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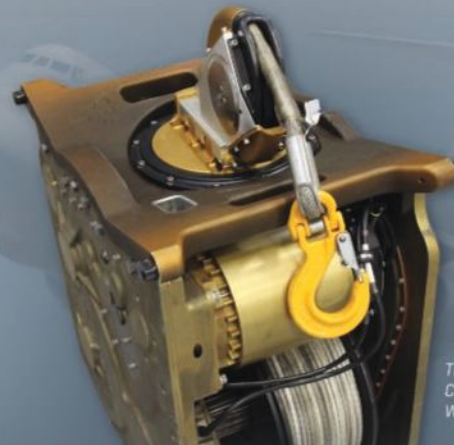
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ON THE COVERS

This week, Aviation Week publishes two editions. On the far left cover, Boeing's prototype for a Challenger 605-based Maritime Surveillance Aircraft sits on the ramp at Toronto Pearson International Airport. Toronto's Field Aviation, a partner with Boeing, installed a radome, a retractable electro-optical/infrared camera turret and other electronic systems on the former bizjet. Photo by Andrew Cline. A package of articles on special-mission aircraft begins on page 48. Elsewhere in both editions are reports on satcoms and cyber (page 30), the next Gripen fighter (page 28) and Delta Air Lines' fleet plans (page 36). Our Defense Technology Edition includes an additional section of articles. On the cover is a Crown Copyright photo of the U.K. Royal Navy destroyer HMS Dauntless, which is being used for preliminary tests leading to the addition of a ballistic missile defense capability.



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Never has such a small number been such big news.

Announcing E-Jets E2, the second generation.

E-Jets invented the 70 to 120-seat segment. Ten years later, they still lead it. And continuous improvements mean they're well ahead of competitors. So what next? E2, the second generation. Three new models, reconceived from nose to tail. Sure, the E2 series inherits all the well-loved family traits. But E2 takes quantum leaps with uniquely efficient new high-aspect-ratio wing designs. With ultra-high-performance P&W GTF engines. With greater seating capacities. And with major cockpit-to-cabin innovations. So it is that the second generation promises even higher achievement than the first. Which is obviously no small thing.

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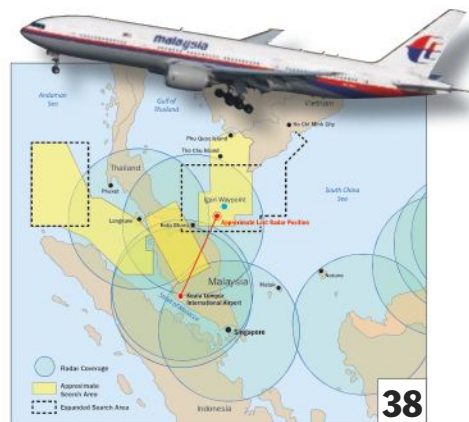
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On the Web

A round-up of what you're reading on AviationWeek.com

Aviation Week's Jim Mathews is an active **Civil Air Patrol aircrew member**. Read his timely Things With Wings post on **how professionals go about looking for missing aircraft** and how difficult it is (ow.ly/uy0Eu). See a related article on page 38 and **keep up with developments** on the missing Malaysia Airlines Flight 370 on **AviationWeek.com**

FROM THE ARCHIVES

In a post on Ares, our defense technology blog, **retired Rocky Mountain Bureau Chief William Scott** recalls Aviation Week's **1989 cover revelation of the F-117A stealth fighter**. Read his reflections, then click through to read the original story (ow.ly/uy1aq). **AviationWeek.com/Ares**

FEAR AND LOATHING IN D.C.

Our latest podcast features several of our Washington-based editors **discussing the Pentagon's fiscal 2015 budget request**. Listen to their analyses of the U-2, F/A-18 Super Hornet, F-35 and more (ow.ly/uy1Hf).

READER COMMENT

On an article about **SpaceX**, "jschrell" writes: "Creating a new staged-combustion engine is a great idea **if you are considering reuse of the core**. The reusable vertical landing approach, not so much. No matter how you do it, **reusability is weight and cost**. If you go for reusability, there are cheaper and far less complex ways to achieve it." ow.ly/uy35j

Thales's Shape concept features eye-tracker technology that allows air traffic controllers to select aircraft on their displays just by looking at them. Read more about this science fiction-like concept, see more photos and watch a video (ow.ly/uy2o8). **AviationWeek.com/ThingsWithWings**



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OVERESTIMATING MANPADS

As a current airline pilot and the director of the Manpad Task Force, I strongly disagree with the recent viewpoint by Rachel Ehrenfeld (*AW&ST* Feb. 17, p. 58).

Man-portable air-defense systems (Manpads) are highly effective against helicopters and light fixed-wing aircraft; that is what they were designed to shoot down. But they have a dismal, if not nonexistent record against large fixed-wing aircraft. Airliners are extremely robust platforms that are highly resistant to such attacks.

Manpads are heat seekers, and because a helicopter's engines are integrated into the airframe, they are more vulnerable for catastrophic loss if struck by a Manpad. Airliner engines are away from the airframe, giving them a distinct advantage in the event of an uncontained engine failure. During the Iraq war C-5, C-17 and Airbus aircraft all took Manpad hits and survived.

Manpads are a terror weapon designed to menace local civilian communities. Money spent on defensive systems would burden the already fragile airline industry.

Clyde Romero

MARIETTA, GA.

SKETCHY PRICE TAGS

Rachel Ehrenfeld says Manpads can be purchased for "as little as \$5,000 apiece on the black market." This figure has persisted for years and is now a part of Internet lore. But to my knowledge, no one has ever actually been able to buy a missile at this price.

If a news organization can purchase a fully functional and operational Manpad (as verified by test firing) for \$5,000, I shall be happy to send them a check for that amount. Given that the value of a usable Manpad—to both state and non-state players—far exceeds this figure, I believe my money is safe.

Guy Wroble

DENVER, COLO.

SPACE SAFETY SHORTCOMINGS

Eddie Johnson's Viewpoint "NASA's Plan Shorts Safety" (*AW&ST* Feb. 3/10, p. 82) is on target in being concerned about the safety of the commercial crew vehicles now under development. The Orion procurement (in 2006) emphasized safety and required that responding contractors demonstrate compliance with the Columbia Accident Investigation Board (CAIB).

During the competition, NASA demanded increases in safety across the board. The initial Orion contract award was more than \$3 billion for an International Space Station and lunar-capable vehicle. Immediately after the award, the winner—Lockheed Martin Space Systems—saw NASA slip its proposed first crewed flight date of late 2011 by two years to allow for agency-driven changes to enhance the system and increase its safety parameters.

Now we are being led to believe that the new commercial vehicles can be developed for a fraction of that amount.

This includes an obviously more costly lifting-body concept that has to provide all the capability of a capsule,



plus be able to land on a runway. The numbers just do not add up to develop a CAIB-requirement-compliant vehicle. NASA is about to settle for reduced safety in the name of political expediency and budgetary constraints, and taxpayers are about to be hoodwinked into believing that the new commercial vehicles are "safe enough."

Tom Megna

LITTLETON, COLO.

PLOTTING A NEW PILOT'S COURSE

I was introduced to *Aviation Week & Space Technology* four decades ago at the Air Force Command and Staff College where the magazine was recommended to help us stay current on what is happening around the world. (We were warned that it may contain some classified references.)

Over the years, I have tracked pilot availability and training. An in-depth report on this topic would be welcome.

Aviation Week & Space Technology welcomes the opinions of its readers on issues raised in the magazine. Address letters to the Executive Editor, Aviation Week & Space Technology, 1200 G St., Suite 922, Washington, D.C. 20005. Fax to (202) 383-2346 or send via e-mail to: awstletters@aviationweek.com

Letters should be shorter than 200 words, and you must give a genuine identification, address and daytime telephone number. We will not print anonymous letters, but names will be withheld. We reserve the right to edit letters.

Who is flying all of the aircraft in the Middle East and Asia? How will we catch up, considering the cost of building time in the cockpit coupled with reduced military training?

Bob Beabout

AURORA, COLO.

PONY UP TO FILL COCKPITS

Reader Alan E. Diehl's premise that the 1,500-hr. requirement to qualify to fly for a regional airline is the cause of the severe pilot shortage is short on substance and long on hyperbole (*AW&ST* March 10, p. 8).

His idea to have an Airline Transport Copilot Rating would only create another cottage industry and add more to the debt of a fledgling pilot.

A recent study by the Government Accountability Office (GAO) found mixed evidence of a pilot shortage. The GAO states that a large number of qualified pilots may be working abroad, in the military, or in other occupations where salaries are higher.

The Air Line Pilots Association (ALPA) issued a statement noting that pilots are in short supply because regional airlines are unwilling to pay a livable wage. The average starting salary for new first officers in the regional airline industry is \$22,400, according to ALPA.

The regional airlines' pilot problems break down to this: Substandard pay and benefits result in fewer pilots. Everyone involved knows the solution. *US Airways Capt. (ret.) John A. Crocker*
TAVERNIER, FLA.

CHECKING FOR 'CHECK 6'

I would like to see *Aviation Week* return to more engineering and technology and less political coverage.

I seldom use the online site because I spend all day at a computer screen, but I would like to see a return of the Check 6 podcasts (with better sound production). They were an excellent complement to the print magazine.

Rodney Keith

ALBUQUERQUE, N.M.



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Susan Herring



Matthijs de Haan



Patrice Moreau



Jacques Ancher



Dwight Yamada



Linh Dang

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

Diana L. Sands has been named senior vice president of Chicago-based Boeing's Office of Internal Governance, effective April 1. She has been vice president-finance/corporate controller and is succeeding **Wanda Denson-Low**, who is retiring. **Robert E. Verbeck**, who has been vice president/chief financial officer of Boeing Defense, Space & Security in St. Louis, has been appointed to succeed Sands. And he will be followed by **Leanne Caret**, who has been vice president/general manager for vertical lift in Philadelphia.

Raymond Moore (see photo) has become a senior professional manager in the New York office of *Parsons Brinckerhoff*, responsible for aviation business development and pursuit of airport projects throughout the Northeast U.S. He was director of strategic initiatives at OTG Management and had been regional director of corporate real estate at Delta Air Lines.

Mike Parra has been appointed CEO of *DHL Express U.S.* He was senior vice president-network operations for DHL Express Americas and succeeds **Ian Clough**.

Susan Herring (see photo) has been named director of initial-phase operations finance for the *Gulfstream Aerospace Corp.*, Savannah, Ga. She has been finance manager of Gulfstream G450 and G550 product lines and senior finance manager of initial phase operations and advanced aircraft programs.

Sonja K. McClelland has become interim vice president/secretary/treasurer/CFO of the *Hurco Companies* of Indianapolis. She has been corporate controller and principal accounting officer, and follows **John G. Oblazney**, who has resigned.

Michael Callahan has been appointed an independent member of the board of directors of *ATK*, Arlington, Va. He is president/CEO of Aspen Partners.

Shawn Bergquist has been named director of *Intertrade*, Cedar Rapids, Iowa, a Rockwell Collins company. He has been Intertrade's supply chain manager and was an executive at MidAmerican Aerospace and GE Capital Vendor Financial Services.

Matthijs de Haan (see photo) has become general manager of *Terma the Netherlands* in Leiden. He succeeds

Richard Jones, who is retiring; de Haan was director of the Holland Space Cluster in Noordwijk.

Brian Clegg has been appointed vice president-global aerial operations for *Erickson Air-Crane Inc.*, Portland, Ore. He succeeds **H.E. "Mac" McClaren**, who has become Washington-based vice president-government, defense and security programs. Clegg was vice president-flight operations for the CHC Helicopter Corp.

Patrice Moreau (see photo) has been named general sales manager for Europe, the Middle East and Africa for *Dunlop Aircraft Tires*, Birmingham, England. He was commercial manager for continental Europe for Barnes Aerospace, Derby, England and had been a sales manager for Bombardier regional aircraft.

USAF Brig. Gen. Michael D. Rothstein has been appointed commanding general of the NATO Air Training Command-Afghanistan, NATO Training Mission-Afghanistan and Combined Security Transition Command-Afghanistan/commander, 438th Air Expeditionary Wing of Air Combat Command in Kabul. He has been commander of the 56th Fighter Wing of Air Education and Training Command, Luke AFB, Ariz. Rothstein will be succeeded by Col. **Scott L. Pleus**, who has been selected for promotion to brigadier general. He has been executive officer to the Air Force chief of staff at the Pentagon.

Curt Blake has been promoted to president from senior vice president/general counsel of Seattle-based *Spaceflight Inc.*

Wes Hurless has become quality assurance manager of *Superior Air Parts Inc.*, Coppell, Texas. He was senior manufacturing engineer/continuous improvement integration lead for Jet Aviation in St. Louis.

HONORS AND ELECTIONS

Jacques Ancher (see photo), retired executive vice president of KLM Cargo

and 40-year employee of the airline, has been named to receive *The International Air Cargo Association's* 2014 Hall of Fame award during the association's executive summit in Istanbul in April.

USAF Gen. (ret.) Duane H. Cassidy has been named to receive the Ronald N. Priddy NACA-CRAF Partners in Airlift Medal for 2014 from the Arlington, Va.-based *National Air Carrier Association (NACA)*. The award recognizes the contributions of Cassidy to the "close relations between U.S. non-scheduled airlines and the Department of Defense through the Civil Reserve Air Fleet (CRAF) partnership in peace and war." The award is named for USAF Col. (ret.) Priddy, who was CRAF director during Operations Desert Shield and Desert Storm. Priddy was president of NACA from 2000-07 and continues as special adviser to its board of directors.

Northrop Grumman Corp. executives **Dwight Yamada** and **Linh Dang** (see photos) have received top awards at the annual *Asian-American Engineer of the Year* festivities, recognizing their leadership, technical achievements and public service in science, technology, engineering and mathematics. Yamada, director of indefinite delivery, indefinite quantity contracts for Northrop Grumman Information Systems, received an Executive of the Year award.

Dang, an automated production line manager for Northrop Grumman Aerospace Systems, received an Engineer of the Year award. She led a team that developed some of the key fabrication processes in high electron mobility transistor technology. ☼



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PROPULSION

Turbojet Reaches Mach 4

Japanese engineers have ground-tested a turbojet in conditions equivalent to Mach 4, which they believe is the highest simulated speed at which a turbine engine has operated. The February round of tests was a step toward building an engine that, unlike a ramjet, has the thrust and efficiency advantages of mechanical compression and the ability to propel an aircraft from takeoff to Mach 5. The major feature of the Japan Aerospace Exploration Agency (JAXA) engine is the use of liquid hydrogen as a coolant and fuel to reduce the temperature of ram-compressed intake air that would otherwise destroy the turbo machinery. The tests omitted the engine's inlet, since the JAXA Noshiro rocket testing center supplied air at the temperature and pressure that the next module downstream—the pre-cooling heat exchanger—would meet at high supersonic speeds. The experimental engine, designed for 1 kN (225 lb.) thrust, was started in those conditions, simulating Mach 3.4 and Mach 4.

KARI Rocket To Test Engine

The Korean Aerospace Research Institute (KARI) plans to launch a one-off rocket in 2017 to test its Woorae-1 engine, the key technology of its forthcoming KSLV-II space launcher. The KSLV-II, a largely indigenous successor to the much smaller Russo-Korean KSLV-I launched between 2009 and 2013, is due to make its first flight in 2020. With a payload of 1.5 metric tons to low Earth orbit, the three-stage KSLV-II will be comparable with the Arianespace Vega and the fully developed E-1 version of Japan's new Epsilon launcher. The South Korean program is fully funded as far as the first launch. The first flight of KSLV-II was originally to also be the first for the Woorae-1, an engine of conservative design burning kerosene with liquid oxygen. Seeing the engine as the greatest source of risk, program managers have inserted a specially built two-stage test rocket into the program.

Satellite Life Extensions

ViviSat, a satellite-servicing startup developing life-extension vehicles for end-of-life commercial communications satellites in geostationary orbit,



Fire and Ice Mix as ISS Crew Capsule Lands

Russian officials considered delaying the return of Soyuz TMA-10M from the International Space Station March 11 because of blowing snow and 0F cold at the landing site 230 mi. southwest of the Karaganda staging area, but decided to proceed with a reduced helicopter-recovery force instead. ISS Expedition 38 Commander Oleg Kotov, cosmonaut Sergey Ryazanskiy and NASA astronaut Mike Hopkins later parted ways after 166 days in space, with Hopkins headed straight back to Houston and the cosmonauts returning to their Star City base near Moscow.

The scorched condition of the Soyuz (here being unloaded by engineers in Kazakhstan) illustrates the rigors of reentry that U.S. engineers are working to overcome with NASA's commercial and Orion crew vehicles. Boeing and SpaceX commercial vehicles will use ablative heat shields, while Sierra Nevada Corp.'s Dream Chaser lifting body mini-shuttle carries a thermal tile system. NASA is evaluating certification proposals from these companies that would include test flights to the station, in an effort to reduce or eliminate reliance on the Russian capsule.

The Orion capsule under development for NASA by Lockheed Martin also uses an ablative heat shield, designed to handle the higher heat loads of reentry from deep space. The first flight of that vehicle, a two-orbit trajectory designed to validate the heat shield design by hurling an instrumented Orion prototype back into the atmosphere at 80% of the velocity it would see returning from the Moon, may be delayed by range-scheduling issues at Cape Canaveral. Its modified Delta IV Heavy launch vehicle probably will fly in October instead of September as earlier planned (AW&ST March 10, p. 12).

has signed up three customers and expects to begin building its specialized spacecraft by the end of 2014. Bryan McGuirk, chief operating officer of the ATK Space Systems/U.S. Space joint venture, says ViviSat plans to gather final financing and begin building its first Mission Extension Vehicle (MEV) this year. The first flight should come about three years later, according to CEO Craig Weston. McGuirk declined to identify the three satellite operators that have reserved MEV missions. ATK will assemble the MEVs at its Beltsville, Md., facility, where a robotics laboratory has recently been upgraded to perfect the software needed for rendezvous and proximity operations. The company believes its market

consists of "more than 200" satcoms that will run out of fuel by 2022, and are candidates for life extension with the addition of an MEV. "The current solution is they would purchase a new satellite, and on average that costs \$300 million, and that's capital up front to do that," McGuirk says.

Green Earth Observation

New green propulsion technology developed by Swedish Space Corp. is expected to help Skybox Imaging sell black-and-white images at resolutions well below 1-meter ground-sample distance, positioning the Mountain View, Calif.-based startup to compete with established remote-sensing service providers in the U.S., Europe



Image courtesy of Altus Air Force Base. Website: www.altus.af.mil.



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and Israel. Skybox Chief Executive Tom Ingersoll says the first two of a planned 24-satellite constellation of small, optical imaging spacecraft can already offer panchromatic products at 90-cm ground-sample distance. But he says follow-on spacecraft being built in partnership with Palo Alto, Calif.-based Space Systems/Loral will employ orbital maneuvering enabled by Ecaps' High Performance Green Propulsion (HPGP) modules to snap sub-meter images, which he says can be resampled to 60 cm or better. "We will be able to lower the satellites' orbit to improve resolution," Ingersoll said on the sidelines of the Satellite 2014 conference in Washington this week. Between the new HPGP modules and the company's ability to resample optical data, Skybox is positioned to offer images at "about 60-cm resolution, and potentially even lower," Ingersoll said. Skybox plans to launch 12 HPGP-equipped spacecraft in 2015 and 2016. Skybox might also be poised to compete with U.S.-based DigitalGlobe, which sells black-and-white images at 50-cm ground-sample distance to commercial customers using a constellation of five orbiting ultra-high-resolution Earth-observation spacecraft.

DEFENSE

Czechs in New Gripen Lease

The Czech Republic government has given the green light to a renewed deal to lease Saab JAS 39 Gripen combat aircraft. Prague will continue to lease 12 single-seat and two twin-seat Gripens until 2027, with an option for two extra years. The new lease will begin in September 2015. The aircraft will be progressively upgraded during the term of the lease adding the capability to engage ground targets along with Link 16 data-link capability.

Airdrop Trials for A400M

Airbus Defense and Space has completed the first phase of its airdrop trials of its A400M Atlas airlifter. The aircraft dropped a range of different loads by parachute during the trials at the Fonsorbes range near Toulouse in 11 flights during a two week period. Crews dropped 26 platforms and containers weighing from 255 kg (560 lb.) to four metric tons using the ramp aerial-delivery system (RAS-wedge), and 11



U.S. AIR FORCE/JIM HASELTINE

First F-35 For Second Training Base

The U.S. Air Force's second training base for the F-35 Joint Strike Fighter has received its first F-35A of 144 to come. The single-engine, stealthy aircraft (on top) arrived at Luke AFB, Ariz., March 10, escorted by two F-16s. Initial training is being conducted at Eglin AFB, Fla. Sixteen of the JSFs are slated to be delivered to Luke's 56th Fighter Wing by the end of the year. Luke will serve as a main base for training international F-35 pilots.

bundles weighing 15-320 kg using the paratrooper doors.

AIR TRANSPORT

No Way, Norway

At least 38 Democratic and Republican senators are joining Airlines 4 America and the union umbrella group Transportation Trades Department's calls for the U.S. Transportation Department to demur on Norwegian Air International's (NAI) application for a foreign air carrier permit. The senators last week signed on to a letter to Transportation Secretary Anthony Foxx claiming NAI's application violates the spirit, at least, of the EU-U.S. open-skies agreement. NAI, a subsidiary of Norwegian Air Shuttle, set up its headquarters in Ireland at least in part to bypass some Norwegian labor laws and to offer competitive international flights to the U.S. The trade representatives further decry NAI's plans to hire Thailand-based crews under Singapore-governed individual contracts. "NAI's structure raises several serious questions about what employment protections will apply to NAI's workforce," the senators say. Pro-NAI proponents, however, assert that an open-skies treaty puts competition questions to rest. "FedEx takes the position that the public interest question was decided when the U.S. agreed to the open market access," the cargo

carrier said last month in commentary on the department's consideration.

Improved RNP Ops Approved

Virgin America has obtained FAA authorization for required navigation performance (RNP) 0.1 operations, making it the first U.S. operator to gain approval at the 0.1 level for the Airbus A320 family. The "0.1" figure defines the lateral containment limits (+/- 0.1 nm) on the charted course within which the aircraft must fly. The smaller the RNP number, the better the access to airports and routes. Virgin America by early April will begin flying the satellite-based procedures—arrivals and approaches—on its routes using five equipped A320s and plans to begin modifying its remaining 48 A320s and A319s by year-end. For landing, RNP approaches provide the aircraft with satellite-based lateral and vertical guidance, similar to ground-based instrument landing systems. To gain RNP approval, aircraft must have onboard guidance and navigation equipment and displays to guarantee the performance, and crews must be trained to fly the procedures.

Correction: An article appearing on page 24 of the March 3 edition mischaracterized a Northrop Grumman communication system. The JETpack is not housed on a pod.

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COMMENTARY

Separating Hype From Reality

Innovation and competitiveness in the space sector

Much has been said about the emergence of new players in the space sector and the need for Europe to revamp the way it allocates its resources, starting with the “rule of geographic return.” This applies primarily to the launcher segment, where SpaceX’s Falcon 9 rocket is perceived as a major threat to Arianespace’s commercial supremacy. Suddenly there is a sense of urgency—if only the slightest—in the European establishment. Should we improve Ariane 5? Should we move to Ariane 6 (shown) as soon as possible? How can we get the price of a launch down to \$90 million, from more than \$130 million today? These are important questions, not least for the thousands of jobs involved. But they miss the point in several respects.

First, Space X still has a long way to go to become a fully fledged competitor in the mainstream commercial launch market. The company is still in the start-up phase, and industrializing the business will be a whole new game. In fact, it is not the first time a player has come up with a significantly discounted price.

In the early 2000s, Proton and Sea Launch brought launch prices down 40%, taking significant market share from Arianespace. But after several failures, prices went back up to their previous level, and Arianespace was back on top. The impressive track record of Ariane 5 (and of Ariane 4 before it) will not be easy to match, although it is certainly not a reason for Europeans to remain complacent, and it does not change the fact that the Ariane system should be much more cost efficient.

Second, SpaceX is a remarkable



ESA

venture for what it stands for—entrepreneurship, boldness, long-term vision, derring-do—but in the commercial launch market, it is just another player trying to break through. Even the idea of reusable engines has been thought of before by industry incumbents. To be truly disruptive, an innovation must either lead to a new application outside the mainstream

market or to a new business model targeted toward the least-demanding customers. Yet SpaceX has been targeting mainstream customers such as NASA or multinational satcom service providers, with a fairly standard value proposition.

In fact, what is truly disruptive in the space industry is not happening with the launchers themselves but rather with the rapid development of mini-satellites. This changes radically the economics of launching objects into space and therefore the kind of

technology involved. Hence, many new innovative launch ventures have popped up to accommodate such payloads, among them S3 (Swiss Space Systems), which is designing a shuttle to be launched from the back of an Airbus A300, or GOLS (Generation Orbit Launch Services), which is using a Gulfstream G-III private jet to launch a small missile able to carry a 40-kg (88-lb.) payload, for a target launch price of \$1 million.

Other significantly disruptive innovations include the recent development of a standard and modular nano-satellite architecture called cubesat that allows satellites to be built using almost exclusively commercial, off-the-shelf components, with the possibility to assemble several of them together, for a price below \$500,000 apiece.

Such innovation itself has triggered a flurry of new service ventures with interesting value propositions, making Google Earth almost look like a dinosaur. California-based Skybox Imaging, for example, raised close to \$100 million to launch a new generation of low-cost, sub-meter Earth-observation mini-satellites and data analytics services.

These examples provide a reminder that, in the space sector, downstream services are by far where the stakes are the highest: They account for 85% of the overall \$100 billion-plus annual space market value, versus 10% for satellites and only 5% for launchers.

So instead of asking themselves whether they can afford a new launcher or a new \$500 million satellite, Europeans should focus their energy and resources on promoting a dynamic service sector. More than anything else, Europe needs dedicated, competitive and innovative service players, which ultimately will offer the only guarantee that there will be a sustainable demand for more satellites and launchers.

Innovation in the space sector is thus not where it seems to be, and competitiveness is certainly not only about the cost of launchers. It is also about making sure new applications are developed, new markets are created, and fully fledged service players are given the support and credit they deserve for making space not only a boxing ring for egos but a truly dynamic and open marketplace. ☛



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COMMENTARY

Small Problem

Unmanned aircraft use threatens to become ungovernable unless FAA acts quickly

A U. S. judge's decision to overturn the FAA's first fine for operating an unmanned aircraft commercially is being described as a "self-inflicted wound," resulting from the agency's failure to put in place regulations to govern the use of small civil UAVs.

The FAA has appealed the ruling, by National Transportation Safety Board Judge Michael Geraghty, putting the decision on hold. But critics of the agency's foot-dragging on releasing its small unmanned aircraft system (SUAS) rule hope the judge's decision—and the threat of an explosion in unregulated commercial use of UAVs—will force the FAA into action.

From filming weddings and homes for sale to delivering beers to fishermen and packages to doorsteps, the FAA is struggling to stop the burgeoning commercial use of UAVs until it can get regulations governing their use in place. On the shelf for years, the SUAS rule is not expected to be released for public comment until late this year and could take two years to become final.

Meanwhile, prospective users are getting impatient and "illegal" flying is on the rise, exploiting the fact that model aircraft are not regulated. The \$10,000 fine slapped on Raphael Pirker for using a UAV to photograph the University of Virginia campus was the first levied by the FAA; Pirker's legal challenge is a test case for agency's ban.

The FAA does not consider a model aircraft flown recreationally to be an aircraft in a regulatory sense. If the same aircraft is flown commercially, however, it becomes a UAV and



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therefore prohibited. But Geraghty found there are no regulations in place governing the use of UAVs, only policy guidance for FAA employees that is not binding on the public.

"The judge ruled if it looks, walks and quacks like a duck, it's a duck," says John Langford, president of UAV manufacturer Aurora Flight Sciences. "The FAA says flying a model aircraft is okay as a hobby, but do the same activity with the same hardware as a business and it's not okay. The NTSB judge destroyed the FAA's arguments."

Manufacturers are not advocating unregulated commercial use of unmanned aircraft. Instead they want the FAA to release the long-stalled SUAS rule and put in place the regulations required for the safe operation of small UAVs. In fining Pirker, "the FAA overreacted, and in doing so destroyed the entire underpinning of what they were operating on. Now they need to release the rule they have had for some time," says Langford.

The FAA has been coming under increasing pressure, including from Congress, to publish the SUAS notice of proposed rulemaking or begin granting

waivers for specific commercial operations, such as using small unmanned helicopters for crop spraying as is already done on a large scale in Japan. Commercial use of small UAVs is thriving in other countries, such as the U.K., where regulations are in place.

Industry is unclear why the SUAS rule is held up inside the FAA, years after an advisory committee provided its recommendations for regulations. "They made the right steps, set up the committee and got the recommendations, but we have not seen anything. This is a self-inflicted wound by the FAA," says Langford.

Appealing the NTSB administrative law judge's ruling, the FAA says it is "concerned that this decision could impact the safe operation of the national airspace system and the safety of people and property on the ground."

"Our paramount concern is safety," says Association of Unmanned Vehicle Systems International President and CEO Michael Toscano. "We must ensure the commercial use of UAS takes place in a safe and responsible manner."

Model aircraft flying, meanwhile, has a good safety record under a voluntary program. "We don't see this as making a case for regulating model aircraft," says the Academy of Model Aeronautics (AMA), arguing Congress's direction to the FAA not to regulate aeromodeling is clear.

"We believe community-based safety programming similar to what has already proved successful for model aviation can be equally effective for small UAS and can allow these platforms to operate safely and harmoniously in the national airspace system," says the AMA.

Langford, an aeromodeler himself, agrees model aircraft should not be regulated, but admits the community faces a challenge from the rapid growth in highly automated small UAVs flown by people who did not grow up with the safety culture of model aircraft flying.

What is clear is that even a successful appeal against the Pirker decision will not take the pressure off the FAA to put safety rules in place quickly—regulatory or voluntary—before the "Wild West" of small commercial UAV operations becomes ungovernable. ☛

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By Pierre Sparaco

*Former Paris Bureau Chief
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since the 1960s.*

COMMENTARY

O'Leary Strikes Again

Irish carrier has high hopes of establishing 'Lakeresque' low-cost, long-haul model

Ryanair Chief Executive Michael O'Leary is back in the news, with more thundering declarations. He says he is, again, envisioning serving long-haul routes, of course at ultra-low fares. And his plans are on a grand scale—perhaps as many as 15 transatlantic city pairs flown by 30 or 50 Airbus or Boeing twinjets. Some may wonder whether we should trust him in light of other sweeping pronouncements he has made that never came to fruition.

But in this case, we should probably take him seriously. After all, Ryanair's route system will not expand forever and two-digit growth rates are now a thing of the past. In the next few years, the Irish carrier expects to surpass 100 million passengers per year. And it certainly plans to remain as profitable as it is now, earning as much as €500 million (\$693.9 million) per year, all while mainstream European airlines endure weak yields.

In the long term, if O'Leary wants Ryanair to further expand he will need to enter new markets. He already operates medium-haul services to North African destinations, catering to leisure travelers. But this will not be enough if he wants turn his airline into a genuine global player. So, in principle, opening transatlantic routes is a logical step, assuming the low-cost model can be adapted to 7-8-hr-long flights. And that is the key question.

In the past several years, low-cost startups tried hard but failed to create long-haul, discount operations.



Ryanair operates nearly 300 Boeing 737-800s. It would order widebodies to serve transatlantic routes.

Today, we all watch Norwegian Air and AirAsia X to see if they can establish a new economic model. Their success is far from certain. On long flights, fuel can amount to nearly 50% of direct operating costs, and savings resulting from the no-frills model are relatively modest. In other words, it is back to basics. In order to reduce expenses, aircraft need to spend more time in the air. And that is where the experiment falters; time zones are the enemy.

To extend the parameters of the usual return-flight-per-24-hr. mode—for

example, between London and New York—an operator would need to create unprecedented flight schedules and may have to offer 3 a.m. departure or arrival times. Would customers tolerate such inconveniences? Possibly, because very low fares are a potent lure. But airlines would first have to overcome the thorny matter of airport curfews. Although next-generation commercial transports' noise emissions are significantly lower than they used to be, local residents have won the war and, with very few exceptions, nighttime aircraft movements are now banned almost everywhere. If these rulings prevail, Ryanair's aircraft may have to remain

on the ground at night, negating an economic gain.

Years ago, when the U.K.'s Cranfield University first evaluated the merits of long-haul, low-fare operations, their economists warned that the need for dense markets, feed traffic and myriad difficulties tied to time zones "all combine to cast doubt on the widespread establishment of the [low-cost] business model for long-haul flights." However, British pioneer Freddie Laker's Skytrain, between London Gatwick-New York John F.

Kennedy Airport, proved successful in the early 1980s.

Eventually, Skytrain failed in the absence of direct sales (no Internet) and because powerful legacy carriers in the U.S. and in Europe ruthlessly counterattacked Laker's initiative to maintain what was still the airline industry's lucrative pathway.

Can O'Leary become the modern day Laker? If he cannot, within the next 5-10 years Ryanair will probably reach the zenith of its potential. And that scenario seems to be the most likely. ☺



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By John Croft

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COMMENTARY

Hard Sell

In-trail procedures could have potential for significant fuel savings

In its rush to prove the business case for airlines to buy and use next-generation air transportation system (NextGen) avionics, the FAA faces a quandary: What happens if trials designed to show positive results reveal the opposite?

An answer could come this summer when the agency closes out a demonstration program in the South Pacific for an automatic dependent surveillance-broadcast (ADS-B) “In” application known as in-trail procedures (ITP).

ITP uses an ADS-B “Out” position, rate and identification data from nearby aircraft to indicate to pilots whether climbs or descents will be possible based on horizontal and vertical separation from other aircraft in cruise flight, particularly in oceanic areas. The idea is that if pilots are aware of potential options they will be more likely to contact air traffic control via data link to ask for a more optimal cruise altitude, typically based on winds.

With the ADS-B “In” equipment, which typically involves ADS-B “Out” data processing in the aircraft’s traffic-alert and collision-avoidance system computer and a pilot interface device, either on the panel or in an installed electronic flight bag (EFB), the FAA will allow an airliner to fly 20 nm or less behind or ahead of other traffic, down from the usual 80 nm in-trail distance for Pacific routes. The ITP software will also let pilots see opportunities to climb or descend through flight levels occupied by other aircraft.

The FAA last year teamed with air navigation service providers in Australia and New Zealand to offer ITP



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to appropriately equipped aircraft. To hedge its bets, the agency also paid for an ITP certification effort with Honeywell, UTC Aerospace Systems and United Airlines to outfit 12 Boeing 747-400s (shown) on routes from California to New Zealand. The ITP applications are run on a Honeywell TPA-100B traffic computer with the right-side pilot interfacing with the software using a window-mounted UTC EFB.

“We’ve seen estimated fuel savings of \$100,000-400,000 per year, but this test is the truth model,” says Scott Miller, product line director for Honeywell. “It will validate the fuel savings and look at the benefits of ITP.”

The test was supposed to begin in August 2011, but delays pushed the start to summer 2012. With 1.5 years on the books, some preliminary results revealed by the FAA fall short of an endorsement.

According to a snapshot presented by the FAA at a Jan. 14 meeting held by the General Aviation Manufacturers Association, only 2-6% of the pilots

of aircraft capable of making ITP requests to air traffic control actually did so in November 2013. In the August-November period, there were 34 ITP requests from 900 ITP-capable aircraft, but only two ITP maneuvers were performed. Nine were denied. Along with the 12 United 747s, Airbus A330 and A340 aircraft outfitted with the airframer’s airborne traffic situation awareness systems also can participate. Average in-trail distances from August through November averaged about 30 nm, compared to the 18-nm minimum the FAA had expected. Pilots that performed ITP climbs reported wake turbulence encounters 2% of the time, with a turbulence severity level of 5 (minimal).

One likely reason for the low uptake in the trials could be that aircraft for oceanic routes now are regularly delivered with navigation systems that qualify for 4-nm required navigation performance (RNP) capability, which allows for 30-nm in-trail separation when requested by pilots and approved by air traffic control. “Airlines have [RNP 4] equipment today,” says Miller. “They don’t have to install an EFB, [traffic computer] upgrade and ITP.”

The downside of RNP 4 is that the pilots do not gain the ADS-B “In” benefit of situational awareness—seeing the leading and trailing traffic rather than relying on air traffic control to assess the situation when asking for an altitude change. That capability did help a United crew flying from London to San Francisco in November to save 1,157 lb. of fuel after requesting a “non-ITP” climb of 1,000 ft. The aircraft was taking part in a Eurocontrol ITP pilot program. Though the climb was not the result of an ITP request, United says ADS-B “In”-equipped aircraft and application of Honeywell SmartTraffic ITP gave the crew the situational awareness it needed to make the climb request.

United tells Aviation Week the London-to-San Francisco fuel savings figure is the only data it can share on its ITP trials until the final report is released, but the airline sees a silver lining from South Pacific routes.

“We are convinced that similar and much larger benefits are being accrued by ADS-B ‘In’-equipped aircraft in the Pacific,” United says. ☺



By Frank Moring, Jr.

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COMMENTARY

Planets, Yes; Life, Maybe

Exoplanet-imaging technology in development

Spectacular new results from NASA's Kepler planet-finding space telescope have raised scientists' hopes that Earth-like planets in the "Goldilocks zone" where conditions are "just right" for life are fairly common in the Universe.

A statistical technique called "verification by multiplicity" suggests that rocky planets roughly the same size as Earth are orbiting 20% of the stars in the sky. And a deeper understanding of what it takes for a planet to be habitable, in the sense that liquid water may be present on the surface, is raising the odds that planetary scientists may find the signatures of life around a nearby star in the foreseeable future.

A NASA-backed team is at work on advanced space-telescope technology that may allow researchers to measure the atmospheric composition of extra-solar planets directly, by blocking the instrument-blinding direct light of a target star. Deployment testing already has been conducted on a "star shade" that could be used for the job, and ground testing of the diffractive optics involved could come as early as next month.

The new analysis of data generated by the Kepler spacecraft, which seeks extra-solar planets by measuring the slight dimming in a star's light from the passage of a planet in front of it, has raised the total number of confirmed extrasolar planets by 715, to almost 1,700. Four of the newly confirmed planets fall in the habitable zone—the distance from the star that probably permits water to exist in its liquid state on the surface (AW&ST March 3, p. 12).

"Statistically speaking, every single star in our Milky Way galaxy has at least one planet," Sara Seager, a professor of planetary science and physics at the Massachusetts Institute of Technology, said during the Goddard Memorial Symposium March 5. "Maybe one in



NORTHROP GRUMMAN/ALEX EVERS

five has a planet the size of Earth, at the same planet-sun separation."

The Kepler reanalysis raises some new questions that remain unanswered. The first extra-solar planets, discovered by their effects on the motion of the stars they orbit, were necessarily Jupiter-class giants. However, almost 95% of the 715 just confirmed from the Kepler data are the size of Neptune—which is four times larger than Earth—or smaller. That includes the four new habitable-zone planets, which are 2-2.5 times the size of Earth.

"We have no idea how they formed," Seager said, pointing the way to more measurement and analysis.

Work that Seager and her MIT graduate students have done also suggests the habitable zone may be wider than originally calculated, when such factors as the type (and energy) of a planet's star and the warming greenhouse effect of gases in its atmosphere are taken into account. To measure those gases, she and other scientists are working with space-telescope engineers to develop the necessary technology for spectroscopic analysis of light passing through exoplanetary atmospheres.

NASA and Orbital Sciences Corp. are developing the Transiting Exoplanet Survey Satellite (Tess), set for launch in 2017. Tess is designed to do an all-sky survey of nearby stars from an elliptical

orbit measuring 17 X 59 Earth radii to detect more planets that may be suitable for direct-imaging measurements. By comparison, Kepler surveyed only a tiny segment of the sky.

Last August at Northrop Grumman's facility in Goleta, Calif., engineers repeatedly tested deployment of a starshade based on the company's Astromesh technology, which is used in large deployable antennas for communications satellites. The deployment went well, demonstrating that a starshade large enough to keep direct starlight out of a space telescope can be launched, positioned in a high Earth orbit like Tess, at a Lagrange point, or in heliocentric orbit, and unfurled.

The idea, says Ron Polidan, manager of science systems at Northrop Grumman, is to align the starshade between the target star and the telescope, using diffractive optics to keep a starlight shadow that is "a couple of meters" larger than the telescope's aperture in place so the much, much fainter planet light can be detected.

The starshade shape chosen for the deployment tests (see photo) is a series of petals that look like a daisy when deployed but generate the required billion-fold reduction in starlight at the telescope. The shade would be a separate spacecraft, stationkeeping at the proper distance for the configuration to work.

"This is a big device, you know, 40-plus meters," says Polidan. "And it flies 30,000-80,000 km [18,640-49,700 mi.] ahead of the telescope. That's partly to take advantage of how diffraction works, so it offers its own set of challenges, but the alignment of these two is probably not as difficult as people think."

As early as next month the team working the problem plans to set up a ground test, most likely over 3-5 km of the nighttime desert in northern Nevada. The equipment will consist of a camera, a subscale starshade at least 1 km in front of it and a light source beyond that to simulate a star.

"In tight budget times we're trying to come up with an affordable solution for NASA," says Polidan. "Exoplanets is a very exciting thing to do, but this is very, very difficult. So part of this is to reduce a lot of the risks and reduce a lot of the costs with ground tests." ☼



COMMENTARY

Costly Cutting?

The Navy plan to stop buying MH-60s breaks a multi-year agreement

In the last decade, Congress has moved increasingly toward the use of multi-year contracts to save on big-ticket defense programs. But the Pentagon's current long-term budget plans call for stopping the purchase of Sikorsky MH-60 helicopters one year before its current fixed-price, multi-year agreement expires. That prompts the contractor to raise the specter of the decision reversing the trend in multi-year contracting.

The Navy had aimed to save \$832 million—or 23.5% of its potential costs—using the multi-year agreement. But its plans are changing due to budget cuts. Originally, the Navy had budgeted to purchase 29 of the helicopters in fiscal 2016. But in its fiscal 2015 request,

The Navy's current budget request would end the purchase of MH-60 helicopters in 2015.



U.S. NAVY

the Navy plans to cut 16 MH-60Rs to mirror expected carrier air-wing reductions. And the Navy is not expecting to purchase another 13 MH-60Rs because the Littoral Combat Ship (LCS) fleet is being reduced to 32 ships from 52.

"Our current budget reflects an overall reduction in MH-60R procurement so that the program remains aligned with other planned force structure reductions," says Navy Lt. Caroline Hutcheson.

Whether Sikorsky will penalize the government for the contract breach is still undetermined, says Samir Mehta, president of Sikorsky Defense Systems. The Pentagon decision has two negative effects, Mehta says. The first, on the supply base, the company is still assessing. The second is an undermining of confidence in multi-year procurements, he says. "This could lead us back to the days of single-year pricing, which doesn't always provide the best value," Mehta notes. ☒

RETHINKING RESUPPLY

The political situation in Ukraine may force the U.S. to reconsider its air-borne supply route into Afghanistan. Tensions on the Crimean peninsula have remained high since Ukrainian leader Viktor Yanukovich was ousted from government in February. Last week, Russia announced it was sending troops and attack helicopters for new exercises near the border with Ukraine. The U.S., meanwhile, is assisting NATO training efforts, deploying 12 F-16s and 300 personnel to Poland and six F-16s to Lithuania.

Since 2011, the U.S. has been using a Northern Distribution Network through Russia to transport supplies in and out of Afghanistan. Army Gen. Martin Dempsey, chairman of the Joint Chiefs of Staff, says the aerial pathway to troops in Afghanistan through Russia and other relationships with the country are now in line for a review. "They will all be under scrutiny,

depending on how the situation in the Ukraine evolves," Dempsey says. Even if Russia were to shut off access to the distribution networks, the U.S. would still maintain access to Afghanistan, Marine Corps Gen. Joseph Dunford, commander of forces in Afghanistan, assured lawmakers during a separate hearing last week. ☒

WISHLISTS FLY

The Senate aviation subcommittee let the commercial sector air its desires last week about congressional action. For the most part, commercial representatives agree about what they want: maintain higher, earlier funding levels for the FAA's NextGen ATC modernization effort and keep pressure on the agency to provide results to industry. They also want Congress, the White House and even the American public to stop eyeing commercial aviation as an automated teller machine, or "piggybank," and treat it more like a national asset.

But when it comes to congressional re-chartering of the U.S. Export-Import Bank, the divisions emerge. Boeing and the Aerospace Industries Association are calling for swift renewal of the bank, while Airlines for America (A4A) cautions lawmakers about the bank's inherent benefit to foreign carriers. But their testimony shared the point that the commercial aviation sector is increasingly, desperately trying to make to Congress—the global aviation industry of 2014 is "very different" from the one that ushered in U.S. airline deregulation in 1978.

Boeing is in fierce economic combat with the Airbus Group, and both keep watch over Chinese and other OEMs. At the same time, U.S. carriers see foreign airlines, state-sponsored or not, elbowing into the lucrative international business while seeking accommodations from U.S. regulators such as customs preclearance facilities. "The U.S. must catch up," says A4A CEO Nicholas Calio.

As Congress gears up to reauthorize the FAA next year, indications are that the message is being heard. Says subcommittee member Sen. John Thune (R-S.D.): "U.S. aviation companies are competing with foreign governments, not just foreign companies." ☒



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The Contender

JAS 39E is more than an upgrade

Bill Sweetman **Linköping, Sweden**

Saab, its Swedish air force customer and Selex-ES have disclosed new details of the JAS 39E Gripen fighter, which has been in full development for just over a year following a six-year risk-reduction and demonstration effort. The JAS 39E is a new aircraft in detail, with only a few structural or systems components in common with the current JAS 39C/D, but it shares enough with its predecessor to take full advantage of weapon-integration experience and uses an evolved version of the C/D's software.

The JAS 39E will be able to engage stealth targets with a fused, multispectral sensor suite (see article below), according to program officials. It will be able to cruise at Mach 1.25 without using afterburner, and will enter service in 2018 with a full suite of weapons including the MBDA Meteor ramjet-powered air-to-air missile (which enters service next year on the JAS 39C/D). The Swedish air force's fixed-price contract for 60 complete aircraft, converted from JAS 39Cs but with new engine, avionics and primary structure, equates to a flyaway price of \$43 million.

Compared with earlier Gripen variants, the JAS 39E has a higher gross weight and can carry 2,400 lb. more internal fuel, mostly due to a redesigned

main landing gear that retracts into underwing bulges rather than the body. The nose gear has also been changed, from a twin-wheel unit to a larger single wheel that is compatible with emergency arrester cables on runways. The main structure has been redesigned with continuous wing-fuselage frames that extend to the inboard wing pylons, where the outer wings are attached, and the fuselage contours have been changed, partly to accommodate more fuel. However, the redesign has reduced the airframe's proportion of the empty weight, boosting useful load.

The JAS 39E is not a classically stealthy aircraft, but the development contract stipulates a significantly lower radar cross-section (RCS) than the

JAS 39C. In conjunction with the all-new Saab-developed electronic warfare system, which uses gallium nitride antenna technology and is described as an intelligence, surveillance and reconnaissance sensor in its own right, and the new Selex-ES Brite Cloud expendable active decoy, the reduced RCS is expected to allow the fighter to survive against advanced threats, including the Sukhoi T-50 fighter and "double-digit" surface-to-air missiles, while avoiding the cost and risk of an F-35-type stealth configuration.

The first customers, Sweden and Switzerland, are buying only single-seat aircraft, but codevelopment of the two-seat JAS 39F is being discussed with Brazil, which selected the new Gripen to reequip its fighter force in December.

The JAS 39E is intended to have a lower acquisition cost than the JAS 39C, despite its greater capability, and to have a lower operating cost than any other fighter. The Swedish air force reports an hourly operating cost of \$7,500 for the JAS 39C, including fuel. For development costs (also covered by a fixed-price contract), Saab's goal is to spend only 60% as much as it would have cost using the same tools and processes that were used on the JAS 39C.

The program has some important events pending this year. On May 18, Switzerland will hold a referendum on its order for 22 JAS 39Es. Saab executives acknowledge that the referendum will be a close vote. Another key goal is to negotiate and close a contract for

SEEKING STEALTH

New sensors being developed for the JAS 39E and close to starting flight tests on the JAS 39-7 Gripen Demo testbed will be able to detect low-radar-cross-section (RCS) targets, and will provide the pilots in a Gripen formation with a new level of situational awareness, according to Bob Mason, Selex-ES marketing director for advanced sensors.

The JAS 39E will have three Selex-ES sensors. The Raven ES-05 active, electronically scanned array radar (AESA), developed by the company's Edinburgh unit, will be the first production AESA to be mounted on a "repositioner," a rotating mount that gives the radar a ± 100 -deg. field of view around the nose. The Skyward-G infrared search and track (IRST) system (from Nebbiano, Italy) is based on experience with the Eurofighter Typhoon's Pirate IRST and Selex-developed land- and sea-based IRSTs. The fighter also has a new identification friend-or-foe (IFF) system with three electronically steerable antenna

arrays, which matches the radar's range and field of view.

The three main sensors will cue one another automatically to display to pilots a fused picture of airspace around the fighter; it will also be fused with the JAS's new electronic-warfare system. Finally, sensor data can be shared between Gripens in a flight via data link.

The IRST is capable of detecting low-RCS targets at distances compatible with a beyond-visual-range missile launch, Mason says. "We have seen them," he responds when asked if Selex IRSTs have tracked low-RCS targets. "We are looking at very small delta-Ts [temperature differences between the target and the background]. Some infrared absorbent paints cause more friction than standard surfaces, and that causes kinetic heating that the IRST will pick up." Skyward-G does not depend on a supersonic target—"skin heating at 300–400 knots is significant"—and detects heat radiating through the aircraft's skin from the engine, as well as skin friction and the exhaust plume.

The IRST uses a long-wave focal plane array sensor (a dual-band system, adding mid-wave capability, is a potential upgrade) with three fields of view. In its long-range search mode, the



Gripen Upgrade

	JAS 39C	JAS 39E
Empty weight, lb.	13,000	<14,000
Internal fuel, lb.	>5,000	>7,400
Max takeoff weight, lb.	30,900	36,400
Engine	Volvo RM12	GE F414-GE-39E
Intermediate/Max thrust, lb.	12,150/18,100	14,400/22,000
Supercruise	No	Mach 1.25
Radar	Mechanical scan	AESA
IRST	No	Yes
Cockpit display	3 6X8 in.	1 8X20 in.

The infrared search and track (IRST) housing ahead of the windshield along with a cooling-air scoop at the base of the fin will be distinguishing marks of the JAS 39E.

Brazil's 36 aircraft by the end of the year.

The risk that neither deal will close is seen as small, but it is a threat because Sweden's parliament approved the JAS 39E program on the condition that at least one international partner must be found. On the other hand, the program is well advanced and the air force need is established: The force's requirement for 60-80 JAS 39Es was approved by a joint-service team headed by an army officer, according to Maj. Gen. Micael Byden, air force chief of staff.

Saab's commercial goal for the JAS 39E is to export 300-450 aircraft over the next 20 years, according to Lennart Sindahl, executive vice-president and head of aeronautics. This represents 10% of the "accessible market," he says, accounting for nations to which Sweden bans major arms exports. Gripen, Sindahl says, has won 50% of its competitions since exports started.

Active campaigns include Denmark, which is expected to start a formal competition in April with the release

of a "request for binding information," and a long-running contest in Malaysia. Brazil's order is regarded by Saab as the first of three tranches, with the JAS 39E in a strong position to replace F-5s and Alenia-Embraer A-1s.

The first of three JAS 39E development aircraft (known as 39-8, 39-9 and 39-10) will fly in the first half of 2015, the company says. 39-9 will follow about nine months later, and 39-10—basically a full-production aircraft but fitted with flight-test instrumentation—will fly in 2017. ☛

GRIPEN

system is an IR telescope with a fast-moving scanning mirror (located in a transparent dome in front of the windshield) and "step-scans" through its search sector. It also has a single-target track mode, and in wide-field mode it provides a night-vision image on the head-up display. As a passive system, IRST does not have inherent range data, but it can perform "kinetic ranging"—the aircraft performs a weaving maneuver and the range is determined by the change in azimuth angle to the target—or the IRSTs on two aircraft can triangulate the target over the TAU-Link.

IRST hardware—the optics, detector and processor—has been improved since the development of Pirate started, but (according to Mason and other industry sources) the most important change has been the development of algorithms, based on operational experience and the analysis of real-world imagery, that look at IR signatures in detail, including variations of color and brightness within the target, in order to filter out false alarms caused by everything from birds to barbecue grills.

The IRST can give the radar a very accurate azimuth and elevation to the target, which allows it to focus its energy and

increase the probability of achieving detection and track on a low-RCS target, Mason says. The AESA provides virtually instantaneous beam-steering within its ± 70 -deg. scan, but the repositioner is slower. One concept to be demonstrated will be the use of two Gripen radars and the TAU-Link to provide a wide-angle picture to both targets.

The new IFF is designed to provide low-latency coverage over the radar's entire field of view and to its maximum range, and is independent of the radar. That approach has been selected to furnish the best possible information on cooperating targets (such as friendlies and commercial traffic), allowing the IRST and radar to concentrate on potentially hostile aircraft.

Selex-ES is now delivering what it calls "C-model" sensors to Saab for installation on the Demo and the three JAS 39E development aircraft. These units are built to production standards, Mason says, but have not undergone the full range of tests required for full qualification. The C-Model IRST is expected to fly on the Demo imminently, the radar is being delivered to Linköping and the IFF will arrive later in the year. ☛

Satellite Cyber

Hybrid systems bring satellite operators new security challenges

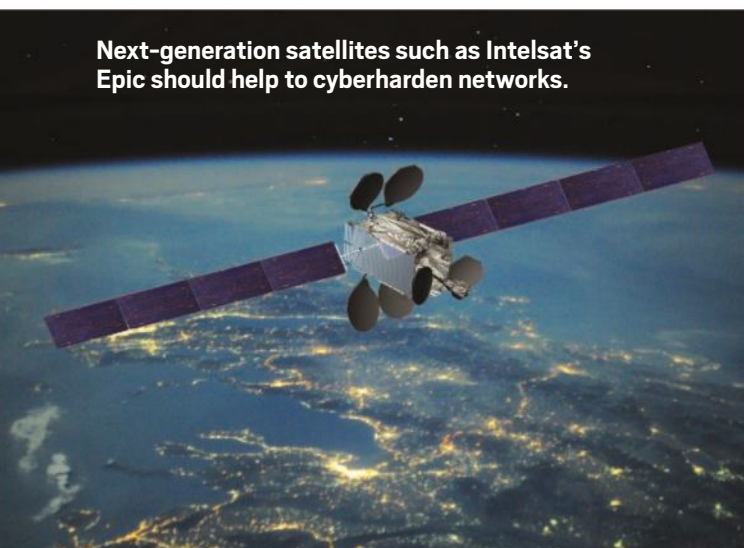
Frank Morring, Jr. **Washington**

The proliferation of cyberthreats to communication networks has presented satellite operators with new challenges in protecting customer data against threats ranging from “hactivists” and con men to state-sponsored snoops.

Security experts say advanced satellite technologies should help operators stay ahead of the rapidly evolving attack technology, even as hybrid systems that link traditional satellite networks and ground-based systems for end-to-end data delivery create new vulnerabilities.

“More and more it is hybrid networks that we are operating, and the services that we are selling use both terrestrial

Next-generation satellites such as Intelsat’s Epic should help to cyberharden networks.



and space assets,” says Thierry Guillemain, executive vice president and chief technology officer at Intelsat. “Because of that we are also vulnerable to the threats you will find on terrestrial infrastructure in general, so we have to take care of the entire system.”

Satellite operators have long had techniques for protecting their signals from unintentional interference and deliberate jamming, and have generally turned a blind eye to government ground stations such as those in Sugar Grove, WVa., that capture telecom signals flowing to nearby commercial satellite antennas.

“This is routine work for us and [our] policy is not to talk about it publicly,” says a spokesman for Luxembourg-based SES.

Intelsat is more open, and it conducted the latest in a series of press briefings on the general subject at the Satellite 2014 trade show in Washington last week. While avoiding citing specifics of security techniques for obvious reasons, Guillemain and Vinit Duggal, his chief information security officer, outlined

the company’s general approach to protecting customer data.

Publicity about denial-of-service hacker attacks that attempt to overwhelm Internet circuits with terabytes of data, criminal enterprises that use fraud to scoop up electronic funds moving on the Internet, and state-sponsored entities that seek government and commercial intelligence via clandestine cybereavesdropping have brought the issue into the open, they say.

“Customers want to know that when their data leave their network it is going through a pre-defined path; no one’s intercepting that data,” says Duggal, who serves on an expert panel advising the White House about critical-infrastructure security. “That’s one of the key areas we really look at for our customers—availability and integrity.”

Reports by computer security firm Mandiant and journalists using information provided by former intelligence contractor Edward Snowden about commercial eavesdropping by a People’s Liberation Army unit in China and the U.S. National Security Agency, respectively, represent a new dimension in the cybersecurity threat faced by communications security experts. In the past, says Duggal, state-sponsored cyberoperations targeted other state-sponsored operators.

“You have militaries going after military intelligence, and vice versa,” he says. “Well, this is completely flipped on its head now. You have Middle Eastern governments and Asian governments, China, going after commercial entities. We as commercial operators are a target.”

So far, the Intelsat officials say, customers have not specifically requested help with such threats, at least from the U.S. government, although Duggal says: “If they did, we would.”

“Our view of the world is that it is an extremely dynamic landscape, and you do not make any assumptions,” says Guillemain. “Everything is specific. You want to be ready for any kind of attempt to breach your system wherever it comes from, no preconception, and you want your security posture to be as comprehensive as possible.”

Typically, privacy issues are handled by the customer through encryption rather than by long-haul service providers like Intelsat. But hybrid systems increase the avenues intruders can use to steal data, overwhelm a system to deny service, or otherwise interfere with communications.

“When you combine satellite and terrestrial, you are actually magnifying the threat vectors exponentially,” says Duggal.

To protect customer data, he says, Intelsat closely monitors the flow of traffic on its networks for the signatures of illicit cyberactivity so it can shut it down promptly. The company applies various information security standards and regulations, such as ISO 27001 and KPMG’s Service Organization Control 3, to harden its network against cyberthreats. As it develops new technology, Intelsat’s engineers “embed” security measures in the systems before they are released because “it is very difficult to secure something after the fact.”

The company also watches its “security life cycle” to ensure its security measures are not overtaken by new developments in the cat-and-mouse game it plays with potential attackers. To that end, says Guillemain, a new generation of advanced satellites that includes Intelsat’s planned EPIC line (see illustration) should boost security. By providing more and tighter spot beams, the new birds will enable faster anti-jamming triangulation, while its software-defined payloads will allow operators more flexibility to meet threats.

“[I have no doubt that] satellites we are building now will give us more ways to deal with the environment,” he says. ☛

Keeping Competitive

Commercial launchers retool and revise business strategies to adapt to changing industry dynamics

Amy Svitak **Washington**

Launch vehicle providers in Japan, the U.S., Europe and Russia are modifying the hardware on their commercial offers and adapting business models in response to low-cost market entrants, new satellite technologies and reduced government demand.

In Europe, commercial launch consortium Arianespace says it wants access to the U.S. government market from which it is currently excluded. Arianespace markets dual launches of commercial satellites aboard the heavy-lift Ariane 5 and must now compete with the low-cost Space Exploration Technologies (SpaceX) Falcon 9 for spacecraft sized to ride in the lower position on the Ariane 5 ECA. This month the company announced plans to consider Americanizing the rocket with U.S. hardware in return for winning access to the U.S. market.

"It may not be envisaged today, but it is a matter of fact that, regarding reliability and cost-competitiveness, we are sure we could deliver to the U.S. civil and military markets the best solutions," Arianespace Chairman and

CEO Stephane Israel told Aviation Week on the sidelines of the Satellite 2014 conference here last week. "If it were the case that this market was to open, we would be ready to think outside of the box."

Today, sensitive U.S. government payloads are launched exclusively on

"People are optimizing for SpaceX's program right now because of the price point they're offering out there"

United Launch Alliance (ULA) Delta 4 and Atlas 5 rockets. SpaceX, which recently proved that the Falcon 9 can loft communications satellites weighing 3,500 kg (7,716 lb.) to supersynchronous transfer orbit, is hoping the U.S. Air Force will approve certification of the rocket this year.

But since Arianespace is already losing small and potentially midsize commercial customers to the Fal-

con 9—including the launch of three second-generation radar surveillance spacecraft in development for the German government—Israel says a third competitor should be an option. "As it seems there is now a willingness to have more competition, three is better than two," he said.

Meanwhile, U.S. rocket builders are also looking abroad. Declining government business and new competition from SpaceX are driving Lockheed Martin Commercial Launch Services to pursue more international customers for the Atlas 5, a highly reliable but extremely expensive rocket whose price has kept Lockheed on the margins of the commercial launch

business. In an effort to step up its game, the company says it will offer a new "refund or reflight" policy in all its future non-U.S. government contracts, according to Lockheed Martin Commercial Launch Services President Robert Cleave,

thereby saving commercial satellite operators the price of launch vehicle insurance.

"I think people are optimizing for SpaceX's program right now because of the price point they're offering out there," Cleave says.

In Japan, a new government space policy is encouraging hardware manufacturers to aggressively pursue export sales of the H-2A launcher, which

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is viewed as a reliable but expensive launch vehicle. In an effort to reduce its cost, H-2A prime contractor Mitsubishi Heavy Industries (MHI) has set its sights on a revamped rocket that by 2020 will be built for half the price of the current version, says Naohiko Abe, vice president and director of space systems business development.

Abe says H-2A recently won its first fully commercial export order to launch the Telesat-12 satellite for Telesat Canada by offering a cut-rate introductory price for an enhanced version of the H-2A rocket. "Our total proposal was accepted by Telesat,

of the Falcon 9. The first Falcon 9 dual launch, slated for early 2015, will drop two new Boeing-built electric-propulsion spacecraft in an orbit from which they will require 6-8 months to reach their operational destination and begin generating revenue.

While Boeing's lightweight design offers the potential to lower launch costs, Lockheed Martin and Airbus Defense and Space are offering all-electric satellites that are somewhat heavier but offer more power and can reduce the time to reach geostationary orbit.

"We have a continuing emphasis on

which will operate similarly to France's Coface, according to Slack.

"For several years, we have been at a competitive disadvantage compared to Europe and the U.S. in that we had no offer of export financing," Slack says. "There are deals where we were significantly—20 percent—lower than the competition, and we lost because of a lack of a viable export-financing forum."

Exiar has \$2.5 billion in deals, and authorization for more, with a pipeline worth \$10 billion and currently no satellite projects, ILS says.

Sea Launch is also planning dual launches of lighter-weight satellites on the Russian Zenit-3SL, starting with a planned first flight of the AngolaSat and Energia-100 in the first half of 2016. Sea Launch emerged from bankruptcy in 2011 and is challenged by being the only commercial launch vehicle that is not backed by a government market. Majority-owned by Energia, a major Russian space hardware manu-

Proton will offer GTO launches of low-mass spacecraft stacked atop ISS Reshetnev satellites starting in 2016.

facturer, it is recovering and building up a hardware inventory to operate on a reduced frequency of 3-5 launches per year. Russian government officials have suggested Sea Launch might be better operated within Russian territorial waters, where it could launch Russian government satellites.

Sergey Gugkaev, incoming chief executive of Sea Launch, says the idea of moving his headquarters from Long Beach, Calif., and the company's equatorial launch base in the Pacific Ocean to a position east of Siberia has no real interest for Sea Launch, unless the move is accompanied by a Russian government agreement to make it eligible for federal missions.

"There are a number of political and government decisions that have to be made in order for this to happen," Gugkaev says. "Our opinion is that if this event and this shareholding change would allow us to get more market share—for example, getting Russian satellites which we are now discussing with Roscosmos—then it would be a good thing for us. But just moving the operations from the U.S. just for the sake of political reasons—I don't see a lot of benefit." ☛



including finance, schedule, launch campaign and so on," Abe says. "The launch vehicle will be the maiden flight of an H-2A enhancement, so we offered a special price and Telesat accepted the small risk."

International Launch Services (ILS), which markets commercial missions of Russia's Proton M/Briz M rocket, says it is offering builders of relatively light-weight satellites, or those using light-weight all-electric designs, a launch configuration in which a satellite built by Russia's ISS Reshetnev would sit in the rocket's lower position and bear the load of a Western satellite sitting in the Proton's upper position.

ILS President Phil Slack says this scenario could put all-electric satellites closer to their final position than the current dual-launch configuration

expanding our market as more spacecraft decrease in mass and are looking for more dual launch opportunities," Slack says, adding that structural improvements to the Proton M/Briz M would enable the rocket to launch two such spacecraft weighing a combined 6,200 kg by 2016.

"Depending on mission design and mass, in many cases we can take them well on their way above GTO and significantly reduce the orbit-raising time frame," Slack says. By mid-2016, Proton also would be flying a new stretched fairing, he says, although plans to expand the 4-meter-dia. (13-ft.) payload shroud to 5 meters have been shelved.

The ILS offer is further enhanced by the arrival of export-credit backing available through the new Export Insurance Agency of Russia (Exiar),

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Airbus says it improves on Sikorsky's rig approach system on the S-92 by integrating sensors into the system.

AIRBUS HELICOPTERS

Hands-Free Flying

Airbus Helicopters is integrating sensors to enable hands-off platform approaches

Tony Osborne Los Angeles and London

For offshore helicopter pilots, the approach to oil and gas platforms is one of the most work-intensive periods of the flight.

During bad weather, pilots can struggle with high winds, while low visibility and clouds sometimes obscure heli-decks that often sit hundreds of feet above the sea level, and obstacles such as cranes and gas flares create challenges in the final moments before touchdown.

But Airbus Helicopters, formerly Eurocopter, is working to reduce that workload—at least during the approach phase—down to just a single button push, allowing pilots to keep their heads up during this critical phase of flight. The company is working on its Rig N'Fly approach system, destined for installation in a new version of its EC225 heavy helicopter, called EC225e (“e” for “enhanced”), which is due to fly for the first time in 2015.

Airbus's system, undergoing flight testing in the south of France, differs from Sikorsky's approach system by integrating feeds from other sensors on the helicopter. Like the Sikorsky system, it uses GPS points to provide it with an approach fix to the platforms. Key to its introduction is the use of Navtech's regularly updated oil and gas platform data that can be fed

into the EC225e's new EuroNav 7 situational awareness system. Rig N'Fly also receives data from the traffic collision-avoidance system (TCAS II) integrated into the helo's autopilot and the Automatic Identification System (AIS), which will be standard to the EC225e.

“The principle is that all the systems are working together in an integrated way during the final approach,” says Rupert Hibbert, a senior manager working on the marketing of the Rig N'Fly Approach system, who demonstrated the system to Aviation Week at Heli-Expo 2014 in Anaheim, Calif., last month.

With rig data already in the flight management system (FMS), as the crew enter the turning point, they push the “Alt A” button on the autopilot controls, activating the system. At 3,000 ft., the system activates the AIS system used to track surface ships, which notes their heading and speed as well as ships in the area near the platform and checks whether any ships are likely to be close or converge with the helicopter's flight path.

“There is often a lot of shipping around any platform, and sometimes these vessels are carrying other oil platforms, some of which are a significant height above the water,” Hibbert

says. “The AIS provides awareness and early warning ahead of the final approach, giving the crew the option to go into the hold until the vessel has passed or to fly around the obstacle.”

The helicopter will then descend toward 1,500 ft. and the initial approach fix (IAF), and the autopilot will use its flight envelope and power protection to maintain course and height, ready for a single-engine failure at any time during the approach. At the IAF, the system activates the TCAS II, which is able to make avoidance maneuvers should it detect any conflicts.

During the period between the IAF, the final approach fix (FAF) and the minimum descent altitude, the helicopter can be flown entirely hands-off and the speed is not limited. “Pilots can enter the FAF at 120 knots, if they wish,” says Hibbert.

As the helicopter reaches the missed approach point, the crew then have the option of flying a missed approach using the “takeoff, go-around” button and starting again or “flying the disk” down onto the heli-deck of the platform. Airbus is looking at introducing a control mode that puts the helicopter into a straight and level hover that would enable the pilot to slew the helicopter horizontally above the pad and reduce power, bringing the helo safely onto the deck.

Part of Airbus's work to develop the system was prompted by the February 2009 incident involving an EC225 operated by Bond Offshore. As the crew approached a North Sea platform during a night-time operation, poor visibility hindered their view of the platform, while visual illusions degraded the crew's visual cues. Meanwhile, the helicopter's audio height warnings did not activate because, according to accident investigators, the helicopter's Terrain Awareness Warning System (TAWS) had malfunctioned and the crew had suspended the warnings. While all 16 passengers and two crew managed to escape the helo safely, the EC225 was damaged beyond repair.

To prevent controlled flight into terrain incidents such as this during approach, Rig N'Fly will use power and envelope protections to stop the aircraft from dipping below 150 ft.

Fifteen EC225e models were ordered by the helicopter arm of Dublin-based Lease Corporation International during Heli-Expo 2014. ☼

Defense Technology Edition

Linking Technology, Programs and Policy Across Defense

BALLISTIC MISSILES

Missile Defense

**New contenders
join the fray**

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BALLISTIC MISSILES

Best Defense

Anti-missile systems meet new threat

Michael Fabey Washington
Francis Tusa and Richard Fisher London

Ballistic missiles have often been a threat with a bigger bark than bite, mostly due to poor accuracy that renders them militarily ineffective unless armed with mass-destruction warheads. But, as reported last month (*AW&ST* Feb. 17, p. DT3), Israeli missile-defense expert Uzi Rubin expects a rapid proliferation of higher-precision weapons before 2020. Rubin's comment that "an iPad can guide a missile" points to some of the key technologies, including satellite navigation systems and open-source, high-resolution image databases such as Google Earth, which would enable the use of scene-matching guidance.

Conventionally armed missiles with circular error probable numbers in the low tens of meters could threaten civilian infrastructure such as seaports, airports, transit hubs and power supplies, as well as fixed or deployed military bases—targets that in the past would have required attacks by costly fleets of manned aircraft.

China is a major potential source of ballistic missile technology. The 2013 issue of the U.S. National Air and Space Intelligence Center Ballistic and Cruise Missile Threat report states that "China has the most active and diverse ballistic missile development program in the world."

While some details are known, China works hard to conceal the plans and extent of its missile buildup goals. Its practice of building tunnel bases for mobile missiles and employing reload missiles for its mobile launchers

complicates estimates of the size of its force. However, China continues development of intermediate-range ballistic missile (IRBM) and medium-range ballistic missile (MRBM) systems, all of which are mobile.

In 2011, a Chinese missile industry official told China's *Global Times* that a new 4,000-km (2,485-mi.)-range IRBM could be deployed by 2015. Both Tai'an and Sanjiang Corp., makers of transporter/erector/launcher (TEL) vehicles, have produced new 12-wheel TELs that could carry new IRBMs. Some Chinese sources note that a possible new DF-26 missile could be an early carrier of a new hypersonic glide vehicle warhead. A prototype of such a system was apparently tested in January (*AW&ST* Jan. 27, p. 18).

In the IRBM class, China's Second Artillery Corps (SAC) has deployed its precision-guided

KBM's 9K720 Iskander tactical ballistic missile pushes up against treaty limits and is highly mobile.



NOV0517

1,700-km-range DF-21C since 2005—the guidance system used has not been identified, but could be a similar radar-correlation system to the 1980s Pershing II missile. The 1,700-km DF-21D anti-ship ballistic missile is believed to be operational. Also, in 2012 the SAC started receiving the 1,000-km DF-16.

In 2013, the Pentagon reported that 1,100 short-range ballistic missiles (SRBM) remained largely targeted against Taiwan, a number that has not increased from 2012. They are mainly 500-600-km-range DF-11A and DF-15 SRBMs, with the latter equipped with

ogy Control Regime limits, but no sales have been reported. The initial version has inertial guidance, but in 2011 an Iskander was tested with an optical scene-matching guidance system.

The proliferation of missile threats is likely to increase interest in defensive systems. Israel Aerospace Industries (IAI) Chairman Rafi Maor notes that “one event can be catastrophic.” The threat thus justifies the purchase of a defensive system. IAI’s systems include the in-service Arrow 2 and developmental Arrow 3 ballistic missile defense (BMD) weapons.

and Poland. It is part of the Obama administration’s European Phased Adaptive Approach to BMD.

The first Aegis Ashore test site was developed and built in Hawaii for the Navy. The MDA-led team is packing up the Romania-bound Aegis equipment, which combines the latest radar system software with Standard Missile (SM)-3 Block 1B interceptors to provide coverage of Southern Europe. It is slated to be operational next year.

Lockheed had to find ways to do in hours what it would take days to do for shipboard installations. The company relied on engineers in Arlington, Va., to use computers to map out and design the mock deckhouse and Aegis setup in New Jersey that houses and tests the land-based BMD site.

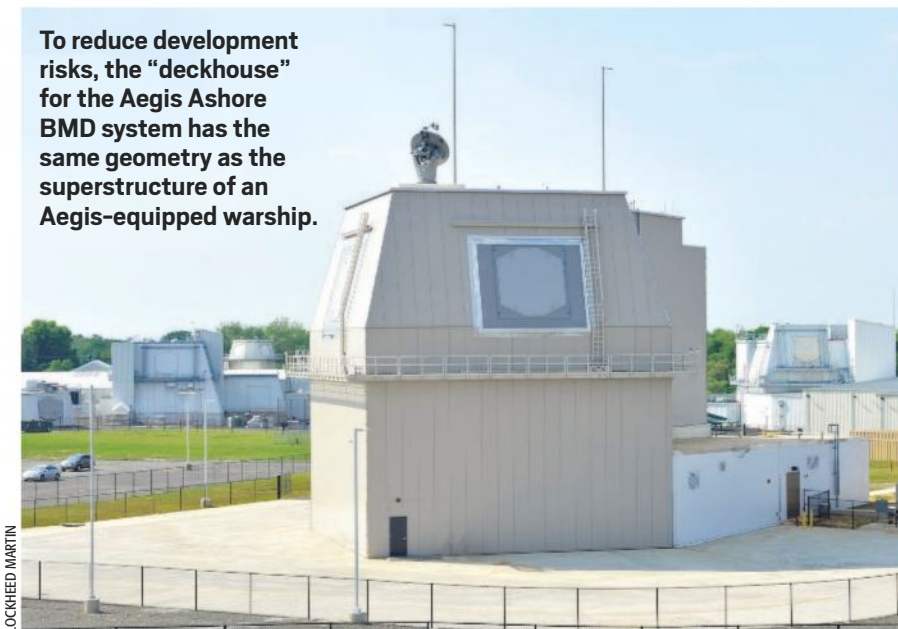
Essentially, Lockheed designed a site that mirrors the deckhouse template of a ship, keeping the same cabling and processing hardware, and positioning command and control setups in similar locations to those found aboard ship. By doing this, the company avoided making alterations and changes that would mean more re-engineering or testing.

There is a major difference: Aegis Ashore operates using a remote launcher. “Aboard ship, the launcher is next to the radar,” Scanlon notes. “In Hawaii, it’s three miles away. It is a big integration effort.”

Lockheed Martin also needs Aegis Ashore to be “relocatable,” he says. This allows the test unit to be moved to Hawaii, for example, and to deliver the first non-U.S.-located system to Romania. To do that, Lockheed Martin engineers bolted certain foundations and other infrastructure instead of welding them, as would be done on a ship. “There is minimal welding—we have 35,000 bolts,” he says.

Then, Lockheed Martin connected Aegis equipment—cabling, wiring and other gear—to pallets or skids of the type used in industrial warehouses, which were easily packed into metal containers and shipped overseas. The pallets could be unpacked and installed in identical Aegis Ashore deckhouses built in forward operating locations by other contractors, requiring more integration involving Lockheed Martin, the Navy and those companies. “We have to roll in the skids, hook it all up and push a button,” Scanlon says. “The concern was that we’d roll in a skid and it wouldn’t fit or work.”

To reduce development risks, the “deckhouse” for the Aegis Ashore BMD system has the same geometry as the superstructure of an Aegis-equipped warship.



LOCKHEED MARTIN

precision (DF-15B) and deep-penetrating warheads. In 2013, Chinese reports indicated that a new 280-km, variable warhead DF-12 may be joining the SAC.

Russia is technically barred from developing MRBMs by the Intermediate Nuclear Forces Treaty. However, this does not extend to SRBMs such as the 9K720 Iskander missile produced by the KBM company, identified in the West as the SS-26 Stone.

The importance of Iskander—deployed forward for the first time in late 2013, within range of Eastern European and Baltic targets—can be judged by the fact that it is one of a few new Russian non-strategic weapons to have entered service since the early 1990s, becoming fully operational in 2010. The Russian army plans to acquire 120 Iskander systems, each with two missiles, by 2018. An Iskander-E export version has been offered, with range reduced to 280 km to comply with Missile Technol-

Rafael, too, is building BMD capability into its integrated air and missile defense systems, through the new David’s Sling and associated two-stage Stunner missile. The Stunner is also proposed for integration into the U.S. Patriot air defense system as a substitute for Lockheed Martin’s Patriot Advanced Capability 3 missile.

Meanwhile, the U.S. Missile Defense Agency (MDA) is pushing ahead with its regional BMD initiative, Aegis Ashore. One challenge faced by Brendan Scanlon, Lockheed Martin Aegis Ashore program director, was to find a way to build a land-based BMD system in a fraction of the time it took to install the same equipment aboard a cruiser or destroyer.

Lockheed Martin is responsible for the transition from shipboard Aegis to Aegis Ashore, to provide the same missile shield enjoyed by the U.S. Navy to strategic partners such as Romania



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Lockheed Martin's concern about Aegis Ashore's fast pace has been shared by the U.S. Government Accountability Office in recent reports. "The program committed to buy components necessary for manufacturing prior to conducting flight tests to confirm the system worked as intended," the GAO says. "As a result, any design modifications identified through testing would need to be retrofitted to produce items at additional cost."

The cost of Aegis Ashore has been rising. "The program established its baseline for product development for the Romania and Hawaii facilities in June 2010 with a cost estimate of \$813 million," GAO says. But the program baseline submitted later that year to Congress was \$966 million, GAO adds, and other adjustments raised the estimated cost in Romania and Hawaii by \$813 million. "It has nearly doubled, to its estimate of \$1.6 billion" as of February 2012, GAO states.

As for operational concerns, Lockheed Martin points out that Aegis Ashore relies on the same technology and components as the seagoing system, including shipboard production. Indeed, some initial unscheduled testing has justified the optimism. For example, the Aegis Ashore testing facility in Hawaii reported its first live track there on Jan. 10, Jim Sheridan, director of Lockheed's Aegis U.S. Navy programs, said in a media briefing three days later.

"They went live with the radar and there were targets of opportunity," he notes, "probably commercial aircraft." The same day, the Aegis Ashore facility slated for Romania tracked a ballistic missile for the first time. "You don't have an opportunity every day with a ballistic missile. It was the first live BMD track for that facility," Sheridan remarked.

Europe, too, is taking steps toward BMD. The requirement for the Euro-

sam SAMP-T surface-to-air missile system, based on the MBDA Aster missile, to have anti-tactical ballistic missile (ATBM) capabilities has waxed and waned since its inception. Early Eurosam briefings always stated that this was a formal ambition, but as budgets and requirements have changed since the early 1990s, so has the urgency of this capability.

However, France made the first efforts to prove the ATBM capabilities of the SAMP-T with trials against representative targets in late 2010 and late 2011. The new Block 1 missiles were fired against a Rafael Black Sparrow target, with successful results. The French government stated from early 2011 that it was a priority to introduce ATBM capabilities into SAMP-T, with an early initial capability to be upgraded later. The threat of Libyan ballistic missile attacks in 2011 added urgency to this plan.

Italy followed France, with ATBM test firings in late 2012 intended to lead to a formal in-service capability. According to the Italian defense ministry, the SAMP-T capabilities are in excess of those provided to date by the Patriot PAC-2 SAM system. Italy is still the only NATO nation to have been targeted by ballistic missiles, in the form of Soviet Scud-Bs fired by Libya's then-ruler Muammar Gaddafi in 1986, in retaliation for U.S. raids on Tripoli.

Singapore, with a stated ATBM requirement, selected the SAMP-T/Aster 30 in September 2013 to replace the aging I-Hawk. It will be used in conjunction with the nation's ThalesRaytheon Ground Master 200 air defense radars, with early warning from IAI-Elta Conformal airborne early-warning aircraft.

The U.K. has lagged behind France and Italy in the development of BMD technologies and systems. British forces do not have a land-based,

medium-range SAM system to form the basis of a BMD capability. Briefings have suggested there were no real plans for a naval-based ATBM capability based on the Type 45 anti-air-warfare destroyer. However, the system deploys the Aster 30 missile used in the French and Italian tests, and the BAE Systems Sampson tracking radar and S1850N early-warning radar have been known since the Type 45's inception to have capabilities for ATBM missions.

Recently, there have been indications that a BMD capability for the Type 45 is being actively pursued. In a February 2014 parliamentary answer, the minister of state at the U.K. Defense Ministry, Mark Francois, said "ballistic missile defense options, including those for the Royal Navy's Type 45 destroyer, will be considered as part of a future Strategic Defense and Security Review (SDSR)." The next SDRS is due to be published after the general election in May 2015.

And although not officially confirmed, Defense Ministry background briefings have said that as part of an around-the-world tour in 2013, HMS Daring, the first-in-class Type 45, visited Kwajalein Atoll in the Marshall Islands, primarily used by the MDA as a BMD test range. It would seem likely that a post-2015 defense review could see the U.K. opt to enhance the Type 45 with the necessary software changes to provide full ATBM capabilities, along with adapted Aster missiles.

Further in the future, MBDA is looking at an Aster Block 2 BMD interceptor, which in fact will be a new missile compatible with SAMP/T and the naval Principal Anti-Air Missile System. The company is looking at a two-stage missile with a kill vehicle similar to the U.S. designs, and an infrared seeker and solid-fuel divert power system developed by Safran. ☼

France and Italy have been jointly working on BMD demonstrations with the SAMP-T missile system and its Aster 30 interceptor.





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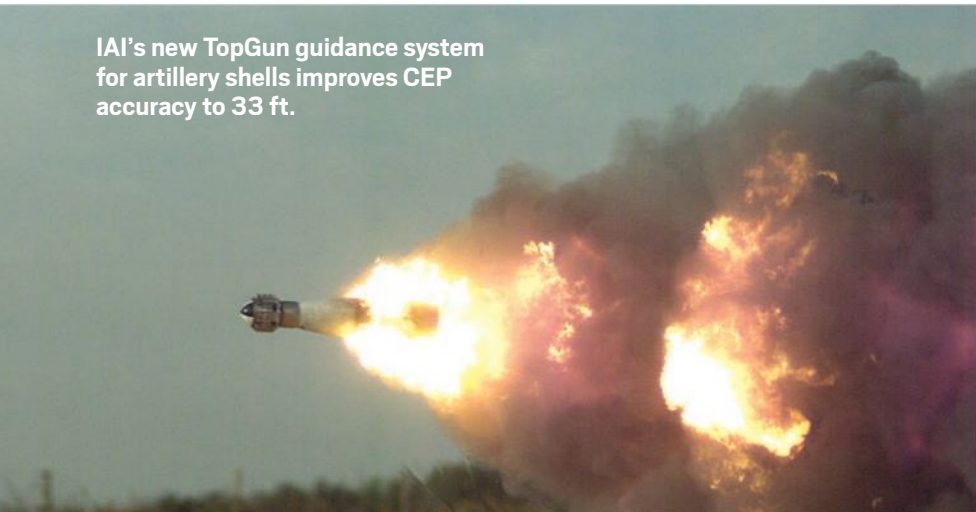


Bang On

Greater accuracy and range restore impact of artillery

David Eshel Tel Aviv

IAI's new TopGun guidance system for artillery shells improves CEP accuracy to 33 ft.



ISRAEL AEROSPACE INDUSTRIES

Empowered by modern technology, artillery is regaining its fabled punch after being diminished by the evolution of aerial attack and missiles.

The introduction of precision strike, driven by guided missiles, had threatened to eliminate artillery from the battlefield. However, advances in such areas as high-g-resistant electronics, durable guidance systems and miniature servos have endowed artillery with advanced capabilities.

The current ability of artillery systems to rapidly deliver powerful yet low-cost firepower, with minimal exposure to enemy countermeasures, is returning this legacy weapon to its traditional role as a tactical and strategic force multiplier.

This is especially evident in developments from the Middle East and Asia, areas of ongoing conflict where new and recently developed artillery systems offer potent battlefield advantages.

As modern ground forces became more maneuverable and efficient, their irregular opponents turned to complex terrain for cover. In contrast to the past, where guns grew bigger and heavier, artillery advances are now about precision, speed and efficiency. This means delivering a payload on target in the shortest time possible and destroying only the target. Collat-

eral damage, though always possible, is nevertheless unacceptable.

Relying on howitzers that have been in service for decades, firing shells that cost hundreds of dollars each, conventional artillery fire is likely to be the least cost-effective bombardment option. The statistical dispersion of shells, moreover, means this is also a weapon most likely to cause collateral damage, a problem for commanders and politicians.

Improving the precision of fire makes artillery more popular with commanders. The Israel Defense Forces (IDF) are considering several approaches in this area, which would be employed at battalion or battery levels, enabling immediate improve-

 **Tap the icon** in the digital edition of *AW&ST* for a look at the latest developments in guns and artillery, or go to AviationWeek.com/artillery

ment of precision without the need to upgrade an entire fleet of self-propelled guns.

One approach pursued by contractor Rafael aims to reduce the dispersion of artillery shells by improving ballistic fire calculations. This involves firing and tracking a test round and measuring its deviation from a predicted trajectory. Using precision tracking sensors, the system provides a new firing data set for the mission that narrows the dispersion of conventional "dumb" shells into a circular error range of a few tens of meters.

Another method implemented by Israel Aerospace Industries (IAI) replaces a standard fuze with a guidance system that converts a shell into a guided weapon. Called TopGun, it comprises a navigation system, autopilot and movable fins that guide a shell to a target with circular error probable (CEP) of less than 10 meters (33 ft.).

Unlike many precision-strike weapons that depend on visibility or other external input, IAI states that TopGun will hit its intended target with the same precision when fired from 10, 20 or 40 km (6, 12 or 25 mi.) under all weather conditions. In fact, IAI says the farther the shot, the better the accuracy, as the system has more time to measure and correct the flight path.

The system maximizes the utilization of artillery, as it enables units to deliver effective fire as necessary, while retaining existing capabilities such as suppression fire, smoke, illumination and other forms of support. TopGun is also designed to integrate a semi-active laser guidance unit in



Guided rockets from IMI can be used for coastal and island defense against sea targets.

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the future, which would give it surgical strike capability.

Designed as an affordable upgrade for artillery shells, TopGun begins qualification testing this year. Assuming qualification by the IDF, the company plans to offer the

The Iranian Fateh-110 is a guided tactical ballistic missile that is also produced in Syria.

guidance system for export. The target price of \$10,000-15,000 positions it as an affordable upgrade for existing stockpiles of 155-mm rounds. IAI intends to compete for the U.S. Army's next-generation Precision Guidance Kit (PGK Mk. 2), expected in fiscal 2016, and is discussing cooperation with manufacturers abroad.

Higher in the artillery fire scale are guided rockets, which extend the reach of ground-launched precision weapons to 150 km. These rockets, known as Magic Spear or Extra, were developed and exported by Israel Military Industries (IMI) and are likely to be fielded with new IDF artillery rocket regiments.

Extra implements an affordable guidance module developed by IMI and offered with the contractor's 160- and 306-mm ballistic rockets. The guidance kit reduces the statistical error of a rocket carrying a 120-kg (264-lb.) warhead to less than 10 meters CEP from the target, regardless of range.

The range and precision of Extra led IMI to offer an innovative implementation of rocket artillery for maritime use. The Coastal and Islands Defense System (CIDS) concept employs rockets to create a defensive shield 100 mi. from a coastline, effectively protecting a significant part of a nation's economic exclusion zone (EEZ), which typically extends 200 mi. out to sea. Guarding this area normally requires significant naval force for security and control. IMI argues that where a small naval force is backed by the effective shore-based firepower of CIDS, deterrence is enhanced.

Here is how the scenario works. Various guided rockets, manned or unmanned, can be deployed to cover ranges of 10-150 km. These rockets would be linked to coastal radars that detect and locate targets at sea. The entire system is linked through a command-and-control network to a local or remote command center tasked with area security. CIDS could defeat an assault force heading to shore or civilian vessels illegally operating in the EEZ. The island commander can launch rockets in a direct, lethal attack or use them as deterrence. Based on targeting data provided by the radars, rockets can be fired at vessels but set to explode above them, thus acting as warning shots.

If the island-protecting Extra rockets are a partial alternative to a naval force, heavier guided weapons with



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bigger warheads and longer range would be an option to air strikes, providing ground combat elements with a weapon system that has theater-strategic effect. Such a weapon is the Long-Range Attack (LORA) missile, developed at IAI's MLM division. This ground-launched weapon is fired from a canister and guided by GPS/INS (inertial navigation system). The missile has a diameter of 610 mm (24 in.) and is 5 meters long. It weighs 1.6 tons and is armed with a 250-kg warhead.

After the LORA missile flies to an altitude of 150,000 ft., it shapes trajectory to hit the target at a preset angle and terminal speed of Mach 3. The speed and shaped trajectory contribute to the weapon's ability to evade most missile-defense systems. The guidance system is also designed to resist electronic warfare and GPS spoofing.

The LORA missile hits targets 250-300 km away with GPS precision (less than 10 meters CEP), which is enhanced with electro-optical terminal guidance. LORA is available in ship- or ground-launch configurations.

A guided ballistic missile produced by the Turkish company Roketsan is

The TopGun system replaces a standard fuze on conventional shells, converting them to guided projectiles.

the Yildirim ("Thunderbolt") J600T, which is based on the Chinese B-611 and co-produced with China. Yildirim is 6 meters long, 600 mm in diameter and carries a 480-kg warhead. Three versions are available with ranges of 150-900 km. Stated accuracy is 150 meters CEP with GPS/INS guidance.

Iran and Syria are both producing guided tactical ballistic missiles: Iran's is the Fateh ("Victorious") -110, and the Syrian versions are designated Tashreen and M-600. Original assessments put accuracy at less than 100 meters CEP, but recent reports narrow this to 30 meters.

The 3-ton Fateh-110 missile is 8.8 meters long and 610 mm in diameter.



Unlike many Iranian missiles, it is likely an indigenous design. From Iran the design migrated to Syria and, apparently, North Korea. The Fateh-110 has a range of 250 km and a 650-kg warhead. Syria's version has a 450-kg warhead and terminal speed of Mach 3.7.

Iran has improved the missile with a thermal seeker for terminal guidance, leading to a version called Khalij Fars ("Persian Gulf"), which is a ballistic anti-ship weapon. 🚀

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Sensors Top Socom Needs

Better information wanted to support special operations

John M. Doyle Washington

U.S. Defense Department leaders think special operations forces (SOF) are uniquely suited for the most likely missions of the future—counter-terrorism and crisis response.

The Pentagon, in fact, plans to cut troop strength and force structure “in every military service” in the fiscal 2015 defense budget “to protect critical capabilities like SOF and cyber-resources,” Defense Secretary Chuck Hagel said before the document’s release March 4. The Pentagon wants to increase manpower at U.S. Special Operations Command (Socom) by



U.S. AIR FORCE

3,700, to nearly 70,000. Sensor upgrades for manned and unmanned aircraft are also sought. But what new technologies are special operators looking for?

Socom “is always looking for us to help them,” Rear Adm. Matthew Klunder, chief of naval research, told Aviation Week Feb. 6 at a defense industry conference. What they like are ideas such as, “Can we be anywhere on the globe and get quick access” and full connectivity, Klunder remarked after speaking at Bloomberg’s Defense Transition conference. In other words, “full C⁴I, comms and maybe even information flow to the people who need to make decisions” anywhere in the world.

There’s always a need for intelligence, surveillance and reconnaissance (ISR) technologies—especially for sensors that penetrate foliage and weather, Air Force Lt. Gen. Bradley

Heithold, Socom’s vice commander, told a National Defense Industry Association (NDIA) conference in February.

“Our focus is on high definition. That’s a game-changer,” Heithold said. “We’re in the business of man-hunting . . . so the fidelity that we get from our sensors is important.”

Socom is also modifying its fixed-wing and unmanned aircraft with updated signals intelligence. “I don’t think we have a gap there, but it’s a game you’ve got to be in all the time. You can’t fall behind,” Heithold told NDIA’s Special Operations/Low-Intensity Conflict Symposium.

Modularity for Socom aircraft is important, says Richard Holcomb, civilian deputy to the commanding general of U.S. Army Special Operations Command. Modular ISR, strike, and airdrop mission packages for aviation assets “are clearly the way of our vision [going] forward,” he adds. Army experts are also exploring how to arm the Bell Boeing V-22 Osprey tiltrotor aircraft. Another area needing study is non-lethal capabilities such as directed energy, Heithold says.

Undersea mobility is a crucial technology. While progress is being made with the Advanced SEAL Delivery System, a mini undersea vessel to transport Navy SEALs from a submerged submarine to shore, he urges industry to come forward with technology that helps SOF’s stealth capability. “Our true magic is going to be our ability to infiltrate and ex-filtrate from the sea, under the sea.”

Adm. William McRaven, who heads Socom, told Congress recently he wants to ensure operators have the communications infrastructure and equipment needed to sustain operations. To the House Armed Services Committee, he noted that Socom “continues to pursue game-changing technologies.”

A priority for McRaven is developing a protective ballis-

Special Operations Command is looking for technologies that will keep operators—such as these Air Force combat controllers—in touch anywhere in the world.

tic suit for special operators in kinetic situations. Called the Tactical Assault Light Operations Suit (Talos) project, the concept calls for lightweight armor with sensors to monitor heart rates, temperature and other vital signs, as well as keeping wearers cool or warm. “If we do Talos right, it will provide a huge advantage over our enemies and give our warriors the protection they need,” McRaven told NDIA.

To spur development, he envisions an X Prize-type competition for industry. McRaven would like to offer \$10 million to the winner, and is working with Pentagon leadership for authority to spend that much. Already, 56 corporations, 16 government agencies, 13 universities and 10 national labs are involved.

McRaven said three prototype suits—without autonomous power systems—are being delivered to Socom in June for testing. The goal is to develop a deployable combat suit by August 2018. He acknowledged that providing such a high-technology suit with an independent power source is “the biggest stumbling block to having a suit that a person can wear.”

He said Socom is planning a “Monster Garage-type” event to attract tinkerers as well as scientists, and have them collaborate with engineers, designers and craftsmen to build components for Talos and “potentially even a complete suit.” McRaven said that solving the problems of powering the suit “will have greater applications across the SOF enterprise.”

“The guy is focused on [Talos],” Heithold said, in urging more industry involvement in McRaven’s aim to protect “the first person through the door” during a raid. ☼



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Handy Support

U.S. Army testing portable close-air-support options

David Hambling **London**

Tactical air support can't arrive fast enough for dismounted infantry, and there's never enough to go around. That may change with the U.S. Army's Lethal Miniature Aerial Munition System (Lmams), which literally puts airpower in the hands of those who want it, in the form of a portable unmanned strike aircraft.

Lmams follows the successful deployment of a small number of AeroVironment Switchblade unmanned aerial systems (UAS) in Afghanistan since 2012. The operational concept is similar.

The system weighs a few pounds and is man-portable. It can be launched beyond line-of-sight from behind cover and transmits video images to a hand-held controller. Switchblade has a flight time of 10 min. with an electric motor, and a communication range in excess of 6 mi. Once a target is identified, the operator locks on and Switchblade pursues and destroys it with a 1-lb. warhead. It is effective against soft targets and light vehicles, and once locked on can track rapidly evading targets.

The Lmams numbers may be considerable. Rather than a



TEXTRON CONCEPT

few dozen units as in previous orders, a recent Army request for information (RFI) asked for pricing for production of up to 500 controllers and 2,500 all-up rounds per year. As the incumbent, AeroVironment is in a strong position, but challengers such as Lockheed Martin and Textron have their own strengths.

Lockheed Martin's offering is a twin-propeller craft known as Terminator. It launches vertically, and has a modular design: the warhead can be swapped out for additional sensors for tactical reconnaissance, a reusable role.

A Lockheed representative says Terminator's strengths are reliability, accuracy, lethality and ease of use. It is backed by the company's experience in small UAS such as Stalker.

Textron's BattleHawk has flight endurance of 30 min., and is reportedly easy to use, the user interface being based on the Android operating system. Textron's Cathy Loughman describes BattleHawk as an evolutionary development: Sol-



LOCKHEED MARTIN CONCEPT

Lockheed Martin's Terminator UAS launches vertically and can be equipped with a warhead for one-time use, or with sensors for multiple recon flights.

diers already have tactical UAS and use them to direct fires. This puts everything in the same package. "BattleHawk provides situational awareness and ability to effectively engage that target efficiently through the same system," she says.

Both systems have top speeds of over 100 mph. Lmams is envisioned as being "organic at the small-unit level," and would be carried by the platoon that uses it. It has been mentioned as a counter-sniper weapon, for its ability to locate and engage snipers while the operator remains concealed. Lmams could also be valuable in countering mortars and other beyond-line-of-sight targets.

Other strengths include accuracy and low collateral damage. For example, Lmams can act as a long-range precision grenade-launcher, able to put a warhead into a foxhole or through a specific window from miles away. With a man-in-the-loop throughout the engagement, Lmams has a "wave-off" capability. If a close-up view shows at the last second that an invalid target was selected, the operator uses a "go-around" option to end the attack. This means that targets can be engaged which otherwise would be uncertain from long range.

The BattleHawk UAS from Textron has a user interface based on the Android operating system.

Training is likely to be straightforward. All manufacturers stress ease of use, and previous experience with small UAS suggests that as little as three days training are needed. This is in contrast to larger UAS, which may require pilot certification. The Army's RFI also requests a quote for up to 150 training simulators per year.

As well as stand-alone mode, Lmams has potential as a networked weapon, prosecuting targets located by tactical UAS or other sensors. Both Lockheed and Textron are exploring these options. Terminator accepts video and GPS data from other assets, so an operator can use these to direct a strike. Terminator can also transmit video and data to multiple users. Loughman says BattleHawk has been integrated in the Army's Precision Fires Manager, a networked system combining real-time targeting data from multiple sensors.

Future developments may see Lmams launched from air, land and sea vehicles. Switchblade has already been launched from a submarine, which could provide a covert precision-strike capability. There are likely to be further warhead and sensor options. Terminator in particular is designed as a modular system, so new options can be added as plug-and-play units.

The RFI suggests beginning Lmams production in the next 18 months, and transition to a program of record is anticipated. ☛



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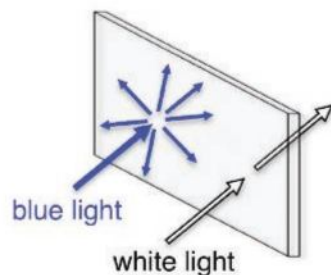


Smartphones are convenient, but hardly secure. Hence, the need for U.S. defense and security personnel to have one with protected communication. Enter Boeing Black, a modular device that guards data, resists hacking and encrypts conversations. The phone's ultimate protection is a self-destruct mechanism triggered by tampering. Boeing doesn't disclose what this involves, but it's probably a technique for erasing data or destroying circuitry. The company isn't releasing much about the smartphone. What's disclosed is that it's based on a proprietary architecture called Pure-

Secure, uses the Android operating system and has a modular expansion port for sensors, satellite connectivity, extra power and other functions. It has a trusted boot, dual-SIM capability that permits users to switch between government and commercial networks, and connections for PDMI, USB and secure digital cards. The device is powered by a lithium ion battery but can be configured for solar power. The phone is 5.2 in. long, 2.6 in. wide and 0.5 in. deep. It has a 4.3-in. display, is Bluetooth-enabled and weighs 5.4 oz. No details on cost, sales or activation timetable. Boeing says the phone is assembled in the U.S., but hasn't disclosed where components are sourced. ☛

SEE-THROUGH VISUAL

Transparent displays are used in platforms from aircraft heads-up and helmet-mounted displays to automotive windshields, motorcycle helmet visors and eyeglasses. Researchers at the Massachusetts Institute of Technology say each system has limitations, mostly in viewing angles. A team led by MIT Profs. Marin Soljacic and John Joannopoulos developed an alternative display technology in which nanoparticles embedded in a transparent material were tuned to scatter a select wavelength—or color—of light, transforming it into a projected image and letting other wavelengths pass through (see illustration). The effect is similar to using smoke as a medium for detecting a laser beam. In proof-of-concept demonstrations, silver nanoparticles, each 60 nanometers across, produced a blue image on a transparent panel. The image was visible from an array of angles. While blue is a characteristic of light scattering by silver nanoparticles, the researchers say the technique can be adjusted to scatter red, green and blue wavelengths to produce full-color images. The work, funded in part by the U.S. Army Research Office, is being optimized. Approaches under consideration include embedding nanoparticles in thin polymer coatings on windshields and other transparent surfaces. ☛



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HACKER'S DELIGHT

As if there aren't enough concerns about computer security, researchers at the Fraunhofer Institute for Communication, Information Processing and Ergonomics in Germany say laptops and other mobile devices are susceptible to hacking through the high-frequency audio signals they emit. According to an *Inside Science* report, an experiment by Michael Hanspach and Michael Goetz demonstrated that data on air-gapped computers—those not connected to the Internet—could be stolen or corrupted by “covert acoustical networking,” a concept some experts had dismissed. With this technique, a nearby computer (65 ft. away in the experiment) retrieved data by capturing ultrasonic frequencies emitted through components of a target computer's sound system. The transmission rate is slow, 20 bits per second, and data volume is correspondingly low. But it's enough to capture keystrokes, login codes and encryption keys. Hackers need a program to retrieve the data, and target com-

puters must somehow be infected with malware that can be activated by a hacker's audio signal. Proposed safeguards include shutting off audio input/output features, blocking high-frequency signals and, most effective, operator caution. ☒



U.S. ARMY

SPECIAL DELIVERY

The British Army is evaluating a method of assuring that adequate fuel is available to aircraft during overseas operations near water. The technique involves the use of a towed flexible barge (TFB)—an established platform—to offload fuel from tankers, which is then transported to shore through waters too shallow for a vessel to enter. In trials last month in Cyprus, a team from 516 Royal Engineers conducted operations with a 69-meter (226-ft.) rubber tube. A hoist dropped the tube in the water and a British Army workboat towed it offshore to a tanker, where it was loaded with fuel. The TFB was then towed to a site within 200 meters of shore and secured by engineer divers to a temporary seabed anchorage. A two-man crew on a hydraulic-powered raft launched to the barge and attached a 200-meter flexible hose. Fuel was transferred at a rate of 2,000 liters (528 gal.) per minute to flexible bladders on shore, each of which holds 136,000 liters. From the bladders, fuel was pumped via a network of pipes and valves into holding tanks for delivery to the flight line and hot refueling of helicopters and other aircraft. ☒



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VERONIQUE CHAM-MEILHAC

Vice president of ballistic missile defense, MBDA

Education: Engineering degree from Ecole Polytechnique Feminine; MBA, Ecole Nationale Supérieure des Techniques Avancées; Institut des Hautes Etudes de Défense Nationale.

Career: Responsible for Exocet seeker-heads; head of MBDA's strategy and marketing division; devised the industrial agreement that created MBDA; responsible for ballistic missile defense since 2004.

Ballistic Vision

One of the rare women executives in the male-dominated business of missiles, Veronique Cham-Meilhac, vice president of ballistic missile defense at MBDA, sees her job primarily as protecting people. A frequent speaker at conferences and seminars, she explains this complex subject in straightforward terms, as she did recently for European Defense Editor Christina Mackenzie.

Defense Technology: What is the ballistic missile threat and where does it come from?

Cham-Meilhac: Ballistic missiles are a palliative for countries with no other way to combat air superiority. They allow a country with few or no fighter aircraft to attack enemy air superiority from a safe position well out of harm's way. Consider Syria against Israel. Syria has few aircraft but many ballistic missiles. And the improved missiles, which began to appear a decade ago, have greater range and might carry nuclear warheads. China developed a missile that can reportedly attack naval targets as well as ground targets.

What do we know about improved missiles?

The DF-21D is the best known of the new Chinese missiles. It has a range of 1,500 km (932 mi.), a ship-homing seeker and is designed to deny access to China's territorial waters. We don't know if the corresponding command-and-control systems have been successfully developed. Many other countries want this type of missile. Iran, for example, doubtless had help developing the Khalij-Fars missile, which is the anti-ship version of the Fateh 110.

How is it that Russia, which has fighter aircraft, developed the Iskander ballistic missile?

The SS-26 Iskander was developed for export as an improved version of the Soviet-era Scud. With its precise guidance system, it is designed to hit targets such as command-and-control centers. The SS-26 is deployed in the Russian exclave of Kaliningrad between Poland and Lithuania. The Russians say they have a 500-km-range national version and a 300-km export version. Some 20 countries are thought to have procured versions of Scuds, so they would be obvious potential candidates for the SS-26.

Why don't European nations develop ballistic missiles?

Because they have combat aviation fleets worthy of the name and do not foresee going to war with any neighbors that would be within ballistic missile range. France did develop the Hades missile years ago, but it was never deployed.

What makes improved ballistic missiles hard to detect?

Solid propellants. In the past, missiles could be detected while being filled with liquid propellant, which could not be done prior to their transport in a truck container. Today they are increasingly powered by solid propellants, so they are ready to fire as soon as they come out of their hidden depots. This means they can only be

detected when fired. The Sejil, Iran's new version of the Shahab, has solid propellant and an increased range of 1,800-2,000 km, for example.

How do MBDA's Aster missiles cope with this threat?

The Aster Block 1 NT (new technology), which is a SAMP/T missile with an upgraded interceptor and has an in-service date of 2020. In the 2014-19 French military program law, a budget has been earmarked from this year to develop the NT, which is qualified against missiles with a range of 600 km. The NT will extend this coverage to 1,500 km, due to its K_a-band seeker and optimized guidance, maximizing the probability of hit-to-kill and enlarging the areas defended. NT will be effective against missiles with a range of 1,500 km, beyond Aster's outstanding performance against conventional 600-km-range missiles. Italy has declared an interest in joining this upgrade program, and in January the U.K. declared it would join France to study an extended antiballistic role for Aster. We are also proposing Aster Block 2, which would extend coverage against current and next-generation ballistic missiles up to 3,000 km.

Ideally, ballistic missiles should be intercepted before they start maneuvering. Aster Block 2 would do that but no European government can self-finance development. We have been self-financing work with Safran on this, but for the time being are having a hard time raising interest among political decision-makers, although in the framework of NATO missile defense this capability would complement U.S. systems. It is a complex subject, particularly in the context of defense cuts in Europe. ☞



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Backup Plan

India seeks quick solution to significant helicopter gap

Asia-Pacific Staff New Delhi

With the Indian government and AgustaWestland on the verge of what could be lengthy litigation over the cancellation of a deal for 12 AW101 VVIP helicopters, the Indian air force (IAF) has decided to fast-track a back-up, with time running out for its shaky fleet of Soviet-era Mi-8 executive transport rotorcraft.

India's defense ministry has formally initiated paperwork and discussions that will potentially lead to a fresh competition. Until then, however, the air force must have helicop-

air force is considering a second, more likely stopgap—modifying some of its brand-new Mi-17 V5 new-generation medium-lift helicopters for the VVIP role. The air force has ordered 139 V5s, several of which performed stellar missions during a massive humanitarian relief effort in northern India last year. But the idea that Mi-17s could be used to ferry Indian government leaders has raised eyebrows in the charged atmosphere that continues to swirl in the wake of the AgustaWestland scandal.

"I don't see how the IAF can even think of flying country leaders in

tractual clause would be the same for all vendors. As no integrity pact and earnest money deposit were received from Rosoboronexport, their techno-commercial offer was not accepted."

This, however, may be a technicality the IAF is willing to overlook.

A Rosoboronexport trade officer based in New Delhi says: "The Mi-17 is a proven platform. We believe it is the right way to go before a permanent decision is made on a new platform. We have also made a proposal to configure some of the yet-to-be supplied V5 airframes for VVIP transport roles. The government is evaluating this offer."

Given the sensitivities surrounding defense procurement, especially in an election year, the Mi-17 option appears likely to be chosen. For the air force, choosing the Mi-17 would provide new airframes without a fresh acquisition.

Sikorsky, which lost the Indian VVIP helicopter competition to AgustaWestland, is observing developments cautiously from the sidelines, careful not to step into the turbulence too directly for now. A top executive in the company's Indian division confirmed that Sikorsky was standing by to respond to any specific request made by the Indian defense ministry. India's 2006 defense buying rules laid down provisions for emergency acquisitions or lease of tendered equipment from a compliant runner-up in the event of a deal cancellation, he points out. He adds that the company had internally prepared a "customized solution" based on the S-92, but would hold onto it until approached by the government.

With the Indian government moving to return the three delivered AW101 helicopters to AgustaWestland, the company has strenuously tried to convince the defense ministry to reconsider. Top defense officials said AgustaWestland had advised the Indian government to keep and operate the three helicopters for VVIP missions, and that a decision on returning them could be made if corrupt practices were conclusively proven in an Italian court. The company is understood to have also offered to maintain the aircraft for that stated period.

But with the Indian Central Bureau of Investigation (CBI) conducting a parallel investigation into the deal, and with the scandal already damaging the government's image in the election season, it appears highly unlikely that AgustaWestland helicopters will fly an Indian prime minister or president. ☛



India's military is considering modifying its Mi-17 V5 medium-lift helicopters to carry dignitaries.

ters to ferry government leaders and visiting dignitaries.

The IAF's New Delhi-based VVIP squadron has told the defense ministry its 26-year-old Mi-8s could be modified to serve another three to four years, though this—in the words of a senior pilot—was an "absolutely avoidable stopgap." His concerns are shared by defense acquisition officers who argue that the aircraft are at the end of their useful life, and ferrying dignitaries in them would "not work."

The possibility of an interim overhaul of the Mi-8 fleet by state-owned HAL has not been ruled out. But the

Mi-17s, considering its maker was eliminated from the original competition for refusing to sign the mandatory integrity pact," says a senior Finmeccanica executive.

The executive is right. In February of last year after the scandal broke, while detailing the 2006 VVIP acquisition effort the Indian defense ministry officially stated: "Rosoboronexport did not submit an earnest money deposit and the integrity pact, along with their technical and commercial proposals. It had been made clear to Rosoboronexport in February 2007 that this was a global tender and hence every con-

Back Again

After a long absence from the market, Delta moves toward renewing its long-haul fleet

Jens Flottau **Atlanta and Frankfurt**

Delta Air Lines is known for its specific fleet strategy—keeping aircraft longer and shying away from buying new types early. Nonetheless, the airline is in the early stages of what could evolve into a massive fleet overhaul.

The airline plans to issue a request for proposals (RFP) for new long-haul aircraft this month. The aircraft are intended to replace the airline's Boeing 747-400s and a significant portion of its Boeing 767-300ERs. A firm decision to order could come by year-end. The airline is reviewing many types, but is particularly interested in the proposed Airbus A330neo.

The oldest of Delta's 16 747-400s was delivered in 1989 to then-Northwest Airlines. The airline is looking at replacing them before the next D checks are due, toward the end of this decade. Delta also wants to start the replacement cycle for its 58 767-300ERs, whose deliveries spanned 1990-2001.

The carrier plans to look at four options: Airbus A350-900/-1000s, all three models of the Boeing 787, the current versions of the A330, and a reengined A330. The Boeing 777X has already been ruled out. "We don't want experimental airplanes," says CEO Richard Anderson. "We are not interested in it."

But yet, an order for a reengined A330 is a strong possibility. "I hope [Airbus] offers an A330neo," Anderson says. "There is a huge need for a small widebody. We really need Airbus to step up and reengine." Anderson is pushing for a new 275-seat aircraft with 5,000-5,500-nm range. He argues that "aircraft that underfly their range are uneconomical. You cannot make a 777 consistently profitable flying only

U.S. East Coast to Europe. That [encompasses] routes that are one- or two-thousand-nautical-miles shorter than what it was designed for."

All three major U.S. carriers have now begun to plans to replace parts of their 767 fleets, pending Delta's decision. The new orders will also lead to retirement of the 747 in the U.S. passenger airline fleet over the next several years; the type is still in service with Delta and United Air Lines.

The multi-billion dollar plan completes the picture of a revitalized U.S. airline industry that has been posting impressively improved profits on a consistent basis, thereby providing the financial means to begin investing again. In addition to large orders for new narrowbodies from the "Big Three" carriers, United has already started the long-haul aircraft replacement cycle with its first 787-8s. It also has orders for 35 A350-1000s, 20 787-10s (United is one the launch customers), 26 787-9s and 10 more -8s. Even American, which has both emerged from bankruptcy protection and combined with US Airways, has 42 787s and nine more 777-300ERs on order.

At Delta, the picture differs somewhat from its competitors: It is taking 84 more 737-900ERs, 30 A321s and 68 more 717s, but its long-haul orderbook has been more limited; it lists 10 A330-300s and 18 787-8s (inherited from Northwest). Since its bankruptcy and

Delta operates more than 30 Airbus A330s and has orders for 10 more. It has indicated an interest in a reengined version.

subsequent merger with Northwest, Delta has only placed one order for new aircraft—100 737-900ERs in August 2011.

In spite of a traditionally cautious approach, Anderson believes Delta now has "good visibility" about the A350 and 787, enough to make a reasoned decision. "Both are pretty well down the road," he says, pointing out that Delta can draw upon the 787 operational experience of its partner carriers Aeromexico and Virgin Atlantic when the two airlines take delivery of their 787s.

The 10 A330-300s on order are for the increased 242-ton maximum-take-off-weight (MTOW) version; the first unit is set to be delivered from mid-2015. The airline also operates 21 lower-MTOW A330-300s and 11 A330-200s. Anderson argues that a reengined A330 would find high demand for transatlantic routes, intra-Asia and even some U.S. West Coast-Asia itineraries.

Airbus has entered talks with General Electric, Rolls-Royce and Pratt & Whitney about reengining the A330, but it has not yet made a decision. The backlog now stands at 258 aircraft, which takes production into 2016 at the current rate of 10 aircraft per month. The program could, however, receive a significant boost through a major order for potentially more than 100 aircraft from various Chinese airlines. It is unclear whether the Chinese order would include commitments for the reengined aircraft.

"Boeing made a mistake in not coming up with an answer for the 767 and 757 market," Anderson says. While the A330 and 787 are candidates for part of the 767 missions, "there is no obvious replacement for the 757." Delta plans to reduce its 757 fleet to about 90 by 2018.

Delta is seeking to fill its 115-120-seat aircraft gap with a model that is slightly larger than the 717s it is currently taking over from AirTran. "The 737-700 is not economical and the -800 is too large," Anderson says. One option could be the Bombardier CSeries with geared turbofan engines. "Our engineers have a lot of confidence in that gearbox," he points out. "But we want to see the aircraft in the marketplace" before placing an order. ☛

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Missing 777 underscores need for data-link technologies in routine ops

Sean Broderick *Washington*, **Jens Flottau** *Frankfurt*, **Guy Norris** *Los Angeles* and **Adrian Schofield** *Auckland*

The story of Malaysia Airlines Flight MH370 reads like bad fiction—a perfectly safe aircraft disappears from radar on a scheduled flight, and the extensive international search-and-rescue effort that ensues finds few clues. It is not fiction, but it should be in light of the technology to monitor aircraft and the massive amounts of operational data available.

On March 8, the aircraft, a Boeing 777-200ER registered 9M-MRO, operated the daily MH370 service from Kuala Lumpur to Beijing. Onboard were 227 passengers and 12 crewmembers. About 40 min. into the flight—around 1:30 a.m. local time—radar and radio contact was lost over the Gulf of Thailand, 90 nm off the Malaysian coast, near Kota Bharu. The aircraft is believed to have been on airway R208 heading for the IGARI waypoint, about to be handed over to Vietnamese air traffic control; it never checked in.

While the initial search focused on the expected flightpath of the aircraft between Malaysia and Vietnam heading principally north, the effort has been broadened. Ships, aircraft and helicopters were dispatched west and east of Malaysia.

According to a *Wall Street Journal* report, the aircraft kept

sending signals without content through the Aircraft Communications Addressing and Reporting System (Acars) for 4 hr. after the last radar and radio contact, which would indicate that the 777's engines continued to run throughout that period. This led to speculation about a possible hijacking. Boeing and engine manufacturer Rolls-Royce had no comment.

Malaysia Airlines CEO Ahmad Jauhari Yahya says the last Acars message was received at 1:07 a.m., well before radar contact was lost.

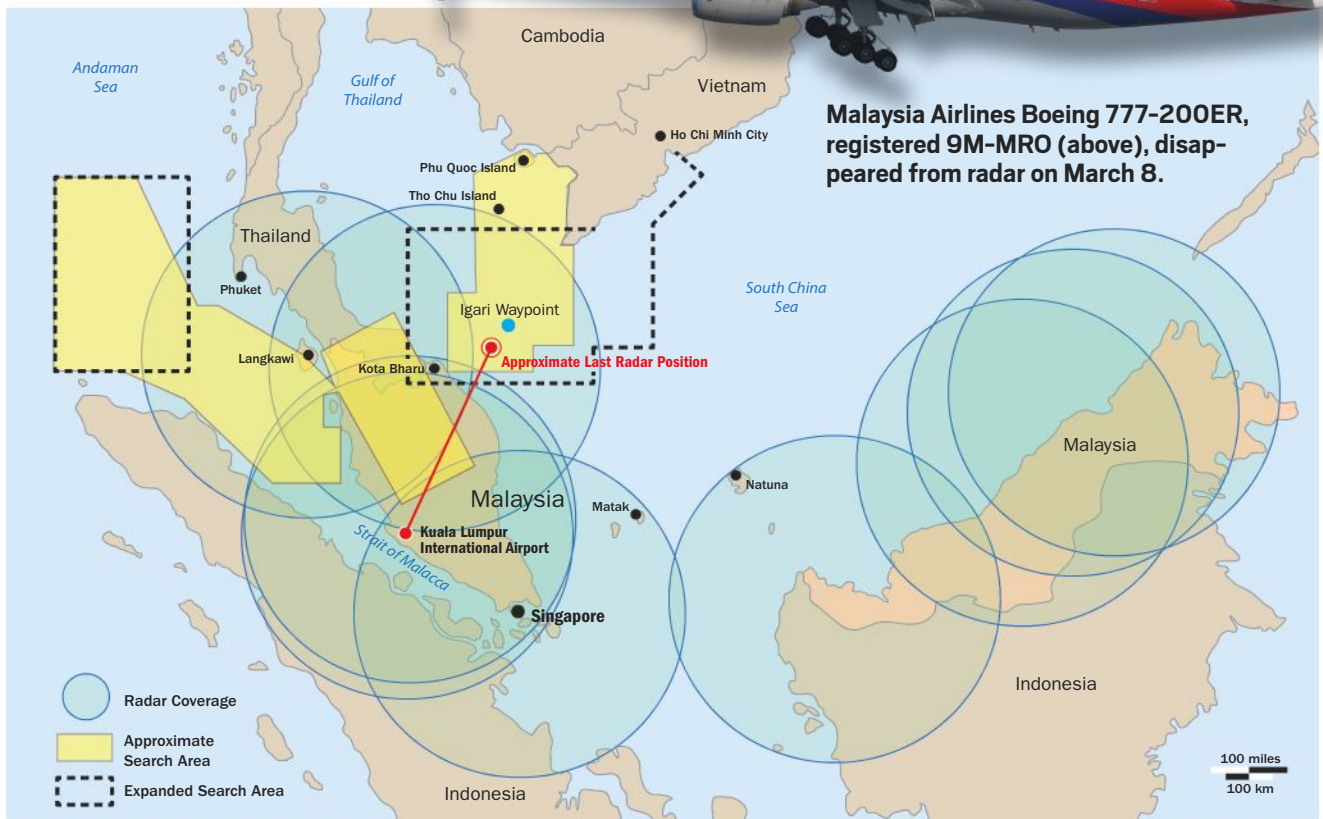
The airline took delivery of 9M-MRO in 2002; the aircraft accumulated 53,465 hr. and 7,525 cycles since then. It underwent scheduled maintenance on Feb. 23, 12 days before the March 8 flight.

Secondary surveillance radar (which interrogates the aircraft transponder for identity and position) only works within range of the radar. Automatic dependent surveillance-broadcast (ADS-B) also relies on aircraft transponders, which can be turned off manually. But had this been the case, primary radar still should have detected the aircraft. ADS-B continuously sends key locator information and works beyond radar coverage, although for now, only within range of a ground station. However, data can be received by other aircraft in the vicinity that are equipped to do so.

Surveillance over the South China Sea is improving, thanks to ADS-B systems that have been installed by several countries in the region. Singapore, Vietnam and Indonesia have such coverage and have agreed to share data. As of December 2013, aircraft are required to be equipped for ADS-B above Flight Level 290 on certain trunk routes



Malaysia Airlines Boeing 777-200ER, registered 9M-MRO (above), disappeared from radar on March 8.



that overfly the South China Sea—although those in question are farther to the east than MH370's scheduled route.

According to International Civil Aviation Organization (ICAO) documents, Malaysia is also implementing ADS-B surveillance to improve coverage of certain air routes that do not have complete radar coverage. This entails installing two ADS-B ground stations at radar sites in Pulau Langkawi and Genting Highland. Installation and testing are slated for 2014-16. Data-sharing with other countries and mandatory aircraft equipage on some routes are planned, ICAO states.

Eventually all commercial aircraft will stream live-status data directly to operation control centers, offering real-time situational awareness that is all but nonexistent today. The key question is whether operators will opt for their datasets and upgrades based on return on investment (ROI)—as they do now—or in response to a mandate issued to prevent another case like MH370.

Malaysia, like most other airlines, has not invested in a system that supplements standard aircraft-status-reporting channels such as air traffic control or Acars—a data link using VHF, HF or satcom over oceanic airspace whose messages are routed via ground stations to the end users.

Research led by the French accident investigation bureau (BEA), following the 2009 crash of Air France Flight 447 (AF447), underscored that feasible supplemental systems exist and can perform safety-related tasks such as tracking aircraft and automatically offloading flight-data recorder (FDR) parameters that go beyond the inflight engine-monitoring function used by many airlines. But the few operators that own them are primarily motivated by day-to-day operational benefits. "Nobody is going to purchase those services without a business case and a return on investment," says Matt Bradley, president of Flyht, which provides flight-data streaming on about 300 aircraft flown by 45 operators.

Today, that ROI comes from monitoring variables such as engine-surge data to head off unplanned repairs, or tracking maintenance faults so ground stations have what they need to keep inbound aircraft on schedule. It is often ancillary benefits from these systems, rather than data derived from safety-specific ones, that provide accident investigators with key insight.

The first clues about AF447's fate came via 24 automatic Acars messages relayed through the A330's Air Traffic Information Management System between the time of its last position report and its impact with the Atlantic Ocean.

Investigators probing the September 2010 crash of UPS Flight 6 near Dubai relied on a combination of Acars messages and data from Boeing's Airplane Health Management (AHM) real-time monitoring service to determine where the fatal onboard fire started, and not from the charred wreckage of the 747-400F.

UPS's AHM strategy underscores the reason that, even when carriers eye the bottom line, such systems are not more widely adopted. The carrier uses AHM for its 747-400s and MD-11s. Their long stage lengths give the carrier a better chance to act on fault messages and to have parts ready at a ground station, cutting aircraft downtime. Reliability is another factor. UPS's workhorse Boeing 757s and 767s do not produce enough schedule-crippling faults to justify the cost of AHM.

Acars helped shed light on some aspects of the AF447 crash, but not on locating the wreckage. BEA in 2010 created a working group to examine how best to pinpoint wreckage location and to alert others of a problem before an aircraft disappears from radar screens. The group ran simulations

using 689 sets of actual flight data, including 44 accidents and 28 incidents. It established parameters, such as unusual altitude, speed anomalies and warnings from onboard systems like TCAS (traffic-alert and collision-avoidance system) that would trigger an automatic response. Tested under binary (true/false) logic rules, the parameters detected 67 of the 68 accidents, and registered two normal flights as possible accidents. Most important, warning times were sufficient to send out relevant FDR data. Applying fuzzy set theory to the parameters, which gives them weight, detected all of the accidents with no nuisance alerts.

BEA then collaborated with Inmarsat to simulate each accident in 597 locations worldwide. Analysis showed that pre-impact transmission would have been possible in 85% of the combinations. In 82%, the corresponding wreckage search zone would be within a 4-nm radius. Trials with the globe-covering Iridium satellite network were similarly encouraging. "This study proves that developing reliable emergency detection criteria is achievable," the working group report stated.

BEA's research, which led it to recommend additional study into live data-streaming, included a demonstration of Flyht's emergency mode triggered by either manual input from the air or the ground, or predefined parameters. The monthly cost is approximately \$1,500 per aircraft, depending on service levels. Coverage is no issue.

However, data-streaming has some drawbacks. Bandwidth costs tip the scales toward event-triggered systems, but these rely on a precursor, such as an aircraft upset, which makes them useless in events such as rapid decompression or inflight explosions.

K_a-band, which powers onboard Wi-Fi on JetBlue Airways and United Airlines aircraft, offers promise. It costs at least 70% less than the more established K_u-band and offers much more bandwidth. While ancillary revenue from inflight entertainment is driving today's equipage decisions, K_a-band service provider LiveTV is convinced airlines will eventually equip for operational benefits; in-cabin revenue will be added value.

Any service based on inflight Internet has a coverage challenge, and K_a-band, being the newest, has the biggest. While service providers expect coverage gaps to be filled and roaming agreements to be struck, they acknowledge that a few satellite launches and business agreements are needed to bridge that vision and today's reality.

Tests to prove the viability of upgrading a standard-equipped flight deck for satellite-based connectivity were conducted onboard Boeing's 737-800 EcoDemonstrator in 2012. A version with higher bandwidth capability is due to be tested this year on a 787 development aircraft, which will be used as the company's second EcoDemonstrator (see page 46). Initial tests in 2012 evaluated an iPad-hosted flight trajectory optimization app which funneled real-time weather data to flight-deck crews. The data were the same as those normally transmitted to flight crews over the continental U.S. But in the case of the EcoDemonstrator, data were sent via satellite to simulate connectivity over oceanic airspace, where live-weather data is currently not available.

Boeing is studying the possible evaluation of a K_u-band satellite system on the 787 EcoDemonstrator. ☛

Editor's Note: This story has been updated to include the correct date of the aircraft's departure from Kuala Lumpur.

Follow coverage of the international investigation into the disappearance of Malaysia Airlines Flight MH370 at AviationWeek.com





Controversial Compromise

Europe amends its emissions-trading plan for aviation, but the debate continues

Cathy Buyck **Brussels**

The European governing institutions have hammered out a compromise deal to prolong the “stop-the-clock” provision on the European Union Emissions Trading System (ETS) for aviation to cover only flights operated within the European Economic Area till the end of 2016. This will ease international opposition to the system and give the International Civil Aviation Organization (ICAO) time to devise a global mechanism to curb aviation emissions.

But Europe’s airlines are not ecstatic about the deal, which for now is still informal, asserting that limiting the European Union ETS to intra-European flights results in competitive distortions. They also question why they have to pay for offsetting their emissions, thereby enriching governments’ treasuries, while the same governments are blocking the implementation of the Single European Sky (SES), which could save up to 18 million metric tons of carbon-dioxide emissions

per year (see article below). The draft agreement does not include a legal obligation for EU member states to invest ETS auction revenues in research and technology projects on climate change; it only requires the countries to inform the European Commission (EC) on the allocation of the revenues. This has been a very contentious issue in the negotiations among the European Parliament (EP), Council of the EU and EC. The council, which represents member states, is reluctant to have any prescriptions on earmarking, whereas EP representatives demand greater environmental stringency regarding ETS revenue spending. Airlines share the EP’s view.

“Airlines are only able to contribute their fair share if the regulatory environment enables them to do so, for example via earmarking of auctioning revenues for the sustainability of European air transport,” says Athar Husain Khan, CEO of the Association of European Airlines (AEA).

The AEA supports the overall draft compromise package that was agreed to by negotiators from the EP, council and EC on March 4 because the “decision to reduce the scope temporarily takes into account the achievements already made at the ICAO level,” it says. The association, which promotes the interests of Europe’s network carriers, recognizes that the agreement is not perfect, and it regrets that the “stop-the-clock” provision was not extended until 2020, when the global market-based measure (MBM) is due to come into force.

“The last thing we want as an airline industry is to be caught in the same mess [in 2017] that we have been caught

SES SLOWDOWN

The Single European Sky (SES) initiative has been touted as the largest climate-protection project undertaken in the European aviation sector. The full implementation of both pillars of the project—airspace consolidation and technology upgrades—could reduce fuel consumption and carbon-dioxide emissions by 10% per flight, according to the European Commission. Lufthansa has calculated that establishment of the SES would enable it to cut annual fuel consumption by about 270,000 metric tons—enough to fly an Airbus A380 from Frankfurt to San Francisco and back about 1,000 times.

European Commissioner for Transport Siim Kallas reiterated at the European Policy Center here March 6 that the SES project “needs to succeed and be implemented—as soon as possible.” He noted that “it will allow us to shorten flights, reduce delays and

emissions, and save about €3 billion [\$4.2 billion] each year, out of a total annual cost of €8 billion.”

The SES program was formally launched in 2004, but Kallas says that “progress here has been less than hoped.” He has publicly criticized EU member states for failing to implement existing SES legislation and last year proposed the “SES2+” legislative package aiming to speed up the much-needed and delayed reform of Europe’s air navigation services.

The European Parliament endorsed the SES2+ package in a plenary vote March 12, but the proposal also needs formal approval from the Council of the EU, which represents the member states. The initial SES2+ targets have been watered down by the EU member states, and a vote in the council is not yet on the agenda.

Under Greek presidency in the first half of this year, the Council of the EU has not included the SES2+ legislation in its work program, leaving the file up to Italy, which takes over July 1 in accordance with the presidency’s six-month rotation schedule. ☉

in in 2013,” says Husain Khan. “Legal clarity, legal certainty, planning and operational stability are key for the airlines. For AEA it is therefore essential that ICAO delivers a global MBM in 2016,” he adds.

ICAO working groups met in Washington early this month to kick-start discussions on establishing a global MBM.

The new EU ETS will cover emissions from all flights—no matter the nationality of the operator—till the end of 2016 between airports in the European Economic Area (EEA), which includes the EU’s 28 members plus Iceland, Norway and Lichtenstein. Flights to and from the EEA’s outermost regions will be exempt during the four-year period. These include: Spain’s Canary Islands; the French overseas territories of French Guiana, Guadeloupe, Martinique, Reunion and Saint Martin; and the Portuguese archipelagos of the Azores and Madeira.

Flights between airports in the EEA and Switzerland also fall outside the scope of the revised EU ETS. The initial one-year stop-the-clock measure, covering emissions on flights operated in 2012, included operations between airports in the EEA and Switzerland because the EC reasoned the country was part of “closely connected areas with a shared commitment to tackle climate change.” The Swiss government has always protested this view.

There will be an extraordinary two-year compliance cycle for 2013 and 2014 aviation emissions, which must be reported by March 31, 2015 (in two emissions reports), with allowances to be surrendered by April 30, 2015.

To speed up the process and quickly give airlines a legal framework, the new aviation ETS will be an EU regulation with binding legal force throughout the bloc as soon as it is passed, probably next month. Unlike the current EU ETS legislation, which is a directive, it will not require transposition into national law of all member states.

All options are left open for the EU to react to the developments of the ICAO assembly in September 2016 and to readjust the scope of the EU ETS from 2017 on. The compromise solution envisions a “snap-back” to the original ETS in 2017 if ICAO fails to deliver credible progress toward a global deal that would begin in 2020. Following pressure from

the EP’s negotiators, this ICAO MBM would “reduce greenhouse-gas emissions from aviation”—rather than achieve “carbon-neutral growth”—and be non-discriminatory, treating all airlines equally, regardless of their country of origin.

The Council endorsed the compromise package March 7, the EP’s Environment (ENVI) committee will vote on it March 19, and it will be submitted for a plenary vote on April 3.

The ENVI vote could prove to be a bottleneck. ENVI negotiator and committee chairman Matthias Groote labels the deal “an acceptable compromise,” though he notes that “we do not yet know whether we will get a majority in parliament.” In addition, he points out that “there is also the question of timing: if we don’t agree by April, we will automatically fall back upon the previous legislation.” In other words: international flights departing from or landing at an EEA airport would be fully included within the ETS scope starting May 1.

Europe’s airlines have differing opinions on the compromise solution. The AEA calls on the EP to formally adopt the trilateral agreement but the European Low-Fares Airline Association (Elfaa) urges the EP to reject what it calls the “unworthy compromise” because an intra-EEA ETS is environmentally ineffective. Elfaa Secretary General John Hanlon notes that since “80 percent of EU aviation emissions of CO₂ result from long-distance flights, this necessarily requires the inclusion of all flights departing from and arriving at EU airports.”

Meanwhile, the International Air Carrier Association (IACA), representing 28 leisure airlines, argues that the stop-the-clock provision discriminates among airlines. “The effects of CO₂ are worldwide. Whilst the rest of world is working toward an ICAO solution, Europe has chosen to hurt its own interests in order not to lose face,” says IACA Director General Sylviane Lust. IACA and its regional-airline counterpart, the European Regions Airline Association, want a suspension of the EU ETS for all flights, pending a satisfactory conclusion to ICAO’s work.

A return to the full-scope ETS is a no-go internationally. And scrapping the ETS till 2020 was simply not a negotiable option for the EC and EP. ☛

Results Wanted

Eurocontrol and European Commission reach turning points with ATM modernization efforts

Adrian Schofield Madrid

After several years of talking about the overhaul of Europe’s air traffic management technology, the time for action finally may be arriving.

European regulators and their industry partners have been working to develop detailed blueprints for a next-generation ATM system that would be standard across Europe, and in some cases provided collectively. Now they

are launching two initiatives that represent the transition to implementation.

With efforts to combine airspace into multinational blocks losing momentum, these technology initiatives may offer the best hope for improvements in Europe’s ATM efficiency.

The European Commission is preparing to select an industry consortium that will oversee the deployment of technologies from the Single Euro-

pean Sky ATM Research (Sesar) road map. Separately, Eurocontrol is about to launch a contracting process that will enable industry coalitions to provide certain ATM services on a pan-European basis.

“The [research] project has done its job, and now it’s time to deploy,” says Civil Air Navigation Services Organization (Canso) Director General Jeff Poole. There is “more awareness of the need to move [forward]. . . . We’ve reached that natural point to change from talking to doing. The ability to implement is there because the background work has been done.”

Sesar, which is the technology facet of the broader Single European Sky effort, has spent many years in definition and development phases. The role of

the Sesar deployment manager (SDM) will be to ensure that selected technologies and projects are introduced as planned.

The European Commission recently asked for expressions of interest in the SDM role and plans to issue a call for tenders in May, an EC official told Aviation Week at the Canso World ATM Congress here March 5. Responses likely will be required by June or July, and the EC plans to have the successful bidder “up and running” by the end of the year, says the official.

It is expected that a broad industry consortium will be the main bidder

Lufthansa and other carriers spent millions equipping their aircraft, some ANSPs failed to meet deadlines to provide the CPDLC service.

The EC is comfortable with the likely prospect of a broad industry consortium being the major bidder. However, one ANSP official worries that if the consortium is too inclusive, it could render decision-making difficult.

The EC is also working to decide the first programs that the SDM will be tasked with implementing. These will come from a list of projects that were developed in earlier Sesar phases.

Meanwhile, Eurocontrol is launching

demonstration programs, which can then be transitioned to full operation.

The agency will issue a call for interest this month, Joe Sultana, Eurocontrol's network management director, told Aviation Week at the Canso event. Potential bidders do not have to actually form consortia at this point, merely signal their willingness to do so. They probably will be given 4-6 weeks to respond, Sultana says.

In a parallel effort, Eurocontrol is developing the specifications for each service. This will allow it to issue calls for tender, a step that is expected to occur by September, says Sultana.

Some of the demonstrations will be approved for full operation more quickly than others, as they will vary in complexity. It is expected that at least a few of the Centralized Services will be operational as early as mid-2015, Sultana says.

Eurocontrol handles many network-wide services from its Brussels facility, but it wants to allow industry partnerships to operate some ATM functions for multiple countries.

The Eurocontrol council must approve every service before it is switched from demonstration to operational. “We would have to be convinced that it's going to work,” says Sultana. Eurocontrol reserves the right to launch a new tender process if the results of a demonstration are unsatisfactory.

Sultana says the agency will encourage consortia to limit their size. Eurocontrol does not want the same companies or consortia to win all the services—the intention is to spread the contracts around, he says. Some less complex services could be handled by smaller ANSPs.

Some of the services already are provided by Eurocontrol, while some are new initiatives that have come out of the Sesar ATM plan.

Six services have been approved to move to demonstration phase: flight plan and airport slot consistency service; advanced flexible use of airspace support service; European ATM information management service; management of common network resources service; network infrastructure performance monitoring and analysis service; and pan-European network service. In addition, feasibility studies are being conducted on another three proposed services. ☼



for this role, including air navigation service providers (ANSP), airports and airlines. A group of Europe's major airlines has already announced its intention to be part of the SDM team. Lufthansa, Air France-KLM, International Airlines Group and EasyJet have formed a partnership known as A4 to work together on certain ATM issues. The A4 airlines are “aiming at playing a decision-making role in the deployment manager organization,” says Air France Chief Operating Officer Alain Bassil.

Lufthansa Chief Operating Officer Kay Kratky says the airlines are anxious to be involved so they can ensure that the ATM technologies being deployed will help airlines reduce costs, and will represent a “tangible return on investment.” He cites Europe's controller-pilot data link communications (CPDLC) program as an example of what airlines want to avoid—after

a separate initiative that will change the way certain ATM services are handled. It is about to begin the contracting process that will allow several industry consortia to provide ATM functions for multiple European countries.

The Centralized Services initiative has been at the planning stage until now, and Eurocontrol is taking the first steps toward making it a reality. The idea is that groups drawn from ANSPs, airports, airlines and manufacturers will bid to develop and operate some services, mainly involving data management.

This approach is expected to yield significant savings, since services will be provided collectively rather than individual ANSPs each developing its own system to do the same thing.

Eurocontrol's Provisional Council recently gave the go-ahead for the first set of services that will be contracted out. Bidders must first establish dem-

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Time for Change

Introduction of time-based separation could reduce delays at pressured airports

Tony Osborne *London*

At capacity-constrained airports around the world, high winds are a major cause of flight delays and cancellations, often as a result of the knock-on effects of reduced airport flow rates.

Landing aircraft currently have to maintain set distances apart due to the wake vortices occurring from the wingtip, but research has shown that in strong headwinds, ground speeds on approach are reduced and the effect of the vortices is quickly dissipated, potentially allowing the distances separating the aircraft to be reduced.

Now engineers at U.K. air navigation service provider National Air Traffic Services (NATS) are putting the principle into action. After more than two years of collecting wake-vortex data at London's Heathrow Airport, NATS is preparing to introduce a new time-based method to separate landing traffic there.

Starting next February, an initial cadre of trained air traffic controllers

are due begin using the time-based separation (TBS) tool, developed in the conjunction with Lockheed Martin at Heathrow. All controllers are expected to complete the transition in 1-2 months, allowing the system to be used on a full-time basis and making the airport the first in the world to use such a system.

Heathrow will perhaps be the ultimate test of the principle. It is the busiest dual-runway airport in the world, with flow rates of up to 42-44 aircraft per hour on the landing runway. But strong winds that are encountered typically 60-80 days a year—likely to increase to 90-100 days this year, after an exceptionally blustery winter—cause up to 40% of the airport's delays, equivalent to 160,000-200,000 min. of delay each year.

According to NATS officials, winds of just 15 kt. at 3,000 ft. can have a small impact on the flow rate, reducing it by 3-4 aircraft depending on the wind direction. Stronger headwinds, of 40 kt. and above, can lower flow rates to 34-35

aircraft per hour on the landing runway.

Through the use of TBS, however, NATS believes it can eliminate 50,000-80,000 min. of delay and improve the airport's resilience against flight delay and cancellation. In an interim report, the U.K. Airports Commission recommends a move toward a TBS system at Heathrow in December, as it looks into improving capacity in U.K. airports.

"We had initially planned the introduction of a time-based separation capability as part of Single European Skies [Sesar], in 2018," says Andy Shand, general manager for customer affairs at NATS. "The airlines and the airports said we need to get this into use, so we took an agile approach to our R&D effort."

As part of the work, NATS used a Lockheed Martin laser imaging detection and ranging (Lidar) device to map the vortices produced by aircraft arriving at Heathrow. The system was initially placed on a British Airways maintenance building to measure the vortices close to the ground and then further out on the approach.

Between October 2008 and December 2010, NATS collected 120,000 aircraft tracks that it then analyzed to begin preparing a tool that integrates data from the Mode-S information provided by the approaching aircraft with the weather state to give the air traf-

Trailblazing

Singapore aims to advance Asia-Pacific ATM

Jeremy Torr *Singapore*

Asia's millions of newly wealthy citizens are keen to travel, and new low-cost carriers are boosting fleets and routes to serve them. But the region's air traffic regime is inconsistent and non-homogeneous—which is why Singapore is taking steps to develop more localized air traffic management expertise.

It has set up the first regional Air Traffic Management Research Institute (ATMRI) as a joint venture by the Civil Aviation Authority of Singapore (CAAS) and Nanyang Technological University (NTU) in Singapore. Under an initial agreement, CAAS will contribute \$39 million and NTU \$17.5 million to recruit and hire staff as well as finance R&D and establish facilities.

The CAAS states that this is the first step toward the development of "a vibrant and self-sustaining eco-system, comprising research institutes and think-tanks, academia, industry



Nanyang Technical University's "North Spine" engineering complex is home to the ATMRI.

players, international ATM entities and aviation stakeholders."

The Asia-Pacific region is expected to continue growing, accounting for 37% of global traffic by 2017, compared to

The magenta-colored time-separation markers on the TBS system display show optimal aircraft placement.

fic controller information on how to dynamically separate aircraft flying the approach. Once implemented, the TBS tool will display a series of magenta-colored separation indicators along the runway track onto which controllers will vector the aircraft, giving them the optimum separation for the aircraft's wake category and the weather conditions.

On a benign day, an aircraft travelling at 150 KTAS will be doing 150 kt. ground speed, covering 4 nm in 90 sec. But an increased headwind means ground speed could be reduced by 20 kt. and the aircraft would be just 3.5 nm in 90 sec. With that principle in mind, the distance between aircraft could be reduced to 4.2 nm from 5 nm between two narrowbody aircraft in the Airbus A320/Boeing 737 size.

In one simulated trial, a group of air traffic controllers was given a 15-min. briefing on the system and tool and then

tried them out. "They found it very easy to adjust to, and feedback was excellent," Shand says. "This can be applied to any system in the world. It's already in the road map for Sesar and the FAA's NextGen implementation."

NATS is working with Heathrow's customer airlines to introduce the system. A key area will be to train pilots to ensure they maintain speeds requested by air traffic control and an even speed balance during TBS operations. "They see the benefits of the system and we have great cooperation from them, and the regulator is extremely

supportive of our efforts," Shand says.

At Heathrow, the TBS system has also been optimized to provide data on the diagonal spacing of aircraft when the airport is using its Tactically Enhanced Arrival Measures (TEAM). Because Heathrow's two runways are not wide enough apart to allow simultaneous parallel operation, landings on both runways have to be staggered, particularly during busy periods of the day.

TBS will only apply to arriving aircraft, but studies are underway to see how the principle could also apply to departing aircraft. ☐



NATIONAL AIR TRAFFIC SERVICES

33% in 2012, says Ken McLean, Asia-Pacific regional director for safety and flight operations at the International Air Transport Association (IATA). "It is critical that the aviation infrastructure, including air traffic management, is able to accommodate this anticipated traffic growth," he notes.

But the amount of regionally developed ATM expertise and technology is "still behind that of more developed regions," says NTU spokesperson Lester Kok. "We still need to work on our [ATM] knowledge in the region, to help bring us up to speed. At the moment, we just buy technology," he tells Aviation Week.

The new ATMRI facility will have more than 1,000 sq. meters (11,000 sq. ft.) devoted to "improving the efficiency of air traffic ... by increasing the predictability of aircraft [regional] traffic patterns," Kok says. "We will be looking at things as simple as aircraft turbulence to work out if we can reduce separation at takeoff and landing. If we can increase the frequencies, we could safely boost airport efficiency by up to 200%."

But boosting capacity at one airport could result in bottlenecks and increased fuel usage at destination airports. "This means we have to ensure our research is done on a regional basis, and that we are looking at the big picture," the NTU spokesperson says. To help, the institute's board is tapping experienced international advisers, including IATA's McLean; Richard Deakin, CEO at international ATC operator

NATS U.K., and Singapore's air force chief, Lim Yeong Kiat.

An example of the work that the institute will research is the use of short-run landing strips. "We are looking at developing and testing new materials that can be used on shorter, more remote runways," Kok says. The new materials will enable larger aircraft to land by reducing braking distances—something of key importance to the more remote Asia-Pacific airports. It also will look at the smart integration of weather and ATM command systems.

The ATMRI says it will investigate the possibility of minimizing what it calls "human performance" issues by developing direct machine-pilot and machine-machine communications without the need to go through a controller. "This will not only reduce the possibility of errors, it will speed things up, too," Kok notes.

However, the new institute has much groundwork to do before it starts signing research deals with industry partners. "We are well aware of the need to produce more people with master's [degrees] and Ph.D.-level experience in the ATM sector," says Kok. These will be hot-housed by the new center to help translate fundamental high-level research into feasible ATM applications for the real world. "And with Singapore's reputation as a place where the very highest standards are being applied in other areas, we think we have the perfect testbed for new [ATM] developments," he says. ☐

Double Demonstrators

Development 787 and leased 757 readied for broad-ranging technology testbed programs

Guy Norris **Seattle**

In late 2012, Boeing's 737-800 EcoDemonstrator undertook a secretive test effort to prove out the natural laminar-flow capability of a near-production representative advanced winglet design.

The results confirmed that Boeing could make a winglet with design tolerances sufficient for laminar flow at production-rate levels, clearing the way for the key drag-reducing design to be featured on the forthcoming 737 MAX. Just as important to Boeing, the tests came in the nick of time for the final design freeze of the MAX and proved the value of the EcoDemonstrator concept—a program to fast-track the testing, refinement and completion of new technologies that improve efficiency, sustainability and environmental performance.

Now, with the first EcoDemonstrator refurbished and in regular service with American Airlines, Boeing is preparing for two successive follow-on test efforts that are more ambitious in terms of both scale and breadth of technologies. The two programs—a modified 787 that will fly this summer and a radically reconfigured 757 scheduled to be tested in 2015—will evaluate a raft of new airframe, systems, propulsion and flight-deck technologies that could be introduced into the production line within this decade or a few years beyond.

Testing of the advanced winglet “is a good example of some of the benefits of having a regular demonstrator available,” says Boeing program manager David Akiyama. “When the MAX program came out with a production technical challenge, we had a vehicle ready to test it. If we [had] not, we would not have had the time to prove it, and we would have had to introduce the technology in a later generation. We had a build concept we could produce at rate, and flying a near-production representative flight-test article was key.”

Boeing is also banking heavily that the experiences gained on the 737-based EcoDemonstrator will increase the number of technologies to be tested on both the 787 and 757 programs. “We learned a lot of lessons on how to pack things in,” says Akiyama. Compared to the 737, which ended up being used to evaluate roughly 15 discrete technologies, “we are looking at between 30 and 35 technologies on the 787,” he adds. The 737 experience also helped Boeing determine a more realistic schedule for the EcoDemonstrators—the second of which was originally expected in 2013. “We planned for a constant cadence of EcoDemonstrators and we are still figuring out what the natural rhythm should be. It looks like an 18-to-24-month cycle gives researchers time to research and learn lessons from previ-

ous demonstrators,” he says.

Boeing will begin conversion of its early development 787-8, ZA004, into the second EcoDemonstrator in early May following completion of engine certification duties for the Rolls-Royce Trent 1000-powered 787-9. “We will probably start flying around the June time frame and fly through July,” estimates Akiyama. Flight tests will mostly be based within the Seattle area with visits likely to Moses Lake in Eastern Washington and possibly to Victorville, Calif.

The 787 will be used to flight-test technologies in six key areas that cover propulsion, connectivity, materials, flight deck, flight sciences and flight-test efficiency. One of the aircraft's Trent 1000 engines will be fitted with a nozzle, plug and sleeve fabricated from ceramic matrix composites (CMC). Developed under a joint effort between Boeing, ATK affiliate COI Ceramics and Albany Engineered Composites, the CMC nozzle has been undergoing noise, structural and endurance ground tests on an engine at Rolls-Royce's Stennis facility. “It is a new-generation material and it promises to help us with propulsion because CMCs are lighter and can sustain higher temperatures. That will help us drive engine temperatures up and yet still be more reliable, so the engine will stay on-wing longer. We think it will be 20 percent lighter with a proprietary nose treatment on it,” says Akiyama. “When you design the whole engine with this material and with this higher-temperature capability, and it takes less weight and drag, you enter a virtuous cycle,” he adds.

The focus on flight-test efficiency is “a new area. There is a large cost and

The vertical tail fin, major wing sections to prevent misreading and several interior systems and fixtures of this leased 757 will be modified for flight tests.



BOEING PHOTOS

A CMC nozzle, ground tested on a Rolls's Trent 1000 at Stennis, will be flown on the 787 EcoDemonstrator.

cycle time involved in doing a lot of flight-test instrumentation, so we are seeing if we can reduce cost and improve the efficiency of flight test," says Akiyama. Technologies to be tested include micro-electro-mechanical systems (widely known as MEMS) transducers and wireless connections that could potentially reduce the volume of dedicated test wiring.

While the 787 is perhaps one of the most thoroughly understood aircraft Boeing has yet developed from an aerodynamic perspective, ZA004 also will play a role in advancing this area of flight science. "We will be doing some basic research. The aerodynamicists want to instrument the wing because, although we know how it performs in service, they want to take it to the next step to correlate computational-fluid-dynamics predictions with real data," he says. The work also will look at ways to get laminar flow over more of the nacelles than is already achieved. "Maybe we could do something better for manufacturing from the technology we will be testing."

Flight tests will also include "innovative technologies to build things quicker and lighter," says Akiyama. Part of the focus will be on better management of heat in the engine nacelle and pylons where currently there is concentrated use of expensive alloys and metals such as Inconel and titanium. "So we are looking at areas where we can use more composites," he adds.

Inside the cabin and flight deck the tests will focus on technology to improve situational awareness, "decision support" and health management. The work will build on the configuration that was tried out on the 737, which included a SwiftBroadband intermediate-gain antenna from CMC, a Thales satcom data unit and a Boeing-built Onboard Network System, which is a network file server that connects via a wireless network to other aircraft systems. "We used SwiftBroadband on the 737 but would like to use a Ku-band satellite system on the 787. So we are working with suppliers to hook up the aircraft with a broadband pipe. We like to think the 737 was the first step toward more data-intensive airplane health-monitoring and management as well as [improved] weather sensors



and the networking of that data."

Flight-deck technologies under test will include touchscreens and experimental displays of information on the heads-up display for better situational awareness. This will include new synthetic-vision concepts. "It is all the things we envision in the next generation. The 787 is perfect for this because it is a blank canvas and has all the software," Akiyama says.

In conjunction with display work, the 787 also will be configured with experimental flight-control-law software to pave the way for the next generation of aircraft, "as well as to improve the current generation," he says. "There will be changes to the 787 for improved tail protection and changes to the high-lift system [leading and trailing edges] to reduce noise and enhance handling."

Plans for the follow-on 757 EcoDemonstrator are well advanced, too. The aircraft, leased from U.K.-based partner airline TUI, is stored at Boeing Field in Seattle where it will soon be radically altered to install a new active flow control (AFC), vertical tail and numerous other changes. Flight tests will be broken into three major phases and conducted throughout 2015.

Modifications to the tail will be based on results from evaluations of a full-scale 757 tail, equipped with AFC, which demonstrated increased rudder effectiveness in wind-tunnel tests run

late last year by Boeing and NASA. The tests used AFC to increase rudder sideforce on demand by delaying airflow separation over the deflected control surface. Using data from the tests, Boeing will position airflow actuators and instrumentation at specific points upstream of the rudder hinge. The ultimate goal is to reduce tail size and therefore drag.

"We will also do some wing changes," says Akiyama. Various advanced-wing concepts ranging from morphing to laminar flow are being considered. "It is all on the table. We like to think of the 757 as a tool kit," he adds. The morphing wing work builds on adaptive trailing edge technology tested on the 737 in partnership with the FAA's Continuous Lower Emissions, Energy and Noise (Cleen) program. Tests of the CMC nozzle on the 787 are also part of Cleen.

Other technologies lined up for testing on the 757 include new cabin sidewall panel materials, a yet-to-be-selected advanced auxiliary power unit concept and new flight-deck displays for assisting crews in better managing speed in congested terminal areas for improved spacing. Ground collision avoidance systems for safer surface operations also will be tested. "We are looking at better situational awareness, as this will be really important for big aircraft like 777X," Akiyama adds. ☼

Natural Selection

U.S. Army eyes less-diverse ISR fleet following withdrawal from Afghanistan

Amy Butler **Washington**

After 13 years at war and an emergency doubling in the size of the U.S. Army's special mission intelligence, surveillance and reconnaissance (ISR) fleet, the service is finally pondering a reconciliation of its specialized air forces with an eye toward retaining less than half of the platforms operational today.

As U.S. forces exit Afghanistan, Army planners are taking an opportunity to rationalize the fleet for the next big military activity. The swift pace of events in Iraq and Afghanistan—including insurgent use of new and different improvised explosive devices—drove the Pentagon to quickly field a host of different platforms, sensor packages and processing capabilities. The sole requirement was to field systems and field them fast; money was little object in the past decade. The Overseas Contingency Operation fund was regarded as nearly a blank check to press into service quickly whatever technologies were needed. As a result, some of the aircraft were purchased, some were modified, some were government-owned and contractor-operated, and in some cases the Army simply purchased the services through a contractor-owned, contractor-operated fleet.

Before the 9/11 terrorist attacks, the Army program of record was for 47 Guardrail and eight Airborne Reconnaissance Lows; the ultimate plan was to buy what was called the Aerial Common Sensor (ACS). The Army has long sought a single platform to ease training, maintenance and supply and collect multiple types of intelligence. But the missionized Embraer ERJ 145, to be outfitted with sensors and processing equipment by Lockheed Martin, cratered in 2006 owing to poor design and spiraling costs. Its follow-on—the Enhanced Medium-Altitude Reconnaissance and Surveillance System (Emarss), won by Boeing—has been only moderately more successful. Despite integration challenges, the Army is buying the first four development aircraft as well as two more, hardly a full fleet. However, as ACS died, commanders began to turn to full-motion-video

(FMV) to prosecute targets in Iraq and Afghanistan. Emarss addresses that need by incorporating that capability as well as other sensors, including communications-intelligence collectors. The Guardrail aircraft to be retained long-term also will be outfitted with FMV balls by fiscal 2017, says Terry Mitchell, director of future planning for the Army's deputy chief of staff for ISR.

At the height of Iraq and Afghanistan operations, the Army's special mission, fixed-wing ISR fleet swelled to 110 manned platforms, Mitchell says. Some are one- or two-of-a-kind types that have employed highly specialized sensors, such as hyperspectral imaging, wide-area airborne surveillance, full-motion video, foliage penetration, and mapping and tracking of "dis-mounts" or individuals on foot.

During the war, the Army proved its ability to "surge" to quickly field such capabilities, says a defense official speaking on background. Thus, there is no need to retain such a large fleet—especially one so diverse with varied training and maintenance needs—in peacetime.

Ultimately, the Army plans for an "enduring" fleet of 52 aircraft, based on three different platforms, says Mitchell.

These will be nine ARLs that are being shifted from the Dash 7 to Dash 8 platform and outfitted with a more modular architecture and sensors; 14 so-called RC-12Xs, the newest of the type based on the Super King Air 200; and 24 "Mission Configurable Multi-Intelligence" aircraft based on the King Air 350ER. These will include the six Boeing Emarss aircraft as well as up to eight Air Force MC-12W Project Liberties to be updated to an "Emarss light" configuration. The remainder of the platforms will come from the best of the Army's quick-reaction-capability aircraft—those rapidly fielded for the



Boeing's Emarss is undergoing testing at Aberdeen Proving Ground, Md.

U.S. ARMY PHOTOS

war. Some of the Air Force's Project Liberty aircraft on the King Air 350ER are going to U.S. Special Operations Command. This is a significant culling of type models; at one time the Army flew six different Guardrail variants, Mitchell says. Guardrail is optimized for signals intelligence collection and is critical to operations in the Korean Peninsula.

Because the Project Liberty aircraft were quickly assembled by the Air Force and L-3 Communications during the war, they lack the growth capabilities offered by the Army's Emarss design, Mitchell says, but they will provide ample capability for the time being.

The ultimate goal is to retain the best sensors from the wars so they can be quickly outfitted onto the aircraft as needed, Mitchell says.

"After the war, we will have a lot of sensor capabilities you would not have seen, except that we had a war" driving technology, he says.

This fleet should be in place around the fiscal 2017 timeframe, Mitchell says. Reducing the number of platforms and platform types will allow for reduced cost in the near term, he notes.

The Army is hoping to streamline its processing, exploitation and dissemination—or ground station—architecture as well. As the urgent-need fleets were fielded in the war, unique ground stations also were quickly fielded. While suitable for quick-reaction capabilities, Mitchell says, the enduring fleet will

Retained Guardrails will be critical to the ongoing mission supporting operations around North Korea.

need to wire into the Distributed Common Ground Station to allow the intelligence collected to be shared, processed and dispatched in a more networked fashion, rather than relying on point-to-point, stovepiped ground stations.

If the Army is able to achieve this fleet plan, it will be the first time in more than a decade it has managed to move forward as desired. The notorious failure of the ACS plan harmed the service's credibility—as well as that of Lockheed Martin as a reliable integrator. The program was marred from the outset by the attempts to cram too much kit onto too small a platform.

This projected ISR fleet—culled to

less than half its size—will operate in concert with the Army's unmanned fleet of MQ-1C Gray Eagles, manufactured by General Atomics, and Northrop Grumman MQ-15 Hunters.

Meanwhile, the service is also reconciling its rotary-wing fleet with a plan to retire all single-engine Bell Helicopter OH-58Ds and TH-67s, which will be replaced with twin-engine Boeing AH-64E Apaches and Airbus Group UH-72A Lakotas. Much like the ISR shift, the Army's rotary-wing plan calls for reducing the number of type models in the fleet. By eliminating an entire type model, service leaders say they gain the most savings, thanks to the termination of an entire maintenance/training regime.

This fleet is expected to operate through the mid-2020s. Beyond that, Mitchell and his team are looking at options. Ultimately, the military hopes to increase the number of persistent platforms—those that can stay aloft for longer periods of time collecting intelligence. This could point to the use of unmanned platforms. Or it could simply capitalize on the inevitable reduction in weight of sensors now being used. Army officials do not intend to fly large-platform ISR collectors such as USAF's, which are Boeing 707-based, or the Navy's 737-based P-8. But miniaturization could allow for fielding more sensors on a platform or for using smaller platforms.

Mitchell says he also is focused on improving the processing, exploitation and dissemination capabilities of the Army, including linking with those of other services. ☐



Boeing and Field Aviation are building an MSA aircraft based on the Bombardier Challenger 605. A Challenger 604 demonstrator had its first flight on Feb. 28.



Tap the icon in the digital edition of AW&ST for a look at how civilian bizjet and turboprop makers are competing for a potentially lucrative maritime surveillance replacement aircraft market, or go to AviationWeek.com/video

Crowd-Sourcing

Compact budgets and sensors open maritime surveillance to business aircraft

John Croft **Toronto**

An estimated \$10 billion in sales to replace 150 maritime surveillance aircraft in the 50,000-lb. category over the next 10 years is leading to intense competition among airframers hungry to “dual-purpose” existing aircraft lines to fill surveillance needs globally. Backfilling for worn out legacy aircraft, including DC-3s and CASA 212s, Fokker F27s, YS-11s and Gulfstream IIIs, is a new generation of medium-class turboprops and business jets converted to maritime surveillance carrying a new generation of smaller sensors that cost less and perform better.

“We are seeing very clearly a move toward cost-effective, multi-mission, special-mission platforms,” says Joar Gronlund, non-executive director at Field Aviation, an aircraft modification company that converted 10 Bombardier Dash 8 Q200s and Q300s to maritime surveillance aircraft (MSA) for the Australian Coast Guard starting in the mid-1990s. “That typically drives you to starting with commercial aircraft. Marry that to an evolution in smaller, lighter and cheaper sensors, and new special-missions platforms are born.”

The action has created what aircraft makers, including Dassault and Bombardier, could see as a burgeoning medium-class MSA niche to supplement a still-sluggish civilian business market. Dassault is offering factory MSA versions of its Falcon 900 and Falcon 2000 business jets; Embraer is offering a maritime patrol version of its ERJ 145 regional jet.

Boeing announced in November that it will partner with Field Aviation to jointly build a business-jet-based MSA that will have mission systems commonality to the larger Boeing P-8A Poseidon, a variant of the 737-800, and a lower cost. The companies are developing an MSA demonstrator using a Challenger 604 and hope to generate the first sales within two years.

The jet offerings will compete head-to-head with turboprops, among them Field’s Dash 8 conversions, Airbus’s variant of the CN235 regional twin-turboprop, the ATR 42 and

72, and Saab’s maritime surveillance and patrol versions of its 340 and 1000 regional turboprops.

With the MSA fleet renewal underway, the trend toward smaller, lower-cost aircraft with similar or better sensor performance is a prime mandate for cash-strapped governments. Based on advances in sensor performance, the same new medium-class MSAs also can perform the jobs of many of the lighter aircraft that had been a part of the legacy surveillance equation, including Cessna 406s and Britten-Norman Islanders.

While jet-powered aircraft are more costly to operate than turboprops in terms of fuel, their benefits come from a faster transit time to more-distant destinations and the ability to climb above weather, capabilities certain customers need.

“In missions with a transit range in the order of up to 300 nautical miles, the best turboprops will generally come up as less costly than the best business jets—particularly when the search criteria of small targets require a relatively low altitude for the surveillance,” says Gronlund. “As the transit distance increases, the jets will naturally fare better.”

Boeing analyzed the maritime surveillance market and determined that a business jet was the best solution to capture a significant portion of the 150 medium-class aircraft it estimates will need to be replaced in the next decade. “Out of that \$10 billion, Boeing could capture 25 percent,” says Bob Schoeffling, Boeing Military Aircraft senior manager of business development. Boeing chose the Bombardier Challenger 605 as its platform, and teamed with Field Aviation to perform the modifications. “Not every country in the world wants or needs a P-8,” says Schoeffling. “We looked at how we could offer a P-8-like capability to generate interest in countries that might not need, or be able to afford, the P-8.”

The MSA is part of a broader Boeing MSA and surveillance portfolio that includes the Insitu ScanEagle and Inte-

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grator tactical unmanned aerial vehicles on the low end and the P-8 on the high end. The company also is developing a Beechcraft King Air 350-based Enhanced Medium Altitude Reconnaissance and Surveillance System (Emarss) that was flight tested in October.

Schoeffling says the key differentiator setting it apart from competitors in the medium-class MSA market is the U.S. Navy's P-8A tactical open-mission software suite that it will port over to the Challenger 605. The software will manage a variety of sensor options that include a 360-deg. active, electronically scanned array (AESA) radar with synthetic aperture radar, inverse synthetic aperture radar and ground-moving-target indicator modes, a retractable electro-optical/infrared (EO/IR) turret, electronic support measures (ESM), communications intelligence (comint), and an automatic identification system to receive identification information from ships. Boeing is also marketing the aircraft for overland surveillance.

Dassault is advertising similar sensors, with the addition of "underwing carrying capabilities" for sensors or weapons and a self-protection suite. Schoeffling says the future options for the 605 could include a self-protection suite, Link 16 data link for coalition partners, and hard points on the wings, potentially for another sensor or other equipment. "I'm not saying we're going to weaponize it," he adds.

Field, a risk sharing partner in the program, funded the modifications to the demonstrator aircraft—formerly a Boeing corporate Challenger 604—that arrived at its Toronto facility in February 2013. The modified 604 first flew Feb. 28 and was painted by Boeing at its facilities in Yuma, Ariz., where Field will conduct the remaining flight tests. Boeing will later install mission systems and sensors in Seattle, leading to an international marketing tour later this year. The Challenger 605 is a modernized version of the 604 that Bombardier began delivering in 2007.

Field has some experience with the type, having modified three Challenger 604s to an MSA configuration for the Royal Danish Air Force in the early 2000s. The Danes equipped the Challengers with a low-profile 3.6-meter-long (12-ft.) composite belly pod housing a Telephonics APS-143 imaging radar, and a retractable ball turret with a Flir Systems Star Safire II EO/IR camera mounted behind the belly pod, aft of the aircraft's pressure vessel. The ball turret is retractable to minimize drag at high speeds. One aircraft is equipped with a hard-point to hold an optional side-looking

FIELD AVIATION



airborne radar (SLAR) or a weapon, and all three have a quick-change interior for executive transport.

Field's mainstay for MSA conversions has come from the Bombardier Dash 8, with nearly 40 conversions of new or used aircraft completed to date for customers that include the coast guards of Australia, Japan, Sweden, Iceland and the U.S. Customs and Border Protection agency. That work continues, although it is becoming increasingly difficult for operators to find good deals on available Q200s and Q300s, the most desirable platforms, as both are out of production and airlines continue to fly them.

The market need for a wider diversity of aircraft prompted the company to "sandwich" the Dash 8 in a standard portfolio that now offers two additional aircraft: the Bombardier Challenger 604/605 on the high end and the Viking Series 400 twin-turboprop, a reincarnation of the DeHavilland Twin Otter, on the low end.

Field partnered with Viking 18 months ago to build a multirole surveillance version of the Twin Otter to be called the Guardian 400, an unpressurized aircraft priced at less than \$14 million that the company says will be attractive to "smaller nations." Modifications, to be completed by Field, will include 360-deg. Selex 5000 search radar for the nose, a retractable EO/IR turret, also on the nose, and additional fuel tanks that boost the maximum takeoff weight to 14,000 lb. from 12,500 lb., giving the aircraft an on-station endurance of 7 hr. for a target 100 nm away. Field is interested in building a demonstrator using Viking's test aircraft, although that aircraft continues to be used for certification testing of a new autopilot, says Gronlund. Instead, the companies are building

CHEAP SHOT

Bill Sweetman **Washington**

The first of two MC-235 gunships, modified from Airbus Military CN235 transports by Alliant Techsystems (ATK), and Jordan's King Abdullah Design & Development Bureau (KADDB), has completed its U.S. testing, including gun firing, and will be delivered to Jordan this month, according to ATK. The second is due to follow in April, and the aircraft will enter service following

missile-firing tests and crew training.

ATK says the MC-235 will be the first fixed-wing gunship to be delivered to an operational user from an international program. (The company also is involved in the Alenia-led MC-27J project.) It is armed with a side-firing ATK M230 30-mm chain gun, as used on the AH-64 Apache, located aft of the wing, and has stub wings with four hardpoints for AGM-114 Hellfire missiles or 2.75-in. rocket pods.

An ATK-developed sensor-and-weapon-system operator console is installed in the



Electro-optical and radar sensors are installed under the right-hand side of the MC-235's forward fuselage.



The MSA business jets will face fierce competition from turboprops in the fleet, including the Bombardier Dash 8, here flying with the Japanese coast guard.

a nose section with sensors to take to the Farnborough Air Show in July. Viking is primarily marketing the aircraft in the Asia-Pacific region and South America.

The 605 MSA should represent less developmental risk for Field, as the work is similar to the conversions it did for the Danish Challenger 604s. "We're not starting with a white sheet of paper. It's very much an optimization exercise, once the project requirements are defined," Gronlund says. The new aircraft will mirror the 604 in terms of the retractable EO/IR turret mounted aft of the aircraft's pressure vessel, but it will have a larger belly radome that can fit more than one manufacturer's radar from a menu provided by Boeing, giving operators more flexibility. The pods in the Field's Dash 8 conversions can carry radars built by Elta, Telephonics or Selex, according to Gronlund.

With the larger pod also comes more drag, but Gronlund says the Boeing mission profile is less demanding than that of the Danish. "They had to fly from Copenhagen to Greenland without getting wet in the process," says Gronlund of the Danish air force mission. "It forced a smaller radome." Gronlund says the radome and non-retractable EO/IR nose turret on the Dash 8 have a 3% performance penalty for transit and high-speed surveillance, in terms of distance covered per unit of fuel burned, and he expects the Challenger 605 penalty to be "slightly higher" when measured during flight testing this year.

Boeing is designing the aircraft for a basic mission endurance of 8 hr., with 6 hr. on station, a mission efficiency of 75% (on-station time/total time). For a target with a 1,200-nm transit, the 605 can be on station in 2.5 hr. and loiter for another 3 hr., a mission efficiency of 60%. "A prop plane can't

do that," he says. Dassault is marketing similar mission efficiencies for its Falcon 2000. Dassault and Embraer would not comment on MSA orders or deliveries.

For the 605 MSA, Boeing plans to sign the customers and buy green aircraft from Bombardier. Field will perform the structural and aerodynamic modifications over an expected 4-5-month timeframe, a process that is somewhat slowed by the limited number of people able to access the sections of the fuselage where large portions of metal have to be cut out for the sensors, says Brian Love, Field's chief commercial officer. After removing the interiors, the under-floor fuel tank must be removed to install the radome. Along with ESM antennas in the radome and tail, and comint antennas on a platform behind the radome and on the wings, technicians will install wiring and power inverters for the electronics and relocate the lavatory from the back of the plane, where electronics racks are placed, to the front of the cabin. Field is also installing an Inmarsat satellite communications system. From there, Boeing will take the aircraft to install mission systems and sensors as well as painting, all of which Field says should take 2-3 months.

Schoeffling says the baseline crew will be two pilots and three crew members for three workstations, with an option to expand to five workstations. The competitors have similar offerings.

Creature comforts on the 605 will include a kitchen and two of the original cabin seats for crew rest or extra passengers.

On the 604 demonstrator, Field is planning for more than 60 test flights in Yuma to verify acceptable handling and measure performance degradation parameters, due to the sensor drag, ahead of gaining Transport Canada supplemental type certificate approval for the modification, which should equate to an FAA approval through bilateral agreements. Beyond the demonstrator, Boeing plans to install mission systems and sensors at a location in the U.S.—which Field hopes will be its corporate headquarters in Ohio.

Boeing is conducting the flight-test program for the sensors and mission systems.

As for the relatively long window for finding a launch customer, Schoeffling says it is a function of the formalized procurement cycles for governments, which generally include requests for information and proposals as well as competitive bidding. "We are well along the way in conversations with several countries," he says. "Unfortunately, buying an aircraft is not like buying a car." ❧



cabin. The avionics system is designed to be sensor-agnostic, the company says. KADDB has selected the L-3 Wescam MX-15 electro-optical turret, including infra-red and high-definition TV sensors and a laser designator, and the Thales I-Master radar, which combines synthetic aperture radar and ground-moving-target-indicator functions. The MC-235 has a self-protection suite including ATK's AAR-47 missile approach-warning system and BAE Systems' chaff-flare dispenser and infrared countermeasures units.

According to ATK, the MC-235 (or the same system installed on the larger C295) is attracting international interest and fits in a different market slot from the MC-27J, which is larger and carries a heavier, longer-range gun. The MC-27J is a multirole system with roll-on, roll-off weapons and mission station, while the MC-235 is a permanent modification. KADDB is leading marketing in the Middle East/North Africa region and the two companies are discussing plans for other world markets. ❧

Supersonic Steps

NASA experiments lay foundation for low-boom, supersonic X-plane demonstrator

Guy Norris **Edwards AFB, Calif.**

With contracts awarded for designs of initial supersonic X-plane concepts, NASA's High Speed Project is working on a new set of foundational technologies, instrumentation and test techniques that will prepare the way for its development later this decade.

"The High Speed Project feels the next major step is to build a flight demonstrator, and we're trying to do everything we can to be prepared for when the time comes," says Tom Jones, High Speed Project deputy project manager at NASA Armstrong Flight Research Center at Edwards AFB, Calif.

The ultimate goal remains targeted at a concept like the needle-nosed NASA-Gulfstream X-54A vehicle concept first floated in 2011. "To get something that is scalable means it is going to have to be fairly sizable. We'd also very much like it to be piloted," Jones

on specially modified aircraft such as the Northrop Grumman F-5E shaped sonic boom demonstrator and NASA-Gulfstream F-15 Quiet Spike, the low-boom supersonic demonstrator would be the first to test fully integrated, tip-to-tail, boom-shaping techniques in the real world to gauge the public acceptance of shaped booms.

Although a market exists for supersonic commercial and business aircraft, their development remains unviable because of laws forbidding overland supersonic flights. Some business jet developers such as Reno, Nev.-based Aerion believe transonic designs flying at around Mach 1.2 could avoid this by exploiting the "Mach cut-off" phenomenon where shock waves sometimes do not reach the ground (see below). However, others such as Gulfstream and Dassault believe the true path to supersonic travel lies in

involved Boeing and Lockheed Martin's Skunk Works and has largely been wrapped up. The two companies are now into conceptual design work to examine a low-boom demonstrator under a NASA Langley Research Center project dubbed Smaart (Structures, Materials, Aerodynamics, Aerothermodynamics and Acoustic Research and Technology).

While this work tackles the low-boom shaping problem, other elements of the High Speed effort are focused on developing low-noise engine nozzles and determining how to fairly evalu-



The newly acquired NASA F-18, ship 846, will be equipped with an Airborne Schlieren Imaging System for supersonic research.

says. "You would get a lot of benefit in an X-plane having a pilot on board, particularly if the outer mold line and aerodynamics are part of what you're testing."

While the broader aim of the project is to develop and test technologies for a new generation of commercial supersonic aircraft, the X-plane is principally designed to demonstrate the feasibility of shaping techniques developed to reduce the sonic boom problem. Although these techniques have been tested in wind tunnels and

designs with boom levels so low that regulators will lift the ban.

Wind tunnel tests have therefore been conducted at NASA to show that careful shaping could reduce the boom for a small supersonic aircraft down to the threshold of acceptability. Industry also has been developing concepts of Concorde-like passenger capacity but with far quieter booms than the long-grounded Anglo-French airliner. This work, conducted under Phase 2 of NASA's N+2 system-level experimental validation program, in-

ate the impact of modified sonic booms on a representative community. Led by NASA Glenn Research Center, the low-noise nozzle work is testing the acoustic impact of various configurations installed on the Nozzle Acoustic Test Rig in the center's Aeroacoustic Propulsion Laboratory.

At Armstrong Flight Research Center, where the X-plane will eventually fly once it is funded, the focus is on readying the test infrastructure as well as designing future experiments for research into boom propagation and



Boeing and Lockheed Martin are each defining low-boom demonstrator designs that could resemble this NASA concept.

community noise measurement. Improved aerodynamic probes to check local flow pressures will be flight tested supersonically as early as April, says Jones. "We are also trying to upgrade some of our supersonic support aircraft," he adds. Research instruments are being installed in an F-15D and F/A-18B, both of which replace older aircraft. NASA's "new" F-15D is the highest-time aircraft in the fleet but replaces an F-15B that was the oldest flying "Eagle" in the world. The recently retired F-18 (ship 852) was similarly the oldest "Hornet" still flying at the time.

Research also is being conducted into a method of visualizing shock-wave data from full-size aircraft using air-to-air Schlieren photography. The technique, which involves capturing images of changing light intensity caused by variations in air density over an object, builds on the development of the Ground-to-Air Schlieren Photography System (Gasps), developed by MetroLaser and tested by NASA Dryden in 2013. Although the Sun will again provide the light source against which the test aircraft will be photographed, the new phase will involve pod-mounted digital cameras on a chase aircraft.

The Airborne Schlieren Imaging System will precisely visualize the flow around the engine inlet and tail region, enabling more accurate modeling than with wind tunnel model tests. "We are hoping to improve our photography using this new capability, which should provide better resolution than any other Schlieren photography, and better than anything ever made yet of a flying aircraft," says Jones.

Dryden researchers have also developed an upgraded proof-of-concept

flight code for the test control room that attempts to predict where sonic booms will hit the ground. "That has all been revamped, and we should be testing that in our control room in a couple of months. We will then be able to put it in the cockpit, and when pilots of the future are flying they could use it like a navigation system to plot waypoints [to] help ensure you won't be booming noise-sensitive areas," Jones says, adding that the software will also be tested on ship 846.

The basics of the code were previously used in a set of supersonic boom tests conducted at Dryden over the past four years. These included the Superboom Caustic Analysis and Measurement Project (Scamp), which looked at focused sonic booms; the Waveform and Sonic boom Perception and Response (WSPR) project to measure community response; and the Farfield Investigation of No boom Threshold (FaINT), an effort to better understand the behavior and propagation of evanescent waves. These waves, which were measured in this latter test with an array of microphones on the dry lake bed at Edwards AFB, are created by aircraft flying at transonic speeds around Mach 1.2.

Knowledge of evanescent waves is useful for understanding the "Mach cut-off" effect in which shock waves from an aircraft flying at Mach 1.2 and an altitude of 35,000 ft. or above do not necessarily reach the ground. Instead, as they enter warmer air closer to the ground and the speed of sound increases, they are refracted upward away from the ground. However, when the shock waves curve upward, they create a series of sonic-boom waves focused along a line known as the "caustic line." Below the line, on the "shadow

side," evanescent waves propagate down. The FaINT experiment was part of NASA's attempts to understand the strength of this effect.

The software code was used in these experiments "with good success," says Jones. "However, you need to know the winds and the conditions of the atmosphere that the shocks are propagating through. So developing that concept for the future and also for pre-flight planning means you will need to have knowledge of the atmosphere. The concept is therefore still being developed as to how to include real-time weather information. So the researchers here at Dryden are talking to NASA Goddard about satellite information and the NextGen weather system."

Additional experiments now in design include an investigation into the effects of atmospheric turbulence on boom propagation, and studies of how to measure human response to sonic booms. While previous tests have gathered input from the large but sonic-boom-seasoned military and civil population at Edwards AFB, the aim of the new study is to assess the reaction of ordinary civilians in a "regular" community living well outside of military airspace.

"We are just now starting to think ahead about how we could conduct tests like that," Jones says. "Right now, our concept is to do a test like that with our F-18 in which we would do a low-boom dive maneuver." In this, the aircraft would roll inverted at Mach 1-plus, which sets up a low-amplitude "N-wave" over a large area of ground. "But you also get a few small areas of very loud booms," Jones notes. "We are interested in trying to do a test like that and how you do the outreach and work with the legislative branches to find a community. That way we'd be prepared for when we get the X-plane."

Testing with the F-18 would only be a stop-gap measure, Jones says. "You still get an N-wave. But we believe the only way, long-term, for supersonic flights over land is to use an aircraft that is shaped for low boom. We proved we could modify booms with the SSBD, but through all the N+2 studies we now think we have the technology to have tip-to-tail shaping to get the amplitude and environmentally perceived noise decibels down where they are acceptable. But you have to get the proof, and to do that, you need an X-plane of scalable and relevant size." ☛

Keeping Pace

Is the U.S. lagging when it comes to electronic-warfare planning?

David C. Walsh **Washington**

Advancements in the Chinese air force, along with a proliferation of technologies that could be converted into electronic weapons, have analysts and officials warning that the U.S. may not be keeping pace.

In November 2011, the Government Accountability Office issued a scathing review of the Pentagon's management of electronic warfare (EW), charging that it had ill-defined coordination practices. The following February, then-Defense Advanced Research Projects Agency Deputy Director Kaigham Gabriel testified to Congress that the U.S. had lost preeminence over the electromagnetic spectrum since "about 1997."

In the electronic domain, the goal is to exploit the spectrum by jamming, altering, misdirecting, mimicking or destroying an adversary's operations—while safeguarding one's own. The spectrum is already facing an increasing barrage from radiated electromagnetic or directed energy.

Chief of Naval Operations Adm. Jonathan Greenert is an advocate for harnessing the spectrum for EW. "We are using the electromagnetic spectrum as a domain and as a means, and we understand and grasp it," he says. "We have to figure out how we can beat things electronically first. Why do we spend all this money kinetically if we can jam, spoof or do otherwise?"

The first step in becoming more adept at EW is to cultivate more awareness of the electromagnetic and cyber-warfare environment, Greenert says. "We need to know what 'normal' is," he expounds. "We've brought all these networks in, and we know when there is a change, but is the status quo the normal? The [next step] is finding out what our electronic signature is on all our units."

The Navy needs to develop radars that can use alternate frequencies, and to assemble cyberteams. "We have got to evolve this paradigm," Greenert says. "We need to prepare the fleet to enact an electronic warfare plan the same way they think of a communications or surface warfare plan."

Kevin Pollpeter is the deputy director for the study of innovation and technology in China, at the University of California-San Diego. Like Greenert, he advocates the convergence of EW and cyber.

In his book "China's Emergence as a Defense Technological Power," Pollpeter notes the relative ease of inserting malicious algorithms in any antenna—with benefits well outweighing costs.

China's e-threat matrix, he says, comprises space, cyber and EW. And it is here—versus conventional arms, where it is definitively outclassed—that China hopes to seize the initiative.

Pollpeter explains that China appears well prepared to employ melded EW and cyberattack; the U.S. is not. That fusion will be "a major part of any operation involving an advanced military power," he says.

Should the Pentagon fail to engage similarly, "systems not protected against such [tandem] attacks will be vulnerable," Pollpeter notes. E-assaults would be worse in light of vulnerabilities with active, electronically scanned array (AESA) radar, which are used on many advanced U.S. aircraft.

Otherwise highly competent, AESA provides "an easy pathway for malware insertion and other cyberattack." Another AESA counter, Pollpeter says, citing Chinese defense industry boasts, is the KG300G jammer pod, using "digital radio-frequency memory."

China's anti-access/area-denial (A2/AD) strategy is gaining favor, too, according to Pollpeter. A2/AD refers to Beijing's increasing demarcation of contested territory as "I dare you" zones, the maneuvering toward which could be construed as a *casus belli*.

The response would be resisted, he



ROTORCRAFT

Mighty Mikes

Measuring sound in the quest for reducing helicopter noise

Michael Dumiak **Berlin**

Temperatures soar to beyond 1,000C in the turbine sections of helicopter engines. This is hardly a hospitable environment for a condenser microphone.

But Berlin-based German Aerospace Center (DLR) researchers, because they needed to take sound measurements in just such inhospitable places for experiments useful in the decades-long pursuit of quieter helicopters, have designed

a special housing and coiled sound canal probe for the job.

These sensors and measurement techniques could be useful in producing turbine designs with lower sound signatures and, overall, in helping to build the quieter helicopter of the future. While the U.S. military is already fielding stealthy helicopters (the 2011 raid on Osama bin Laden's compound outside the capital of Pakistan is a prime example), urban residents living near trauma hospitals could also benefit from quieter helicopters, especially late at night.

Engine acoustics experts Lars Enghardt and Karsten Knobloch worked five years to develop the new probe, first deployed in a series of noise-measurement experiments last year in labs at French helicopter engine manufacturer Turbomeca. Research partners included Spanish environmental consultants Anotec, Danish sound engineering company Bruel & Kjaer, Swiss federal technology institute EPFL in



The EA-18G Growler specializes in electronic attack and enemy air defense suppression.

believes, as much or more via EW/cyberwarfare ops such as jamming radars as through traditional kinetic means, including capable anti-radiation missiles. Even limited spectrum/cyberwar/kinetic successes might “greatly complicate U.S. Air Force operations.”

Targeted in this “quick war, quick resolution, preemption and surprise,” war scenarios would be “centers of gravity,” specific U.S. command and control networks, and other nodes.

Significantly, Chinese writings propose not widespread extirpation of the enemy or “victory” in the usual sense, but localized, time-specific information dominance. “The goal is to paralyze, not annihilate the enemy, but merely render him deaf, dumb and blind,” he says.

Another development may be a speed-up in program maturation. Gabriel and others describe a “democratization” of EW, pointing to the avalanche of easily reverse-engineered mobile consumer electronics, i.e. tablets and smartphones. These help enable adversarial nation-states like China (and its plausibly deniable “patriot hackers”) to jam frequencies and otherwise im-

peril the U.S. defense establishment’s encrypted communications. Likewise, “lone wolves,” industrial spies and anarchist groups can employ these methods. The core technology was previously closely guarded but is now within the reach of millions of people.

And newer, smaller devices are not less powerful, but more numerous, offering access to more frequencies for malevolent aims, Gabriel testified. Relatively crude, the devices are cheap and easily manufactured. Concentrated on the same target and launched in numbers, they become an asymmetric force multiplier.

Other experts are more measured in their comments about a gap between Chinese and U.S. capabilities.

U.S. Air Force Col. (ret.) Wayne Shaw is a longtime EW officer who flew missions over Bosnia-Herzegovina, Iraq and Afghanistan. He now presides over the Association of Old Crows—an influential EW advocacy organization.

Shaw has a professional’s concern about Chinese EW/command and control and similar capabilities, but leavens it with can-do optimism and

a tally of America’s e-warfare assets.

About the airborne warning and control system (AWACS), a platform that can control 100-plus other aircraft at once, he says, “China has only a handful” of KJ-200/2000 AWACS. “That hardly makes for a robust capability.” The U.S. owns about 70 E-3 Sentry AWACS brimming with advanced EW and electronic intelligence exotica, offensive and defensive.

The People’s Liberation Army Air Force (Plaaf) KJ-200 maxes out at about 20,000-ft. orbiting altitude, limiting line of sight, versus the much higher orbiting E-3; “an operational disadvantage,” he quips, “for orchestrating air wars over hundreds of miles of airspace.”

The KJ-2000, based on the Soviet IL-76 airframe, is “not exactly new technology. And they have only about four of them.” It should be capable of orbiting higher, but Shaw believes there are too few to make “a really viable fleet.”

U.S. E-3 AWACS significantly outclass the Plaaf’s. The Chinese, Shaw concludes, “will be closing the gap for a long time to come.”

In addition, the U.S. maintains its fleet of EA-18G Growlers, which specialize in electronic attack and enemy air defense suppression. Shaw, who has viewed crews in an EA-18G simulator during a high-threat scenario, notes that “it is an incredible capability.”

Other serious U.S. EW tools include the MALD-J (Miniature Air Launched Decoy-Jammer), which can be launched from B-52s, 16 at a time, and the Next Generation Jammer (NGJ), reportedly soon to replace the legacy ALQ-99 jamming pods.

Concludes Shaw: “Don’t lose the faith.” ☛

Lausanne, and Trinity College-Dublin among others. The experiments helped build a full-scale-engine test database with extensively detailed internal measurements; the DLR is going to continue to use the probes in more specific helicopter noise-propagation measurements in aero turbine nozzles, as well as for a new rig in Berlin that is designed for thermoacoustic testing of gas turbines.

The German-designed heat-resistant stainless steel probe looks a bit like an otoscope, the instrument health-care providers use to examine ears. The probe has a coiled tube attached to one end. One end of the tube rests flush against the heated element, in this case the engine’s combustion chamber wall. Sound travels through a canal in the tube, passing over the membrane of a small condenser microphone. The sound then continues traveling through the coil, which wraps a half-dozen times before opening to a cooling air supply vent.

The coil is there to eliminate potential echo and resonance from interfering with the sound measurements; the longer the tube, the better the damping.

The researchers introduce a little cool air and overpressure into the probe to further protect the microphone from hot gases and soot. A mathematical equation corrects for the distance the sound is traveling away from the hot combustion chamber. The sensitive condenser microphones—which can cost \$2,300 apiece—can withstand about 70C. The probe cools the air temperature from more than 1,000C at the heat source to less than 50C by the time it passes over the microphone 20 cm up the tube. The team constructed 50 probes and used 36 to build a sound database for the helicopter turbine.

Damping helicopter noise is a kind of Holy Grail for helicopter manufacturers and engineers. As far back as 1975, a report for the FAA by Hamilton Standard’s Bernard

Airbus's twin-engine EC145 T2 incorporates many recent noise-reduction advancements from European researchers.

AIRBUS



Magliozzi described many areas inside a helicopter where noise-generation sources were “just beginning to be understood.” It still remains a complex phenomenon and difficult to measure, says Philipp Kramer, head of general engineering research for Airbus Helicopters.

Helicopter noise is layered like an onion—a louder noise source masks a quieter one, and one’s perception of the sound depends on where the helicopter is in relation to you. By far the loudest noise sources are the main and tail rotors. In recent years, Airbus and other helicopter manufacturers have experimented with blade shapes and “active” rotors that try to mitigate the thumping sound caused when one blade cuts through the vortex shed caused by the blade in front of it. Kramer points to the Airbus “Blue Edge” design, in which the outer part of the blade is swept forward and the tip swept back, as a prime example.

Even less-radical recent sound improvements are being incorporated into new production designs, Kramer says, such as the EC145 T2.

But in addressing the noise inside a helicopter cabin—or in trying to reduce a helicopter’s overall sound signature—engineers will need to consider the turbine engine.

The shielded microphones are bringing a new precision to understanding engine sound. Enghardt says years of testing show

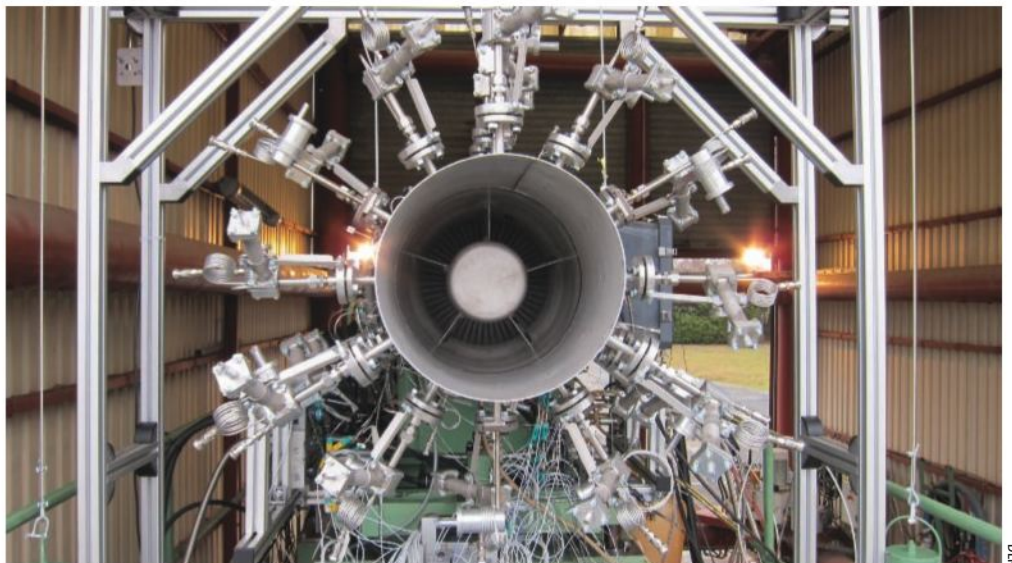
Seen head-on, these hot-gas microphone probes look like cylinders extending from the intake of the turbine.

that different combinations of design features and operating conditions result in widely varying noise levels—it is just not clear precisely why and exactly where the noise is coming from. Different combustion chamber shapes cause different frequency resonances and vibrations in the sound spectrum.

If the engine combustion prompts a lot of pressure fluctuation near these frequencies, they can become strongly amplified, the researchers say. A detailed database of sound measurements taken from previously uncharted places in the engine could show how that happens—and result in quieter designs.

DLR’s Knobloch adds that “new thinking” will help.

“When you look at an engine you try to get as much power out of it as you can. It can be that [if it is] the design for an engine that makes less noise, you have to take a different path,” he says. “We want to answer some of these questions.”



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ISRAEL AEROSPACE INDUSTRIES

Rafi Maor

Chairman, Israel Aerospace Industries

Age: 64

Birthplace: Tel Aviv

Education: B.S. in aeronautical engineering, Tel Aviv University; executive program, INSEAD Business School, Fontainebleau, France.

Experience: Chairman of the board, ECI Telecom, 2012-13; president and CEO, ECI Telecom, 2006-11; president and COO Indigo NV, 2004-06; general manager of IAI's Malat (UAV) division, 1993-96.

Going Global

Rafi Maor returned to Israel Aerospace Industries as chairman in November 2013. He had worked on the Lavi fighter program and led IAI's unmanned aircraft systems division before leaving the company for the information and telecom industries. Maor gave his first media interview to Senior International Defense Editor Bill Sweetman at last month's Singapore Airshow.

AW&ST: What is your view of how big the civil unmanned aircraft system market will be, and how soon it will start to take off?

Maor: When I managed the UAV division 20 years ago, we were in the first stages of "crossing the chasm," where the customer starts to believe in the scalability of the solution. There was a lot of skepticism within air forces, especially among pilots, about how far you can go with a UAV. Today, when you talk to air force commanders, everybody understands that everything that can be unmanned will be unmanned.

Ten or 20 years ago, had I told you to expect an unmanned aircraft to fly over the ocean, it would be what I'd call "beyond visual range." Today, it's well within visual range. When you fly the new Super Heron, it is flying at 30,000 ft. and crossing commercial airways, whether it is military or not. You need certification to fly it. You would not fly in an unmanned [Boeing] 787 today and nor would I. But theoretically it does not need a pilot in normal operations and it is debatable whether it needs a pilot in an emergency. A computer today can make a Category-3 landing, so there is no reason why a cargo aircraft today would need a pilot.

When do you expect to see an unmanned commercial aircraft?

It may take six years, maybe 16 years—in my opinion, in the next 10 years—be-

fore you start seeing unmanned cargo aircraft. This issue is consuming many engineers and much entrepreneurial time in IAI, but I can't tell you what we are doing, for very obvious reasons.

What are the next steps with Taxibot?

Lufthansa has been checking the system out at Frankfurt, without passengers, for around three or four months, and later moved into tests which are to be finished soon with live customers on board. Next we will certify the system with the assistance of Airbus, and after that we expect Boeing to certify it for the 737. The next stage will be widebody aircraft. We are looking for partners—it may be Lufthansa again, or someone else. Also, we are establishing a company to run this business globally—probably located in Europe, but possibly in Asia—and we are looking for technical partners and some investors.

How big could Taxibot be for IAI?

This company could easily be turning around hundreds of millions of dollars, up to \$1 billion a year. We have a goal for when we want to get there, but I don't want to share it.

Taxibot is a revolution, and as such the biggest task today is the financial model. It's a super-complex issue. Let me try to segment the market for you. In some areas, the operator of this

equipment is the airport authority. They could offer a price-changing model based on hours: when the airport is more congested and the waiting times are longer, they could charge more. A second market segment that is more immediately addressable is the airlines. If you look at United Airlines at Chicago [O'Hare International Airport], they are using their own tractors.

What can IAI do to become more competitive?

It starts with the ability to deliver innovation and what I call "winning-difference" quality. At the end of the day, we may be a very large company in Israel, but looking at the global world, in terms of scale relative to our competition, we must be unique in delivering advantages. IAI is the largest engineering employer in Israel—we have 6,000 engineers today and in the next three years I expect that number will be increased by at least 20 percent.

It is not just the excellent technology that we have, but also our ability in the defense area to combine this with the vast operational experience of our local users. Unfortunately, we are in an area where we use this technology pretty often and we have some experience that was gained by sweat and blood. That is valuable information that we have and others do not. We spend a lot of money on R&D, \$1 billion a year today. That is not all from us—some of it is very unique, carried out for certain customers.

As to whether our future growth will be organic or non-organic, it will probably be both. We will mostly grow organically, but we will identify good mergers and acquisitions that we can leverage along with large customers, or territory or technologies. The Taxibot operation could be a "reverse M&A," where we bring investors inside the company. ☐

Front Lines

Israel plans to defend against new types of threats within the cyber realm

David Eshel **Tel Aviv**

Since 2002, Israel has been working to protect its critical information systems from cyberthreats. Key among the initiatives was the creation of the National Information Security Authority under the national secret service.

"Ten years after, we could be satisfied that at the national, military and critical infrastructure level, we were protected," Rami Efrati, former head of the civilian division of the Israel National Cyber Bureau, tells Aviation Week.

But that was an illusion. With organizations becoming interconnected with less-secure entities, the former become larger targets that are more vulnerable to attack. "We can effectively protect a military network or a central database at police headquarters," Efrati says. "But who will protect the computerized production line of a pharmaceutical industry, or water desalination plant?"

According to Efrati, even with the best security systems, modern advanced persistent threats—in which embedded computer systems have been infiltrated by attacks that can remain dormant for years, quietly collecting information and funneling it back to the originator—are compromising almost every network.

The more developed and connected societies are, the more vulnerable they become, and this is not limited to compromising privacy or information security. As the "Internet of things" becomes a way of life in the very near future, many systems that our lives are dependent on could be

compromised. This trend is particularly alarming for the defense, energy, transportation and finance sectors, where compromised security can be catastrophic.

"In the past, we considered our networks secure as long as they were not connected to the Internet. Today, we know that no network is protected and no electronic appliance is secure."

In 2012, Prime Minister Benjamin

factors will help Israeli developers facilitate international information-sharing about evolving threats and cybersecurity.

"Such advanced threats require protection beyond the perimeter, by monitoring the activity inside your own network—based on intelligence, and analysis usage patterns—seeking to spot anomalies that could indicate such illusive threats," Efrati says. Such skills are beyond the abilities of a commercial company or a small business, even if it is part of the supply chain serving a defense company or government agency.

The cyberbureau also encourages academic research, by funding institutions that offer computer science, math and engineering. It also seeds



ISRAEL DEFENSE FORCES

Israel's National Cyber Bureau is funding research and development to defend global computer networks.

Netanyahu announced the creation of the National Cyber Bureau as the authority within his office providing defensive capability for Israel. The initiative also encouraged investors and entrepreneurs to support cyberstartup companies. Netanyahu set a goal for the Israeli cybermarket to become one of the top five global leaders in cyberdefense.

The bureau supports high-tech companies in developing advanced solutions to address the challenge of cyberattacks. The organization backs human capital for cyberoperations, supporting research and development and establishing collaborative environments for information sharing, simulation and testing. All of these

venture capital funds for companies and collaborates with the Defense Research & Development Directorate to find commercial technologies with a "dual-use" application.

Efrati led the establishment of Cyber Innovation and Research Centers in Israel by well-known world technology companies. The efforts yielded rapid results. "In less than two years, the number of Israeli companies associated with cybersecurity increased from 50 to 220, raising more than \$400 million in 78 funding cycles," he says.

The new trend also has attracted international corporations seeking to develop their own capabilities in the area. Cisco already has said it is committed to establishing its "Cyber In-

novation" center at Beer Sheba, which is known as the "Cyber Capital" of Israel. It is home to the National Cyber Campus—CyberSpark, a cyber industry zone to be located adjacent to Ben-Gurion University, where Israel's national Computer Emergency Response Team (CERT) is established.

Other companies including Cisco, IBM, General Electric, Lockheed Martin, Intel, EMC Corp. and RSA, the security division of EMC, are already familiar with Israel's advances in this area. Enhancing these capabilities with cybersecurity would be an obvious evolution from the electronic design, software development and networking they have already developed.

Because the threat of cyberattacks is international, the solutions will need to be global as well, Efrati explains. "Getting there is not simple, it takes time, confidence-building and considerable investment, but together we can get there. We expect our new CERT to be connected to other CERTs in other countries, sharing information about threats, attacks, vulnerabilities and methods," he says. "We also plan to establish sectorial CERTs, addressing specific industry sectors such as aviation, transportation, health care, finance or energy. By focusing on specific sectors the dialogue between cybersecurity experts and information-systems personnel would be improved, enabling more efficient cooperation and better response in time of emergency."

In addition to emergency response teams, Israel's cyberbureau has also established a "national test range"—a testbed for developers. The facility collects data sets of representative systems and threats, emulating large-scale systems and real threats in a safe, yet responsive and realistic environment. Israel plans to open the testbed to its international partners.

The threat remains real and changing. Cyberattacks are already targeting some of the most sensitive assets that nations have safeguarded for years—assets that are now more vulnerable to attack than ever before.

"When a rocket is fired at you across the border or a missile is launched from a distant nation, you know exactly where it came from. Attribution is clear, and in such cases, even if the specific attacker is hidden, there are 'fingerprints' that can iden-

"Today we know that no network is protected and that no electronic appliance is secure"

tify the perpetrators and the origins of weapons," Efrati says.

Cyberattack is a type of asymmetric warfare. It is much easier to attack, but far more difficult to defend against. Attackers are launching their activity shaded by the anonymity of the web, assisted by hired hackers and crowds of "bots"—millions of users unaware that their personal computers and smartphones are being hijacked to carry out unlawful espionage, criminal acts or to deliver attacks.

"Cyberattacks are hidden and illusive, and as such, bear no attribution. Yet they have the potential to cause even greater damage than missiles and bombs," Efrati says. "Such attacks are cheaper to launch [and] operations do not require significant infrastructure or national support.

In fact, attacks are often launched using proxies, hiding their true origin, thus avoiding retaliation by the victim."

The asymmetric nature of the threat is that even small but determined militant groups

now have access to potent weapons, without needing to maintain a powerful arsenal.

Still, despite the secrecy, the knowledge required to launch cyberattacks is far from universal. "An attack against a critical infrastructure is a military operation, based on intelligence, planning and execution that requires financial [outsourcing] or operational means far beyond those available to ordinary hackers," Efrati says.

"High-risk cyberattacks are likely dependent on support from national levels and this support is most likely covert, unless it is compromised. These capabilities already exist in cyberspace, primarily in the anonymous, lawless 'darknet,' where cyberterror and cybercrime flourish," he notes. ☒

CYBER ALLIANCE

Bill Sweetman Singapore

One example of Israel Aerospace Industries' (IAI) push toward new international joint ventures is Custodio, a Singapore-based cybersecurity research and development company being established in collaboration with the nation's Economic Development Board and announced in February at the Singapore Airshow.

For IAI, Custodio not only represents expansion in the Asian market but "the evolution of ISR [intelligence, surveillance and reconnaissance] into the cyber domain," according to IAI President/CEO Joseph Weiss. The goal is that Custodio will grow to have an 80-90% Singaporean workforce, including its executives. It will develop next-generation security tools, IAI says, which can then be transferred to commercial users.

The joint venture fits into Singapore's five-year cybersecurity master plan, adopted in 2013. "The vision is to become the regional hub for cybersecurity in Asia," says EDB managing director Yeoh Keat Chuan. "[We offer] a trusted location, a diverse talent pool and connectivity."

Custodio will focus on what IAI sees as the three key challenges in cyberdefense: active defense, or the ability to catch the hacker in the act and protect vital data while gathering information on the attacker; geolocation, or the attribution of an attack to a specific nation or region; and identification or anomaly detection, which involves learning about attackers' behavior and providing early warning of an attack.

Geolocation and attribution are "the Holy Grail" of cyber, according to Esti Peshin, IAI-Elta director of cyber programs. Peshin played a lead role in establishing the new joint venture. Until that can be solved, she says, the cyber domain is "inherently asymmetric," favoring an attacker who can remain hidden. ☒

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A **non-compulsory** briefing/clarification meeting will be held at **13:00 on 4 March 2014** at the VIP Boardroom, ACSA Offices, ACSA Upington International Airport, Upington, South Africa. No bidding documents will be available at the briefing session.

Site visits may also be arranged by contacting ACSA Procurement on below contact details.

CLOSING DATE

The bid closes on Monday, **12 May 2014 at 14:00 SA time**. All bid documents must be provided in duplicate (printed) and sealed in a clearly marked envelope/package marked with the **bidder's name, bid reference number and bid description**, and deposited in the bid box situated at the Reception, ACSA Offices, Riverwoods Office Park, The Maples, 24 Johnson Road, Bedfordview, Johannesburg, South Africa.

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Complete bids will be evaluated in three phases.

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Proposals that do not meet any one of the following criteria will be disqualified and will not be evaluated further (valid proof/certification must be provided):

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- South African companies should submit a valid and original Tax Clearance Certificate. The lack of an original SARS Tax Clearance Certificate with no explanation/application will result in disqualification

NB: No tender will be awarded to any person whose tax matters have not been declared in order by the South African Revenue Service.

Phase Two – Functionality (max 100 points)

Functionality is a hurdle phase which will disqualify bidders not meeting minimum requirements.

Only bidders scoring minimum points per evaluation criteria for functionality will be considered on Price and B-BBEE.

Phase Three – Price and B-BBEE

This phase is based on the 90:10 preferential formula, with 90 points reflecting price and 10 points reflecting B-BBEE recognition. ACSA will only accept DTI criteria as proof of B-BBEE status.

Enquiries and Contact Information

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Fax: 086 535 9125

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Aviation Week & Space Technology

March 17, 2014 VOL. 176, NO. 9 (ISSN 0005-2175)

Two Penn Plaza, New York, N.Y. 10121-2298

Member of Audit Bureau of Circulations and Magazine Publishers of America. Published weekly, except for one less issue in January, February, April, May, August, November by Penton Media Inc., 9800 Metcalf Ave, Overland Park, KS 66212-2216. Periodicals postage paid at Shawnee Mission, KS, and additional mailing offices. Canada Post International Publications Mail Product Sales Agreement No. 40026880. Registered for GST as Penton Media, GST # R126431964. Title reg. ® in U.S. Patent Office. Copyright © 2014 by Penton Media. All rights reserved. All rights to these names are reserved by Penton Media. **Postmaster:** Send address changes to Aviation Week & Space Technology, Attention: Subscription Services, P.O. Box 5724, Harlan, IA 51593-1224

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June 10-11—MRO Baltics, Eastern Europe & Russia (BEERs). Sheraton Warsaw (Poland).
July 16—Farnborough Civil Manufacturing Briefings. Farnborough (England) air show.
Oct. 7-9—MRO Europe. Madrid.

Aerospace Calendar

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April 1-2—SpeedNews Second Annual Aerospace Manufacturing Conference. The Battle House Renaissance, Mobile, Ala. speednews.com/aerospace-manufacturing-conference

April 8-10—MRO Americas. Also, **April 9**—MRO Military. Both at Phoenix Convention Center. events.aviationweek.com/current/mro/index.htm

April 11—Society of Experimental Test Pilots' East Coast Section Symposium. NAS Patuxent River, Md. www.setp.org/table/east-coast

April 14-17—Asian Business Aviation Conference and Exhibition. Shanghai. www.abace.aero/2012/

April 30—American Institute of Aeronautics and Astronautics' (AIAA) 2014 Aerospace Spotlight Awards Gala. Washington. www.aiaa.org/gala2014

April 30-May 1—Speednews 12th Aerospace & Defense Industry Suppliers Conference. Jonathan Club. Los Angeles. speednews.com/aerospace-and-defense-industry-suppliers-conference

May 5-9—AIAA's SpaceOps 2014 13th International Conference on Space Operations. Pasadena (Calif.) Convention Center. www.aiaa.org/spaceops2014

May 12-15—Association for Unmanned Vehicle Systems International's Unmanned Systems 2014. Orange County (Fla.) Convention Center. www.auvsishow.org/auvsi2014/public/Content.aspx?ID=1394&sortMenu=102000

May 19-22—National Space Symposium. Berlin. www.nationalspacesymposium.org/

May 20-25—ILA Berlin Air Show. www.ila-berlin.com

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Warning Signs for Supply Chain



Captain is vice chairman of Deloitte LLP and is based in Seattle.

Last year was a record one for commercial aircraft sales orders, production and backlog, with an astonishing 1,274 aircraft delivered—about twice the volume produced just nine years ago. The forecast continues to be rosy, with more than 30,000 commercial jets expected to be produced over the next 20 years to address new demand, particularly in Asia and the Middle East, and replace older, less fuel-efficient models. New aircraft are in design phases. Factories are planning rate increases. OEMs and suppliers are busy. What's not to like about this picture? Deloitte's recent informal feedback from suppliers is reason for pause, and there may be plenty to be concerned about.

The commercial air transport value chain is putting enormous pressure on suppliers, which could have a detrimental effect. Low airfares drive airlines to buy new aircraft at lower prices. OEMs are reducing their costs by investing heavily in lean manufacturing, digital product development and supplier rationalization. Finally, OEMs are demanding suppliers—whose products now make up the majority of aircraft manufacturing costs—to respond in kind to these pressures with significant price concessions.

As shown in the accompanying chart, OEMs have borne the brunt of financial investments and risk recently, evidenced in their lower operating profit margins compared to their suppliers'. With supplier margins being about twice the average for OEMs, it is no wonder that prime contractors are driving hard bargains and advocating for a change in the cost structure and business model for aircraft production.

The supplier business model has changed in the last 10 years from "build to print," to the "risk-sharing partner" approach, where suppliers get paid when the OEM gets paid, and the supplier pays for and is responsible for design authority. That means the subcontractors have to hire skilled engineers and designers. They also in turn need to manage a larger supply base themselves and require the same kind of skilled supply chain management personnel as the OEMs.

This is a big change for the subs. In essence, they need to put their balance sheets at risk, invest much more of their own working capital, substantially increase their

skilled workforce in engineering and supply chain talent—and meet the new expectations of cost reductions. This is occurring in an environment that requires the highest levels of quality and reliability, meticulous adherence to the promised dates of delivery and year-on-year cost reductions.

What are the implications of this change? The financial, talent and operational challenges of becoming a "super-supplier" may not be addressable by some companies, because they do not have scale, possess a strong balance sheet or have access to the required talent. Some might simply drop out of business. Many of the smaller suppliers may be acquired to enable the surviving bigger companies to gain better economies of scale. With fewer suppliers to work with, OEMs may find that vendors will be able to control prices for components and systems better, due to fewer competitors being available, especially when some are maxed out and don't have capacity. This could lead to bottlenecks and manufacturing capacity-related delays, OEM margin pressure and/or supplier price increases.

The aerospace industry (and defense, for that matter) has encountered certain cost and schedule reliability issues in the past, with frequent aircraft program delays. Execution difficulties, plus the new supply chain model challenge, spell potential trouble on the horizon for the industry—additional risks of schedule delays and constrained ability to meet production volume demands. OEMs may potentially have to bail out certain suppliers, or worse, deal with ones that fail financially. Although it is a worst-case scenario, we saw this happen in the last decade as suppliers started to make the transition to the new business model.

However, we have seen some progress already, with OEMs taking some design authority back in-house, recalling some of the manufacturing work packages, executing of supplier development and surveillance programs to de-risk the supply base, and financial support to help certain suppliers. However for OEMs, driving hard bargains may result in supplier consolidation that could have an adverse impact. For suppliers, the new reality is upon us. Continuous cost reductions and pricing pressure are here to stay. ☐

A&D Industry Operating Margins

	2011	2012	2013
OEM	6.3%	6.4%	7.5%
Tier 1	13.2	12.8	12.7
Tier 2	15.8	16.2	17.1
Tier 3	11.0	9.6	2.1
Aerostructures	5.0	4.9	5.5
Electronics	11.4	11.9	12.1
Propulsion	11.6	12.2	13.7
Services	5.5	6.5	6.1
TOTAL A&D	8.4%	8.6%	9.4%

Source: Deloitte LLP



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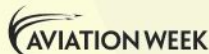


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