of their three dimensions. These spacecraft are therefore below the size threshold at which detection by the Space Surveillance Network (SSN) can be considered routine,” wrote Anthony Serafini, chief of the FCC’s Experimental Licensing Branch.

“The proposed addition of Kᵤ-band radar reflectors to the satellite would overcome this issue with respect to only . . . the small portion of the SSN that utilizes Kᵤ-band frequencies. Use of GPS data from the satellite will be available only if and while the satellites are functional,” he added.

“In the absence of tracking at the same level as available for objects of 10 X 10 X 10 cm, and in the event of a conjunction with an operational spacecraft, the ability of operational spacecraft to reliably assess the need and plan effective collision avoidance maneuvers will be reduced or eliminated. Accordingly, we cannot conclude that a grant of this application is in the public interest,” the letter said.

Nevertheless, a month later on Jan. 12, an Indian Polar Satellite Launch Vehicle blasted off from Sriharikota in Andhra Pradesh with India’s Cartosat-2 Earth-observation satellite and 30 secondary payloads, including the four SpaceBEE prototypes.

On March 7, Spangelo and Craig Scheffler, listed as the company’s spectrum management consultant on the FCC application, received a second letter from Serafini informing them that the agency was rescinding authorization of a second request to operate another four cubesat-size satellites, pending further review.

Swarm had been planning to fly four more SpaceBEEs on a Rocket Lab Electron booster.

“The International Bureau requested that the grant be set aside in order to permit assessment of the impact of the applicant’s apparent unauthorized launch and operation of four satellites, and related statements and representations, on its qualifications to be a commission licensee,” the letter said.

An Indian Polar Satellite Launch Vehicle lifted off on Jan. 12 with an Earth-imaging satellite and 30 secondary payloads—including four unauthorized nanosats for a U.S. startup.

In an email to Aviation Week, Antrix Corp., the commercial arm of the Indian Space Research Organization, said its launch service agreements stipulate “the customer shall be responsible for obtaining all permits, authorizations and notices of non-opposition from all national and international authorities who have jurisdiction over the customer spacecraft mission.

“Antrix has requested its U.S. clients cross-check with FCC for compliance of regulations before exporting future satellites to India,” the statement said.

Swarm Technologies’ unauthorized launch was first reported by IEEE Spectrum on March 9.

—With Jay Menon in New Delhi
China’s Rapid-Response Rocket Is Prominent in 2018 Program

Bradley Perrett, Beijing

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hina will conduct five missions with Long March 11 solid-propellant launchers this year, confirming that the fast-response rocket is finally regarded as mature. One of the launches will be from a ship, says Li Hong, the head of China’s main space-launcher builder, Calt, indicating a previously disclosed plan.

In an extensive preview of the 2018 launch program, Li makes no mention of a flight by the new Long March 7. And the Long March 5B, designed mainly to put a space station into orbit, is now scheduled to fly not this year, as previously planned, but in 2019. That is consistent with what looks like a general one-year slippage in the Long March 5 program arising from a launch failure this year. Development of Long March 8, intended to be a low-cost launcher, also appears to have slipped by about a year.

The missions of the Long March 11 will be among 36 launches scheduled this year for various types of rockets that are all called Long March, all made by parts of state space industry group Casc, though they are not all interrelated. Most missions will be done with Long March 3As and Long March 2Cs, members of China’s original series of hydrazine-fueled space launchers. Lofting Compass navigation satellites is a major task this year. Another is to send the Chang’e 4 probe to the far side of the Moon.

The first of the five Long March 11 missions was conducted on Jan. 19. Rockets of this type can place a 350-kg (770-lb.) payload in a 700-km (430-mi.) sun-synchronous orbit, Casc President Wu Yansheng said in June 2017. Calt is part of Casc.

Because it uses solid propellant, the Long March 11 can be scored for long periods and prepared for a mission very quickly. It can be fired after only hours of notice, rather than months, state media have reported. This is militarily valuable. Under the concept that the U.S. calls operationally responsive space, small satellites are hurled into orbit tactically, as and when forces need them—for example, for reconnaissance.

But the Long March 11’s entry into regular service has been slow. It first flew in September 2015, again in November 2016 and not at all in 2017, indicating that to some extent it remained developmental. The plan to use it five times this year means officials now regard it as reliable.

The sea-launch mission will use a converted freighter ship. “The critical technology has been mastered and the detail scheme for the launch has been worked out,” the Xinhua state news agency says, quoting Li. Sea launches have the advantage that a floating platform can be placed on or near the equator, giving a low-inclination satellite the greatest possible velocity boost from the Earth’s rotation. Sea launches can also avoid either the danger of sending a rocket over populated places or payload loss from having to maneuver around them.

Of this year’s 36 “Long March series” launches, 14 will use Long March 3As, Li says. Rockets of that type can loft 8.5 metric tons (18,700 lb.) to low Earth orbit or 2.4 metric tons to geostationary-transfer orbit. The continuing importance of this launcher, now 24 years old, is underscored by Li’s expectation that it will also be used 26 times in the following two years. The Long March 8, with much the same launch capacity, is evidently intended to replace it. Eight of this year’s Long March 3A launches will each place two satellites in orbit.

The Long March 2Cs, with low-orbit capacities of 3.85 metric tons, will be used for six launches in 2018. In one, this type of launcher will be mated for the first time with the Yuanzheng 1A restartable upper stage, a simplified version of the original Yuanzheng 1.

Another Casc unit, Sast, builds the hydrazine-fueled Long March 4 and new Long March 6, which, like the Long March 7, burns kerosene with liquid oxygen. In discussing the 2018 launch program, Li did not mention Long Marches 4 and 6, probably because he is not responsible for them. But they could be included in the total of 36 missions.

The Long March 7 program will advance in 2018 with higher “product reliability,” Li says. “The Long March 7 development team is also working on development and design of improved rockets [that is, versions] for satellite-launch and other types of missions.” The reference to greater reliability hints that the design of Long March 7 is being reviewed and perhaps changed to minimize the risk of failure.

Li says the Long March 8 is now due to fly in 2020. Lu Yu, director of Calt’s science and technology committee, said in June 2017 that a first flight in 2018 was possible but that probably two more years of development would be needed, implying entry into service in 2019.

The Long March 8 is intended to loft 7.6 metric tons to low Earth orbit or 4.5 metric tons to a 700-km sun-synchronous orbit. Calt is trying to develop it quickly and economi-
around June 2019,” says the news agency in a report citing the deputy director of the manned-flight program, Yang Liwei.

“Long March 5” is the name of China’s biggest launcher type and also its first version. The Long March 5B is the second version, designed to deliver bulky loads of up to 23 metric tons to low Earth orbit—specifically, each of the three modules of the space station. An enlarged fairing replaces the second stage of the original version.

Whether the first module of the space station will be risked on the first flight of the Long March 5B is not known. The political consequences of losing the module would be great, because the Chinese government exploits its space program heavily for nationalistic propaganda. For example, the second flight of the original version was preceded by extensive and detailed media coverage. When it failed, there was just a terse statement saying so and then a media blackout.

Before the failure, in July 2017, the Long March 5B was due to fly this year. The failure was caused by a manufacturing fault in a YF-77 hydrogen-burning engine of the first stage, according to a source close to the Chinese industry (AW&ST Oct. 16-29, 2017, p. 57). The manufacturer, Calt, still had to verify the finding but now says it has definitely identified the problem.

The extent of the Long March 5 program delay became apparent in September 2017 when an official said the Chang’e 5 lunar mission, which only the big new rocket in its original version can launch, would be pushed back to late 2018, a year later than previously planned. That new timing of the Chang’e 5 mission was notably not repeated by Chinese space officials in several interviews they granted during the country’s annual parliament meeting this month.

“Assembly and fitting of the cabin of the space station’s core module will be completed this year,” the China News Service says. Also this year, “large-scale integrated testing of the module will be progressively conducted,” it reports. This work is presumably not proceeding very intensely, since the unavailability of the launcher has given the engineers and technicians making the station an extra year to get it ready.

**Chinese Working on Giant Engine for Long March 9**

**THE FIRST-STAGE ENGINE WOULD BURN KEROSENE**

**THRUST IS TO BE 480 METRIC TONS**

*Bradley Perrett  Beijing*

Complementing a demonstrator for a huge first-stage rocket engine, possibly this year, is among the technology acquisition projects being undertaken by China’s main space industry group in preparation for a go-ahead for manned Moon missions. Work on engines for second and third stages and on the structure for the giant launcher, informally called the Long March 9 and due to go to the Moon around 2030, is also underway.

The Long March 9’s targeted payload to low Earth orbit is 140 metric tons (310,000 lb.), of which 50 metric tons would be sent on a trajectory to the Moon. It would therefore have about six times the capability of China’s current largest rocket, the Long March 5.

The engine technology demonstrator is part of research intended for an engine generating 480 metric tons of thrust. The organization developing the hardware, the Academy of Aerospace Propulsion Technology (AAPT), says the demonstrator, which it calls a prototype, will be a complete engine. But AAPT also says it lacks test facilities for engines of this size, raising the possibility that the hardware it is building will be a scaled-down engine. Work on a second-stage engine of about 200 metric tons thrust and one for the third stage, generating about 25 metric tons...
thrust, is also in progress, AAPT says.

The organization, part of state space industry group Casc, would strive to deliver the engines for the Moon rocket eight years after getting a go-ahead for their full-scale development, says the official newspaper of the Ministry of Science and Technology in a report citing AAPT President Liu Zhirang.

For the big engine, which will burn kerosene, a turbopump has been built, says Li Hong, head of Calt, the Casc unit that leads overall development and production of most Chinese space launchers. It must be a huge pump, because the engine will generate four times the thrust of the largest Chinese rocket engine to date, AAPT’s 120-metric-ton-thrust YF-100.

Li, quoted by the China News Service state news agency, says the thrust of the planned engine is 480 metric tons. The ministry’s newspaper, Science and Technology Daily, says the engine is in the 500-metric-ton class. The F-1 engine that powered the U.S. Apollo program’s Saturn V rocket had a thrust of 680 metric tons.

“A complete prototype for the engine in the 500-metric-ton class can be built and assembled this year,” Science and Technology Daily says, quoting Liu. Despite the reference to a “prototype” in the Chinese-language report, the program, not yet fully launched, cannot be ready to build anything closer to the final hardware than a technology demonstrator.

“Because of the great parameter changes that come with rises in thrust, the current test and verification equipment cannot satisfy requirements” of the Moon rocket propulsion program, the paper cites Liu as saying. “We cannot always do 1:1 scale tests. As a result, only simulations and scaled-down tests can be done for some technology and hardware. This increases the degree of difficulty for the program.”

The three engines will variously use kerosene and hydrogen as fuel, Liu says. He does not identify which engine will burn which fuel, but the third-stage unit and probably the one for the second can be expected to use hydrogen—a conventional choice, because of the element’s high ratio of energy to mass when burned with oxygen.

The Moon rocket will have a diameter of 10 m (33 ft.), according to the China News Service, which adds that a sample piece has been made. Fabricating the rocket structure will be a great challenge for the program, a senior space industry official in China tells Aviation Week.

Calt last year showed a concept design for the Long March 9 with what appeared to be four engines, each with two thrust chambers, mounted in the core first stage and two in each of four boosters. If 12 such engines had 480 metric tons of thrust each, the total at liftoff would be an extraordinary 5,760 metric tons. Alternatively, if each booster had only one such engine, or if there were only two twin-engine boosters, the total would be 3,840 metric tons.

The senior official says the required thrust for the Long March 9 is 3,500-4,000 metric tons, and the mass at liftoff will be around 2,800 metric tons. This weight is lower than that of earlier concepts and the same as Saturn V, which departed with 3,400 metric tons of thrust. The Chinese payload to low orbit is higher than the Saturn V’s 118 metric tons, but AAPT no doubt expects to improve on the efficiency of the F-1. The sea-level specific impulse of the huge U.S. engine, comparing thrust with fuel flow, was 263 sec.; Chinese officials say the YF-100, using the staged-combustion process for driving its propellant pumps, has demonstrated 305 sec.

Although AAPT is working on huge solid-propellant boosters, Calt is very unlikely to use them if it settles on kerosene-burning engines for the first stage. Its published schemes have consistently used either kerosene and liquid oxygen or solid propellant at liftoff, for simplicity. The concepts featuring solid-propellant boosters had hydrogen-burning engines for the core.

Calt published these concepts for Moon rockets of about 5,000 metric tons launch mass in 2013.

If the Long March 9 has 12 engines with 490 metric tons thrust each, the launcher’s total thrust at liftoff could be an extraordinary 5,760 metric tons.
A viation Week & Space Technology /March 26-April 8, 2018

FAST 5

Arianespace’s Stephane Israel

A recent mishap cast a shadow on the otherwise near-perfect reliability rate of the Ariane 5 launcher. Arianespace CEO Stephane Israel discussed the corrective action, along with the Ariane 6, market challenges and Europe’s doubt on reusability, with Aviation Week’s France Bureau Chief Thierry Dubois.

The Ariane 5’s Flight VA241 suffered a “trajectory deviation.” Can you give us an example of a measure you have taken after the European Space Agency’s (ESA) inspector general made his recommendations? The trajectory deviation is perfectly understood; it will be corrected for VA242 in March. The inquiry commission’s investigation found it was the result of an erroneous value in specifications for the implementation of the launcher’s inertial measurement units.

We are now working on improving the mission preparation process and quality controls, both by eliminating the root causes upstream and adding downstream complementary end-to-end checks. Those measures are very simple to implement.

Are you fearful of a weakening market for GEO satellites, which has been Arianespace’s bread and butter? The geostationary orbit remains key for us, but priorities have shifted over the last few years, with the Soyuz and Vega. The constellation market calls for lower orbits, and our backlog is now much better balanced. With the Ariane 6 and Vega C, we will strengthen the rebalancing.

The geostationary market has for two years sent indications it is slowing. We have to accept that, although we anticipate an uptick this year. Our customers are adjusting their strategy in broadband and are wondering whether they should go for low and medium orbits. Demand for broadband will energize the market, and there will be solutions in low, medium and geostationary orbits.

What milestones remain in the development of the Ariane 6 to keep it on schedule for a first launch in July 2020? The critical review for the launcher’s definition will take place this summer. Toward the end of spring or the beginning of summer, we will fire a P120 booster for the first time. The slight delay [from April] does not result from a technical issue. We are customarily very cautious.

Combined tests—meaning the launcher is on the launchpad—are scheduled to begin in November 2019. We have conducted trials of the Vinci engine for the upper stage and the Vulcain 2.1 main engine. All the lights are green for launching in summer 2020.

When do you expect the European Commission will announce a formal, long-term commitment for the Ariane 6 and Vega C? There is no such thing on the market as a launcher without institutional support. Two-thirds of SpaceX’s backlog, in value, is U.S. institutional.

The Ariane 6 and Vega C have been conceived to answer Europe’s needs. The players in Europe are the states, ESA, the European Commission and [weather organization] Eumetsat. All are assessing how the missions they need over the 2020-23 period may use the Ariane 6 and Vega C.

We will not have a single-procurement entity, but we hope for a framework contract that includes all stakeholders. Institutional needs are significant. We count on five such launches per year for the Ariane 6 and two or three per year for Vega C.

The more the rules are defined for European missions, the more we can expand into export.

In light of SpaceX’s recent success with the Falcon 9 and Falcon Heavy, should Europe step up research into reusability? The relevance of reusability depends on the mission. As the orbit gets lower and the satellite lighter, the booster becomes easier to recover. And from 30 to 40 missions per year, you offset the slower production rate.

We have to look at all the evolutions possible for the Ariane 6. Reusability is one. As early as 2014, we began working on reusable engines with the Prometheus [demonstrator], which is slated to be ground-tested in 2020. State agencies are working on other technology bricks.

The Ariane 6 is at the beginning of an adventure where we will have to be ever faster in the innovation cycle. We are acquiring the technology bricks to go down that road, if we choose to. ☛
The answer can be seen outside the hangar at Embraer’s Gaviao Peixoto Airfield, the main base of the E2 flight-test campaign, where several prototypes of the manufacturer’s latest commercial aircraft family are parked. On the surface, Curado, CEO of Embraer until mid-2016, and his team characteristically decided to remain cautious. But a closer look reveals that the aircraft is a substantial departure from its predecessor in many ways. Now, Curado’s successors, Paulo Cesar de Souza e Silva and John Slattery, aim to turn the program into the success they forecast it would be.

The Embraer 190-E2 received its triple type certificate from Brazil’s aviation authority ANAC, the U.S. FAA and the European Aviation Safety Agency on Feb. 28. Norwegian regional carrier Wideroe will take delivery of the first aircraft on April 4 and start scheduled services later in the month. Wideroe and other customers will fly an aircraft that looks similar to an E1 and is intended to feel like one for pilots, but which is actually quite different. Embraer used the five years of development and testing to come up with a much more technologically advanced machine than its predecessor (AW&ST March 12-25, p. 48).

Given all the changes to the aircraft, the E2 came pretty close to being an all-new design rather than just a re-engined version of the first-generation E-Jets. In that sense, Embraer’s jump...
was much bigger than the Boeing 737 MAX or Airbus A320neo. And in that sense, too, the E2 is hardly a symbol of caution.

Not only is the E2 technologically a new aircraft, it marks change in other ways, too. With it, Embraer looks to break into segments of the airline market to which it so far has not had access. Many hopes are pinned on the E195-E2, which will enter service in 2019. Can it become the Embraer equivalent of the Airbus A321neo—the largest family member with the lowest unit costs—and open up a new market and spur strong demand?

The E2 also gave Embraer an opportunity to improve the efficiency of its production system, although the lower overall level of production compared to Boeing and Airbus does not (yet) justify equivalent investment in change and automation. In terms of orders, the transformation has yet to pay off. The E2 orderbook is decent at best, and parts of it are at risk. The company lists 100 firm orders for the E175-E2 from SkyWest Airlines and 74 firm orders for the E190-E2, plus 106 for the E195-E2. The total backlog, in theory, is therefore 280 aircraft. However, the numbers include 25 E190-E2s and 25 E195-E2s 50 for former Indian regional carrier Air Costa, which is no longer operating.

Uncertainty hangs over the SkyWest order, too, because the E175-E2 is not compliant with U.S. scope-clause agreements. Although the airline could not operate them if they were delivered today, Embraer insists there will be no change to the 2021 entry-into-service target for the model. “Once the airlines see the aircraft perform, they will be willing to pay the price and renegotiate the contracts with the unions,” E2 program director Fernando Antonio Oliveira says.

Embraer Commercial Aircraft President and CEO John Slattery expects “strong order momentum” for the E2 shortly after certification and service entry. By far the most important sales campaign in the early market-introduction phase of the program is that for JetBlue, which is weighing how to replace its large fleet of 88 Embraer 190s (64 of which have been delivered). It could make a choice as soon as this summer in what would be a very important signal to the market.

Embraer delivered 101 commercial aircraft in 2017, but that level of production will not be sufficient to meet the company’s business targets for the E2 and recover its investment in a timely manner. Slattery says output needs to increase to 14 aircraft per month following the usual phasing-in period of the new model. That is almost double the current production rate, which is now relatively low in the transition phase. He would like to see a rate of 16 aircraft per month and dreams of an even higher level, possibly 18 per month. Embraer achieved its annual delivery record to date in 2008, when it delivered 162 first-generation E-jets.

One of the big advantages Embraer has over the Bombardier C Series is the very large installed base of 700 first-generation aircraft in the size category (plus another 700 of the smaller E170 and E175). But Slattery wants the E2 to move into mainline flying big time, particularly the E195, which could play out its large trip-cost advantage vis-a-vis the A320neo and 737-8 where demand does not justify higher capacity. Embraer’s customer base is far thinner in that segment, however.

Embraer argues that E195 trip costs are 22% lower than the A320neo’s and 24% below the 737-8’s on a typical mission. But that is based on a 154-seat configuration for the A320neo and 160-seat layout for the 737-8, while in fact most airlines would put in many more seats. The unit-cost disadvantage, which Embraer sees at 6% and 8%, respectively, could therefore be larger. And, unfortunately for the Brazilian manufacturer, many airlines are still focusing on unit-cost reduction rather than overall risk reduction, the core of its long-standing argument that the industry should “right-size” its fleet.

With the E2, Embraer is therefore making a big bet that the mainline airlines’ behavior will soon change. But will it really, given that low-cost carriers are growing rapidly in many markets?

Rightsizing was also part of the exercise Embraer went through when it identified changes as it moved from the E1 to the E2. The smallest version, the E170, was dropped completely. The E175, highly successful with U.S. regional carriers in the E1 configuration, will be continued as an E2 with one additional seat row and up to 90 passengers in a high-density layout. The E190-E2 remains unchanged in capacity (up to 114 seats), but the E195-E2 is much larger than its E1 predecessor. Embraer added three seat rows for a maximum capacity of 146 and a more typical configuration of 132. “We wanted more differentiation from the E190,” says Oliveira.

Embraer debated delivering the E195-E2 before the E190-E2 but decided against doing so. The largest E2 version is scheduled to be certified at the end of this year and enter service with launch operator Azul in the first
half of 2019. Two prototypes have begun flight-testing.
But mere passenger capacity is not the only difference between the three remaining models: The E190-E2 and E195-E2 share the same engine (Pratt & Whitney’s PW1900G-JM) but have bespoke, very high-aspect-ratio wings. The E175-E2 has a bespoke scaled-down wing and engine (PW1700G-JM). Embraer argues that level of differentiation was key to enhancing performance of the aircraft, which have longer ranges than their predecessors at up to 2,880 nm for the E190-E2 and 2,600 nm for the largest variant.
According to the manufacturer, the E190-E2 is exceeding its performance targets. Embraer calculated a 17.3% fuel-burn improvement over the E1 version. That translates into greater range, too. Maintenance intervals are also longer than planned. And pilots need 2.5 days of transition training in a simulator versus a target of three days.
In terms of aircraft configuration and efficiency, many changes were driven by the closed-loop fly-by-wire (FBW) system developed in-house.
Embraer describes the E2 FBW as a fourth-generation system. The 1980s-era AMX fighter had only rudder and spoiler fly-by-wire; on the E1, the system covered pitch and yaw. The first full FBW system was introduced on the Legacy 450/500. The KC-390 military transport aircraft was the first for which Embraer developed its own FBW software.
The E2 system offers full envelope protection in all phases of flight. The stick shaker was kept as a feature for maximum commonality with the E1, but it was not actually needed for certification. The FBW includes an angle-of-attack (AOA) limiter that reduces the control column nose-up authority when the stick shaker is activated. The aircraft would slowly descend to keep minimum speed at the AOA limit rather than apply takeoff/go-around thrust. The system also includes over-speed protection that commands nose-up to reduce speed.
For simplicity, the FBW only has two modes (normal and direct) rather than the three used by Airbus (normal, alternate, direct). Embraer says it keeps handling characteristics similar to those of the E1, but the underlying control laws are very different.
Not only does the FBW allow better protection than the E1’s open-loop system, it also reduces oscillations in turbulence by making automatic inputs.
While the E1 was designed conventionally and a FBW was added, the system was built into the E2 design from the beginning, which affects weight and component size in multiple places. For example, because the ailerons are used in more situations throughout the flight, engineers were able to take 200 kg (440 lb) out of the wing structure. And since they also are activated during braking, larger wheels and brakes could be avoided.
The FBW allowed Embraer to move the wings somewhat forward and the center of gravity envelope backward. The lower force needed to maneuver in turns made it possible to reduce the size of the horizontal stabilizer by 10% and not increase the vertical stabilizer, in spite of the aircraft having become larger and heavier—the E195-E2 maximum takeoff weight (MTOW) increased to 61.5 tons from 58.7 tons. The exercise reduced fuel burn by 1.5%, too. In a conventional design, the vertical stabilizer would have had to be 15% larger.
A surface forward of the vertical stabilizer and on the fuselage top is needed for stability on the E1, but not on the E2 any longer because the FBW system handles the requirement automatically.
Embraer considered making the E2 wings of composite materials rather than metal, but it decided the switch was not yet justified economically. Had the wings become even larger, it would have made the change. While the E-195-E2’s wing is aerodynamically similar to the E190-E2’s, it has a different wing-tip and some structural modifications. For all three models, the flaps are single-slotted. They were double-slotted on the E1, which made them more complex to move and maintain, and they produced more drag. The slats are used aerodynamically on the E2 more than on the E1. The engine pylon is shorter than on the E1 and no longer attached to the flaps. It is slightly bent at the end to avoid turbulence and, in combination with the flap track fairing, it is used to produce a cleaner airflow.
“We went through system by system to see whether change was needed [compared to the E1] and did a lot of trade-offs,” Oliveira says.
The gear now has doors, which reduces fuel burn by 1%. Aerodynamic cleanup was also the target when many of the small doors and antennae were removed from the rear fuselage. Antennae are now on top of the aircraft.

Inside the cabin, the side walls were replaced for 1 in. of additional space on each side. The new overhead bins are about 3 in. deeper to allow International Air Transport Association standard trolleys to be stored wheels-first.

The E2 main landing gear has a trailing arm to save space and ensure that sufficient weight is placed on the front gear during taxi.

The E2 main landing gear has a trailing arm to save space and ensure that sufficient weight is placed on the front gear during taxi.

That enables each bin compartment to hold four trolleys so every passenger can store one big piece of carry-on baggage overhead and keep the space underneath the front seat free for smaller items and more legroom.

The E2 was also the catalyst for modernization of Embraer’s commercial aircraft production system. “Huge investment went into manufacturing technology,” Oliveira says. “The hangar allocation changed, and we introduced a lot more automation.” Given the much smaller output, even more advanced concepts of a lean, moving production line have not been pursued to the same extent as in the Airbus and Boeing factories. But Slattery says more change could come if production stabilizes at a higher-than-expected rate.

Another factor plays an important role as well: Embraer plans to continue producing the E1 for the foreseeable future. “We can build it for as long as we want,” Oliveira says. That is mainly a function of the E175-E2 scope-clause issue and its current market success. At the end of December 2017, there were just five E195-E1s to be delivered, but there were 46 E190s. At 103 outstanding orders, the E175-E1 remains the real driver of the dual strategy, however.

Final assembly of the E-Jets will remain spread across several hangars, but processes are changing in almost all of them.

Engines and cabin interiors are installed in the F220 building in Sao Jose dos Campos, which has been completely redone for the hybrid line. As the E2 is introduced, a dedicated station for the new version will be retained for the first four to six customer aircraft in a phased approach to making the full line hybrid and so as not to disrupt the faster workflow on the E1s. In a second phase, one of the stations will be used in hybrid fashion for both the E1 and E2 to segregate risk in case any delays occur. In phase three, both E-Jet generations will be outfitted at all stations.

Earlier in the production process, the hybrid approach has already been implemented: Forward and center fuselages are built at Embraer’s Botucatu plant on a joint E1/E2 line and then joined at the manufacturer’s main site in the F107/2 hangar.

The F107/3 building remains dedicated to wing production—wing panels continue to be built in Evora, Portugal, and shipped to Brazil. The plan is to implement a moving line with 90% automated drilling and riveting for the E2, with all three models worked on at the same stations. In the F60 hangar, the wings are attached to the fuselage.

Embraer’s current maximum commercial jet production capacity stands at 14 aircraft per month. In 2018, the company expects to build 85 to 95 aircraft, 10% of which would be E2s. The ratio of E2s will dramatically increase next year, unless major unexpected orders for the E1 materialize.

Preparations for E2 service entry have been intense. One hundred engineers work in program support and maturity, most of them embedded in their original divisions. Embraer defined 600 crucial points for aircraft maturity that will be monitored in the flight-test campaign. It has also made a point of much deeper supplier scrutiny to ensure maturity of systems and components. “We went to suppliers to check inside their box,” says Carlos Barra, director of commercial fleet performance and tech support. “In the past we have not done this to the same extent,” he says.

Embraer’s efforts are based on the E1’s less than perfect introduction more than a decade ago, which it does not want to repeat. “The E1 is now very good, but it took us 10 years to get to the level we wanted,” says Johann Bordais, president/CEO of Embraer Services and Support. Embraer targets a 99% dispatch reliability for the E2 after 12 months and 99.5% after four years.

Wideroe, the E2 launch operator, is a special case. It has operated only turboprops to date. The carrier has been taking the project extremely seriously. “The level of commitment is very high; they are maybe too happy with the aircraft,” says Bordais. On the other hand, “a super-experienced uninterested airline would not be good,” he notes.

Embraer has tried to embed Wideroe in the preparations as much as possible. In fact, the airline seconded one pilot to the E190-E2 winter trials performed in the Northern U.S. and Canada in recent weeks.

Embraer is focusing on creating a list of mitigation tactics in case any issues show up in scheduled operations. “It is important that the systems have enough margins, but it is continuous work even after entry into service,” says Barra.
Fast forward to 2018 and the era of business-friendly President Mauricio Macri, and things have begun to change substantially. His much more open economic policies have started a major transformation in many sectors, certainly in air transport. Once a cozy monopoly for Aerolineas, then a hard-fought duopoly with LATAM Airlines, the market has now opened to competitors. Avianca Argentina is building a regional network based on an incoming feet of ATR 72s. Andes Lineas Aereas plans to introduce international routes to Montevideo, Uruguay and Asuncion, Paraguay, this year. But the biggest structural change is the advent of low-cost carriers (LCC): Flybondi launched its first domestic services in late January and Norwegian Air Argentina (NAA) plans to follow in June.

In 2017 alone, the government approved 630 new routes for 13 different airlines, most of them very small. The numbers indicate a huge interest in capturing a share of what airlines consider to be the next big thing in Latin American air transport. And they have good reasons to be optimistic: Argentinians have among the highest per capita income in the region, yet travel only half as often as their Brazilian neighbors. Air transportation is an obvious means of travel in a country as large as Argentina, where 50 million people annually take long-distance bus trips because of high air fares.

Some of the north-south trips can take up to 60 hr. But airlines believe they can offer competitive prices. “We can be lower than the bus fare and still make a profit,” Flybondi Executive Chairman Mike Powell says. The government expects air traffic in Argentina to triple by 2019.

NAA may well be the most unusual new entrant, with its European LCC parent. But the group’s decision to launch a subsidiary in Argentina is also further proof that airlines are willing to bet big money on the country’s air transport sector. But its efforts show that starting up an airline there is still a painful exercise, at least initially. NAA was granted an air operator certificate (AOC) on Jan. 26. The company was also granted authority to fly on 152 routes, including 72 domestic and 80 international markets. The first Boeing 737-800 has arrived, although local operations are now not planned to start until June. The launch of NAA is complemented by, and linked to, Norwegian’s entry into the country’s long-haul market. In February, the carrier launched four weekly flights from London-Gatwick Airport to Buenos Aires using its fleet of Boeing 787s. NAA will not only offer low-cost point-to-point services but also connecting markets.
Flybondi began flying its first Boeing 737-800 in January.

Flybondi is currently forced to sell seats at an average of $50, but would like to lower that to about $35 to drive load factor and promote its services. The government is looking at revising the regulation, but if it does not, Flybondi is prepared to take legal action.

There are also concerns about infrastructure. Most airports, like El Palomar, are in desperate need of upgrading. And while Aeropuertos Argentinas 2000 has promised big investments in the facilities in its portfolio, they may not come fast enough to avoid disruption and bottlenecks. The country’s air traffic management system is also prone to failures and capacity constraints—a painful reminder that the era of strong regulation and operational efficiency is not long past.

Then there is the question of how much government support Aerolineas Argentinas will still receive, and how that will continue to distort the market. According to local media reports, the airline received $170 million in 2017 and will get about $90 million in direct subsidies this year. Financial assistance is not the only looming issue. LATAM Airlines Argentina went through an extensive legal battle in 2013 over the use of a maintenance hangar at Aeroparque, because it was not a state-owned airline. The new competitors have to hope that under Macri’s economic reforms such extreme cases of protectionism are a thing of the past.

Flybondi expects to operate a fleet of about 30 aircraft by the end of 2021. It started scheduled flights on Jan. 26 with the first service on the Cordoba-Iguacu Falls route within Argentina. Cordoba, the nation’s second-largest city, is Flybondi’s first base, but operations will be heavily focused on Buenos Aires’ El Palomar Airport, in the process of being developed for civil use.

The airline, backed by Cartesian Capital Group, Yamasa Group and private investors, received its AOC on Jan. 10. The carrier has also been awarded rights for 42 domestic and 43 international routes.

Flybondi is focusing on the Boeing 737-800 for now. The airline has secured the first five aircraft on lease from SMBC, Avolon, DVB, GECAS and BBAM. It plans to add another five aircraft by the end of the year. Powell says the company may place an order for either the Boeing 737 MAX or the Airbus A320neo before the end of the year.

The airline’s main base will be El Palomar Airport. The facility is currently a military base that is being taken over by civil airport operator Aeropuertos Argentinas 2000. It is 14 km (9 mi.) from the city center, closer than Buenos Aires’ main international airport Ezeiza, but farther out than downtown airport Aeroparque. As many medium-haul international flights are transferred from Aeroparque to Ezeiza, Powell sees El Palomar as well-positioned to capture part of that market.

Flybondi is following the ultra-low-cost model, with some exceptions, as it is forced to perform line maintenance and other functions in-house that would typically be outsourced.

But establishing the LCCs will not be easy. First, pilots have to be Argentinian nationals by regulation. For Argentinian pilots that now work abroad, Flybondi, Norwegian, Andes and the other carriers could provide an opportunity to return home. Regulation has eased, but it has not gone away. The government still defines minimum fares per route. Flybondi is currently forced to sell seats at an average of $50, but would like to lower that to about $35 to drive load factor and promote its services. The government is looking at revising the regulation, but if it does not, Flybondi via its sister carrier and beyond. NAA plans to build up a fleet of about 20 aircraft within its first year of operations, and then continue to grow further.

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President/Publisher: Gregory D. Hamilton; +1 (212) 204-4368; hamilton@aviationweek.com
Managing Director, Global Media: Jane Blackhall (UK); +44 (0)20 7975 1670; jane.blackhall@aviationweek.co.uk

**U.S. Sales Office**

Managing Director, Americas: Beth Wagner; (703) 997-0261; beth.wagner@aviationweek.com
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British A&D Is in Shambles

By Antoine Gelain

In June 2016, on the eve of the Brexit referendum, I wrote in this magazine that the British aerospace industry was at a crossroads, faced with the prospect of a political outcome that could seriously compromise its future.

Almost two years later, one can now officially say that the British aerospace and defense sector (A&D) altogether, including the British Armed Forces, is in shambles.

Not a week goes by without some senior industry executive, highly ranked military official or politician commenting on the dangers of a bad Brexit deal, the worrisome state of the defense forces or the frailty of the British industrial base.

Of course not all of that is directly related to Brexit, but the process of exiting the European Union is destabilizing an industry that was already struggling (see graph) and exacerbating budgetary uncertainties that, coupled with weak political leadership, contribute to the general malaise.

For a start, the Armed Forces are trying to make sense of the government’s confusing signals and to articulate a coherent strategy for a badly needed modernization. After 15 years of continuous presence in Iraq, Afghanistan and more recently Syria, the forces are beset with a serious “war fatigue” syndrome; their operational equipment is aging (such as Tornado fighter jets, Duke frigates, Warrior vehicles), and recent investments in new capabilities (the F-35, aircraft carrier, Ajax vehicle, cybersecurity and such) have not yet borne fruit. Gen. (ret.) Richard Barrons, former Commander Joint Forces Command, bluntly stated that the British Armed Forces were close to breaking, with the Royal Navy underfunded, the Royal Air Force at the edge of its engineering capacity, and the British Army 20 years out of date.

Defense Secretary Gavin Williamson has tried to reassure the defense community by announcing that the UK will soon launch a “Combat Air Strategy” aimed at assuring the defense community by announcing that the UK will launch a “Combat Air Strategy” aimed at maintaining a world-leading combat air capability, but the statement came across as hollow and noncommittal when the French and Germans have signaled their intention to jointly develop a future “European” fighter jet.

Meanwhile, clouds continue to darken for British defense companies. Their historical leader, BAE Systems, has been in a strategic dead end for years, overdependent on unpredictable and sparse government contracts and looking powerless in the face of a changing environment, as if it has never recovered from the failed merger with EADS.

Other major defense players also are embroiled in existential crises—Cobham, Babcock, Chemring, even Ultra Electronics, one of the historical stars of the sector, whose longtime CEO had to resign following several years of disappointing results.

On the commercial aerospace front, things are not any brighter, although the tentative transition deal gives industry until 2020 to reach a trade agreement.

All stakeholders agree that Brexit will have damaging effects on the industry’s global competitiveness. Airbus is increasingly worried about potential supply chain disruptions once the UK is officially out of the EU after March 2019. With 15,000 employees across 25 sites and £5 billion ($7 billion) spent every year with UK suppliers, the stakes are huge. This spurred Klaus Richter, Airbus chief procurement officer, recently to request that all suppliers establish contingency plans to ensure deliveries will not be impacted.

All this would still appear manageable if it did not come at a time of great stress on the British supply chain. Rolls-Royce, the country’s biggest commercial aerospace supplier, is struggling to fix its Trent 1000 engine, and GKN, the second-largest, is fending off a hostile takeover bid from corporate raider Melrose plc. GKN’s perceived potential breakup prompted a group of members of Parliament to call on the government to block the deal, citing national security and arguing the takeover would mean the end of one of the UK’s industrial jewels. It is ironic that many in the British business community see GKN as a last bastion of UK engineering excellence. Ten years ago, no one would have blinked an eye at the prospect of it being acquired, let alone by another UK-based company.

Sadly, it is a reflection of the anxiety that surrounds the British aerospace and defense sector today. As politicians march blindly toward an ominous end to the Brexit process, business stories such as GKN’s or Airbus’ remind us that, as much as British people cherish their independence, the only pragmatic and constructive way forward for their aerospace and defense players is “in,” not “out.”

Antoine Gelain is the managing director of Paragon European Partners. He is based in London. The views expressed are not necessarily those of Aviation Week.
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Global Aerospace and Defense Industry

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