AerospaceDaily & DEFENSE REPORT

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Inside:

Aluminum Ties

AMAG Austria Metall said it is acquiring a 70% share of the German company Aircraft Philipp Gruppe to increase vertical alignment expertise in the machining of aluminum and titanium for the aerospace industry along with aluminum rolling, casting and recycling. AMAG said the move would create value in the direction of mechanical processing, such as milling and drilling, and the manufacturing of special components. The combination is expected to cut costs for closed-loop-recycling of plate-off cuts and chips from milling processes, as well as "improve" buy-to-fly-ratio, "optimize" logistics and "considerably reduce" the carbon dioxide-footprint, the company says.

Daily Briefs

BRAZIL conducted its first flight of a **SAAB** F-39 Gripen Aug. 20.

JOHNS HOPKINS UNIVERSITY APPLIED PHYSICS LABORATORY has $50m U.S. Air Force contract for air warfare systems.

U.S. AIR FORCE's Nellis AFB in Nevada opened Virtual Test and Training Center Aug. 17. First missions in the VTTC scheduled for spring/summer 2021.

HONEYWELL has $20.8m U.S. Air Force contract for repair of advanced display core processor and digital mapping service in F-15Es.

MANTECH SRS TECHNOLOGIES INC. has $16.3m U.S. Air Force contract for systems engineering and integration support to the Space and Missile System Launch Enterprise.

PROGRAMS

Top UAE Diplomat: Israel Peace Agreement Should Ease F-35 Deal

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The Israel-United Arab Emirates (UAE) peace agreement should open the door for the U.S. government to approve a six-year-old request by Abu Dhabi to acquire Lockheed Martin F-35 fighters, the UAE's top diplomat said.

The agreement, also known as the Abraham Accord, commits the UAE to normalize relations with Israel, but remains tentative until a final pact is signed. Once the deal is formalized, the U.S. should approve UAE's long-standing request to receive access to the F-35, Emirati Foreign Minister Anwar Gargash said in an interview with the Atlantic Council on Aug. 20.

"The UAE expects that its requirements will be accepted and we feel that with the signing of this peace treaty in the coming weeks or months—whatever it is—any hurdle toward this [F-35 purchase] should no longer be there," Gargash said.

A senior Emirati military official first expressed the country's interest in an F-35 acquisition during the Dubai Air Chiefs conference on the sidelines of the 2009 Dubai

F-35 DEAL, P. 2

F-35 DEAL, From P. 1

Air Show. With a mural-sized picture of the F-35 as a backdrop, the Emirati officer told a crowd that included senior U.S. military officials that the UAE wanted a fifth-generation fighter.

The UAE formalized its interest in the F-35 around 2014, Gargash said, presumably by filing a letter of request to the U.S. State Department to initiate a Foreign Military Sales case.

"What I know very clearly is the UAE has been very happy with its F-16s, and it's time to upgrade them," Gargash said. "The F-35 has always been a target for the UAE's defense requirements."

The Obama administration made no move to publicly acknowledge the UAE's interest in the F-35, but that changed after the Trump administration took over. During the 2017 air show, top U.S. defense officials said they would consider the UAE's request for a classified briefing on the F-35.

But progress seemed to stall. Two years later, the U.S. delegation to the air show declined to answer questions about the UAE's interest in the F-35. In the interim, the UAE decided to invest in new upgrades for its Lockheed F-16 and Dassault Mirage fighter fleets, extending their viability for at least another decade. Although the U.S. position never was articulated, Gargash implied the UAE's publicly non-friendly relationship with Israel, a major U.S. regional ally, was the source of the delayed approval for the F-35 request.

"I think the whole idea of a belligerent state of affairs [between the UAE and Israel] will no longer be there," Gargash said. "It's part of the vistas that the deal will open."

FUNDING & POLICY

Report Favors Commerce Office To Lead Space Traffic Management

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An independent panel that conducted a review commissioned by the U.S. Commerce Department has concluded its Office of Space Commerce (OSC) is the best-suited federal agency to oversee future space traffic management (STM).

The National Academy of Public Administration (NAPA) evaluated the suitability of the OSC, FAA Office of Commercial Space Transportation, NASA and Defense Department (DOD) to manage increasing space traffic and the risk of orbital collisions. It released its report on Aug. 20.

"Following its evaluative criteria, the panel determines OSC to be best suited to perform STM tasks within the federal government," the report states. "[F]urthermore, its operating plan to move forward is not defined by a vision to build a large bureaucratic structure, but . . . places the highest priority on serving as a trusted convener."

The report calls on Congress to "enact, without delay, appropriations and any required authorities for OSC to build this critical capability with requisite personnel, office infrastructure and authorities."

The Commerce Department is seeking $15 million for STM in its fiscal 2021 budget, an official told reporters following the report's release. NAPA estimates $153 million to $218 million will be needed to mount an STM capability over five years (fiscal 2020-24). "In FY2025, it is anticipated that the STM task will be in a steady state of funding," the report states.

There are an estimated 500,000 objects already in orbit, including 2,800 active satellites, and the number of vehicles launched increases each year.

"As space becomes increasingly congested with ever-larger numbers of domestic and foreign commercial companies, researchers, universities and military/intelligence agencies launching orbital assets, the issue of space traffic management becomes ever more salient. With the risk of orbital collisions growing astronomically, we face a crisis that must be urgently addressed," the NAPA report warns.

A Senate amendment to fiscal 2020 appropriations legislation provided money to the Commerce Department to contract with the non-profit advisory academy to review STM candidate agencies. The OSC is an office within the National Oceanic and Atmospheric Administration, which is part of the Commerce Department.

The academy's report notes that neither the DOD nor NASA expressed an interest in performing space situational-awareness (SSA) and STM functions relating to commercial space activity. NASA and the FAA, which regulates and manages commercial space launch and reentry activities, are "potentially attractive candidates" for the mission, it states.

The OSC's concept of operations would be to "work collaboratively with military, non-military, domestic and international actors in order to maintain a sustainable space domain in which commercial and research activities may thrive," the report states. "OSC views its STM responsibilities principally as a data-management function, rather than principally as a task of managing space traffic."

Michael Dominguez, a former senior Pentagon executive

REPORT, P. 3

TECHNOLOGY

Rolls-Royce, Reaction Engines Team For High Speed And Hybrids

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Rolls-Royce and Reaction Engines have entered a new strategic partnership to develop high-speed aircraft propulsion systems and study potential applications of Reaction's heat exchanger technology for next-generation civil engines and hybrid-electric propulsion systems.

The partnership, which comes in the wake of announcements earlier in August that Rolls-Royce is studying high-speed technology for supersonic transport projects underway at Virgin Galactic and Boom Supersonic, marks a key step in Reaction's quest to gain market traction by introducing its pre-cooler system into future propulsion systems.

Reaction's lightweight heat exchanger (HTX) forms the core of the company's novel Synergistic Air-Breathing Rocket Engine (Sabre) operating cycle, which is designed for hypersonic flight above Mach 5 as well as for low-cost access to space. However, the pre-cooler technology in the HTX also has attracted broader interest from high-speed project developers because of its ability to significantly delay the onset of compressor delivery temperature limits to a higher Mach number.

This capability, demonstrated in 2019 during runs up to Mach 5 equivalent air temperatures at the company's TF2 ground test facility in Colorado, could enable conventional turbojets and turbofans to be modified to operate at significantly higher speed. Alternatively, the pre-cooler could be integrated with a new centerline engine as part of an integrated heat exchanger/thermal management system.

The new partnership builds on continuing study work with Rolls-Royce that began in 2018 when the UK engine maker and Boeing became investors as part of a funding round that raised £26.5 million ($35 million). In addition to the UK government, which in 2013 announced a £60 million commitment to assist with development of the Sabre demonstrator engine, BAE Systems also made a strategic investment in 2015. BAE Systems, Rolls-Royce and Reaction also have been collaborating on hypersonic propulsion system work under a UK Ministry of Defense contract announced in 2019 as part of technology work underway in parallel with the UK's Project Tempest.

"It's probably the most significant commercial partnership deal that we've signed with a company and we are on the brink of commercializing this technology," Reaction CEO Mark Thomas says. Speaking to Aviation Week, he adds that "the real intent is to get the technology to market. Aerospace has high barriers to entry and aero engines have probably the highest barriers to entry of all. So the best way to get our technology into engines is through a partnership with a world-leading company like Rolls-Royce."

Beyond the high-speed applications, both commercial and military, Thomas says the deal also represents a "broadening of our relationship with Rolls-Royce into other areas as well on a more meaningful and formal basis. It allows us to access next-generation civil aero engines, as well as potentially hybrid electric systems where there's a gas turbine involved. It really widens the aperture and opens worlds of opportunity here for both companies if we can make this marriage work."

Under the terms of the partnership Reaction remains free to continue Sabre development as well as to exploit the heat exchanger technology in other commercial sectors, including automotive and energy. The work with Rolls will include two main thrusts; "One will be high speed propulsion where there's an obvious marriage between the pre-cooler and the jet engine. We'd like to see how fast that jet engine can go, and to see if we could get beyond Mach 4 which would be incredible," Thomas says. In 2019 Stephen Hillier, the former UK chief of the air staff, suggested the technology could be tested on an EJ200 Typhoon engine.

"Secondly, we will architect our heat exchangers into the next-generation engines where they can be applied in various locations for intercooling, recuperating and for producing cooled cooling air. That is a much more involved activity with more integration and will require our engineers to work together in teams," he adds.

REPORT, From P. 2

who was acting Air Force secretary and the DOD executive agent for space, chaired a five-member panel that adopted the report unanimously.

Commerce Secretary Wilbur Ross celebrated the issuance of the report. "I am pleased to see that following an intensive survey of key government and industry stakeholders, NAPA's findings independently validate that the Department of Commerce is the best civil agency to lead the commercial and international SSA/STM mission," he stated. "The findings of the senior panel highlight the urgent call to action needed to ensure a safe and sustainable space environment to support a thriving U.S. and global space economy. We look forward to working with the Congress to quickly advance this critical space mission."

OPERATIONS

NASA To Probe Source Of Small Space Station Pressure Loss

MARK CARREAU, mark.carreau@gmail.com

HOUSTON—The International Space Station's (ISS) three-person U.S. and Russian crew prepared Aug. 21 to retreat to the orbiting science lab's Russian segment Zvezda service module for the weekend, to support efforts by NASA and its partners to isolate the source of small internal air-pressure loss first detected in September 2019.

"That rate has slightly increased, so the teams are working a plan to isolate identify, and potentially repair the source," according to an Aug. 20 NASA status report summarizing the plan. "The leak is still within segment specifications and presents no immediate danger to the crew or the space station."

Hatches between the station's collection of European, Japanese, U.S. and Russian modules will be closed during the retreat so ground-control teams can monitor the pressure in each compartment supporting research volume, habitation, airlock and docking port functions.

"The U.S. and Russian specialists expect preliminary results should be available for review by the end of next week," according to the status report.

The detective work falls during a break in a busy few months of activities for NASA's Chris Cassidy, the current Expedition 63 commander, and cosmonauts Anatoly Ivanishin and Ivan Vagner. Those included the high-priority NASA Demo-2 test flight of the SpaceX Crew Dragon, which brought NASA test-pilot astronauts Bob Behnken and Doug Hurley to the ISS for two months and ended on Aug. 2.

During Demo-2, Behnken joined Cassidy for four spacewalks to complete a 3.5-year effort to replace external solar-power system batteries with more efficient units and perform maintenance and other upgrades.

During crew-exchange activities planned for October, Cassidy, Ivanishin and Vagner are scheduled to end a six-month tour of duty. They are to be replaced by seven U.S., Japanese and Russian astronauts and cosmonauts, who likely will increase demands on the station's life support systems.

"The test represents no safety concern for the crew," NASA stressed in the status report.

During the weekend retreat, Cassidy, Ivanishin and Vagner will share the Zvezda service module, the 43-ft.-long ISS living compartment launched by Russia in July 2000 and initially occupied as a habitat by the first permanent U.S. and Russian space station trio on Nov. 2, 2000.

While gathered in Zvezda, Cassidy, Ivanishin and Vagner will have access to Poisk, a mini-research module and docking port for the Soyuz MS-16 capsule that launched them on April 9 and is to transport them back to Earth for a parachute-assisted landing in Kazakhstan on Oct. 22.

The Soyuz also serves as a lifeboat should an emergency arise between scheduled launches and landings.

PROGRAMS

Russia's ISS Nauka Module Arrives At Baikonur Spaceport

MAXIM PYADUSHKIN, mpyadushkin@gmail.com

Russia is preparing to expand its segment of the International Space Station (ISS) with the arrival of the 20-ton Nauka Multipurpose Laboratory Module (MLM) at the Baikonur spaceport in Kazakhstan on Aug. 19.

According to the Roscosmos State Corp., the module's launch to the ISS is planned for the spring onboard a Proton rocket.

The assembled module was too large to be shipped in one piece by train, so its external equipment was removed and carried to the spaceport in 14 railway cars. Roscosmos subsidiaries Energia Corp. and Khrunichev Space Center will reassemble the Nauka and conduct final control tests.

It was built in 1995 as a backup for the Zarya Functional Cargo Block, the first ISS module, which Russia decided to redesign as a scientific laboratory. The launch initially was planned for 2007 but it has faced numerous delays.

Nauka is expected to be inserted onto the Zvezda module's Earth-facing docking port and become Russia's primary ISS research module. According to Khrunichev officials, Nauka will be able to carry up to three tons of scientific equipment. The module also will add an airlock, third crew cabin and second toilet for the Russian segment.

Nauka will be equipped with the European Robotic Arm. This 11-m (36-ft.) manipulator will be able to handle up to eight tons of external payloads and support astronauts during space walks.

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TECHNOLOGY

Near Earth And Kaman Test Autonomy For K-Max Helicopter

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Near Earth Autonomy and Kaman Aerospace have conducted initial test flights under a U.S. Navy-funded program to develop an advanced autonomy system for Kaman's 6,000-lb.-payload K-Max external-lift helicopter.

The program, supported by Naval Air Systems Command (Navair), is aimed at developing an autonomy capability that is broadly applicable to large military and commercial vertical-takeoff-and-landing (VTOL) aircraft.

The effort follows on from the Office of Naval Research's Autonomous Aerial Cargo/Utility System (AACUS) program under which Aurora Flight Sciences, working with Near Earth, demonstrated autonomous flight of a full-size helicopter.

In the December 2017 AACUS program's final demonstration, a Bell UH-1 modified to unmanned operation responded to a request for resupply from a Marine on the ground, planned and executed a route, avoided obstacles and selected a safe landing zone, all autonomously.

Following the AACUS program and under the Unmanned Logistics System-Air (ULS-A) joint capability technology demonstration (JCTD), Near Earth is working with the U.S. Army and Marine Corps to develop and test a version of its autonomy system scaled down to fit into small and medium-size cargo drones.

Initial K-Max flights under the Navair program involved captive carriage of the payload developed for the ULS-A JCTD, strapped to one of the helicopter's landing legs. The open-loop flights, with the pilot flying the K-Max, gathered data to show the lidar sensor could detect obstacles such as trees, structures and vehicles reliably and in sufficient time to enable safe takeoff, flight and landing.

The AACUS program demonstrated the "art of the possible," but involved a challenging concept of operations (conops), Near Earth CEO Sanjiv Singh said. The full-size helicopter was required to select a safe touchdown point as it flew into the target area, without hovering or overflying the landing zone first to identify any potential hazards.

The ULS-A JCTD and K-Max programs are focused on making the autonomy technology practical, Singh said. Unlike the AACUS conops, where the UH-1 approached the landing zone along a glideslope, logistics drones and helicopters are more likely to arrive and depart vertically or hover to deliver or pick up slung cargo. This makes the perception problem easier, he said.

Under the Navair program, which runs to September 2021, Near Earth is developing an autonomy system that will be tailored to the external-lift mission and integrated into the K-Max. This will be flight-tested first with the system outputting commands that are followed by the pilot. In parallel, Kaman is upgrading the Marines' unmanned K-Max to enable fully autonomous flights.

Near Earth, meanwhile, sees a commercial application for its autonomy system in the emerging market for electric-VTOL air taxis. As these have multiple rotors providing increased propulsion redundancy and safety, Singh said, they are likely to follow more-vertical approach and departure profiles than helicopters and therefore be better-suited to the autonomy system's capabilities.

PROGRAMS

U.S. Navy Seeks Long-Range Air-Delivered Maritime Mines

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The U.S. Navy has started searching for a new, air-delivered maritime mine with more than twice the range of the Quick-strike-Extended Range version.

A request for information (RFI) published on Aug. 20 by Naval Sea Systems Command, entitled "Long Range Aerial Delivery of Maritime Mines," lays out potential performance requirements.

"The mine may be required to deliver a minimum 500-lb. explosive payload for a minimum of 100 nm, with [a] 2,000-lb. explosive payload and ranges beyond 100 nm desired," the RFI stated.

Meeting such requirements would result in updating of maritime mines for a new era of extended-range warfare.

The practice of mining estuaries, harbors and other maritime chokepoints by aircraft began in World War II, but the nature of the mission has made it increasingly risky in modern warfare.

MINES, P. 7

FUNDING & POLICY

DOD Issues $7.3 Million To Aircraft Engine Repair, Satcom Companies

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The Pentagon on Aug. 21 awarded a total of $7.3 million under Defense Production Act Title III to invest in the aircraft engine-repair and satellite-communications industrial bases.

The awards are aimed at strengthening sectors hit hard by the spread of COVID-19.

The Defense Department paid $3.7 million to Stockton, California-based Aero Turbine for General Electric J85 engine parts and manufacturing. The Air Force intends to use the single-shaft turbojet powerplant through 2040.

Aero Turbine is a small business that provides turbine engine and accessory overhaul, repair and testing services to the Air Force, Army and Navy. The funds were authorized and appropriated under the Coronavirus Aid, Relief and Economic Security (CARES) Act.

"The investment will positively impact operational readiness by reducing delay times and driving time and cost savings for the U.S. government," the Pentagon said. "Additionally, Aero Turbine will be able to retain critical workforce capabilities throughout the disruption caused by COVID-19 and to restore some jobs lost due to the pandemic."

Additionally, the Pentagon paid $3.6 million to Nashua, New Hampshire-based AQYR Technologies to sustain and expand production of the Global Broadcast Service Portable Receiver Suite.

AQYR is classified as a small business innovation research company and is the sole-source supplier of portable receiver-suite tactical and portable terminals. This platform streams video, imagery geospatial data and other intelligence products, while reducing the chance of discovery from signals-detection systems.

These CARES Act funds will ensure the government receives long-term industrial capacity and protect the skilled workforce that was disrupted by COVID-19, according to the Pentagon.

BUSINESS

Aerion Gets Space Florida Investment Boost

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Florida's aerospace and spaceport development authority Space Florida has agreed to invest in Aerion Supersonic in a deal aimed at supporting development of the high-speed aircraft manufacturer's new production site in Melbourne on the state's east coast.

The economic development agency—created in 2006 to bolster aerospace activity in Florida—will assist with recruitment of employees as well as the development of the site, which is dubbed Aerion Park.

No specific value has been released for the arrangement, which is described by Aerion as a "multi-million dollar" investment. Construction work on the facility is expected to begin later this year in advance of assembly of Aerion's AS2 supersonic business jet prototype starting in 2023.

Aerion announced the selection of the $300 million site in April 2020 after a two-year review of alternative locations around the U.S. Covering 60 acres, the facility is expected to generate at least 675 jobs in the state by 2026. The site will house final assembly of the AS2, a Mach 1.4-capable aircraft, as well as facilities for research and development, maintenance and a customer completion center.

As well as selecting the Florida location for the skilled workforce in the region, Aerion says the site also will provide direct access to the nearby, U.S. Navy-run Jacksonville Range Complex operating areas where supersonic flight testing will be permitted.

PROGRAMS

China Verifies Technology For Lightweight Inter-Satellite Laser Link

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BEIJING—China has verified operation of a lightweight, low-power technology for inter-satellite laser links, which should be valuable for mass constellations of low-orbit communications satellites.

The demonstration by state weapons and space group Casic has come months before a similar test planned by the Pentagon's DARPA.

Among the advantages of the technology is resistance to jamming and spoofing.

A pair of satellites launched in May verified the technology, Casic said in a statement carried by Chinese media.

"The Xingyun 2 Satellites 01 and 02 recently achieved two-way communication in a complete chain process under conditions of stable telemetry, meaning the payload has been verified," Casic said. "There has been a communications breakthrough for the Chinese internet-of-things constellation."

The terminal has a mass of 6.5 kg (14 lb.) and power consumption of 80 watts, according to the group, whose main business is building weapons such as surface-to-air systems.

Its reference to the internet-of-things implies the technology will be used in a constellation for general civilian use, perhaps like the StarLink system of thousands of satellites that SpaceX has begun to deploy. SpaceX is working to provide optical connections between StarLink satellites.

But the Chinese armed forces should be as interested in this technology as the Pentagon. Officials of the U.S. Blackjack program this year are aiming to launch spacecraft designed to test inter-satellite optical communication.

Linking satellites by laser first was demonstrated in 2001, when the European Space Agency's Artemis spacecraft in geostationary orbit connected optically to the Spot 4 satellite in low orbit. But Artemis' optical terminal weighed 157 kg and consumed 150 watts.

By comparison, SpaceX says the total mass of a StarLink satellite (as yet without laser communication) is 240 kg. The small size is key to achieving the low cost needed for high numbers in low orbit. (Huge and vastly expensive geostationary satellites do not need to be numerous, because, being so high, each can cover about 150 deg. of longitude and latitude.)

The defunct LeoSat project for a constellation similar to StarLink's in concept but less populous, was to be based on satellites of 1,250-kg launch mass. A 430-kg payload was to include four optical terminals.

LeoSat expected an optical data backbone in space would be 1.5 times faster than terrestrial optical fiber backbones.

In its statement, Casic added that a constellation with inter-satellite laser communication is less reliant on terrestrial networks. Ground stations can be fewer and cheaper, and the system can provide communication to more of the Earth's surface. Moreover, global telemetry can be achieved, according to Casic.

A KZ-1A rocket put the pair of Xingyun 2 satellites into orbit on May 12. The KZ-1A has a low-orbit payload of 300 kg, according to its manufacturer, Casic subsidiary Expace. So the two Xingyun 2 satellites, if identical, weigh no more than 150 kg each. They were developed by Xingyun Co., part of Casic's establishment at Sanjiang.

Casic's statement was presented as a news report published by the China News Service on Aug. 13. Widespread reproduction of the report by other state media with identical wording indicates it was in fact a Casic statement.

MINES, From P. 6

To lay the mines, an aircraft has to fly at low altitude and slow speed, making it an easy target in an age of integrated air-defense systems.

The Air Force and Navy sought to address that problem by introducing the GBU-62B Quickstrike-ER, a 500-lb. or 2,000-lb. mine derived from the Boeing wing-kit-equipped Joint Direct Attack Munition-Extended Range (JDAM-ER).

The wing kit allows the delivery aircraft, such as a Boeing B-52, to release the unpowered Quickstrike-ER mine at 35,000 ft., at which point the weapon can glide for 40 nm. The mine sinks to the seabed and uses sensors to detect a vessel overhead.

As air-defense systems become more sophisticated, a 40-nm standoff range may not be enough. In 2014, Col. Michael Pietrucha, a U.S. Air Force Reserve officer, proposed in the *Air & Space Power Journal* to develop a powered version of the JDAM-ER. The motor would extend the range of the Quickstrike-ER mine to about 100 nm, Pietrucha wrote.

Boeing displayed a full-size model of a 500-lb. Powered JDAM at the Air Warfare Symposium in late February.

FUNDING & POLICY

Space Officials Back Establishing Exploration Rules Of The Road

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Participants in a webinar on the utilization of space resources this week expressed growing interest in establishing rules—akin to NASA's proposed Artemis Accords—to ensure a conflict-free, reduced-risk approach to the human exploration of the Moon, Mars and other deep-space destinations.

Resources like the vast quantities of water ice believed to reside within shadowed craters at the Moon's south and north poles promise to reduce the costs of initial exploration substantially, according to a joint presentation from NASA, Luxembourg, Japan, Brazil and Secure World.

Those efforts then could be leveraged under evolving international agreements and maturing technologies to identify and mine resources of economic value, as well as create jobs.

Apollo

Preventing a repeat of NASA's canceled Apollo program and subsequent false starts at renewed lunar exploration depends on implementing a sustainable strategy, Mike Gold, NASA's acting associate administrator for international and interagency relations, told the Aug. 19 virtual gathering, which was hosted by the Secure World Foundation and the Brazilian space agency.

"Far too often, we have been caught up domestically in a debate between the Moon and Mars," said Gold, who leads an effort to forge bilateral agreements between NASA and partner nations to return the Moon with human explorers by 2024 in response to a March 2019 White House directive. "The two really go together. The Moon will be necessary as we develop the technology and hardware to move on to Mars."

If NASA's goal is to launch humans to Mars in the 2030s, then its surge to reach the Moon in four years must be sustainable, he stressed.

"If you are going to have a sustainable space program, you are going to have to live off the land," Gold said. "It's very important, if not absolutely required, to be able to extract and be able to utilize resources if we are going to have a sustainable, long-term presence on the Moon. It's probably even more true when it comes to a sustainable, long-term presence on Mars."

Webinar participants expressed support for the Artemis Accord objectives, unveiled by NASA in mid-May, and those of The Hague International Space Resources Governance Working Group, which was established in 2016 to forge cooperative principles for the use of deep-space resources.

Based on a 2018 study of the space-resource value chain initiated by the Luxembourg Space Agency, resources such as volatiles, metals and lunar soil could provide between $100 billion and $302 billion in exploration savings through 2045, according to Joseph Mousel, the agency's space resource policy officer.

"In both scenarios, the largest potential savings will come from using propellants from space resources," he told webinar participants. At the Moon, that would mean extracting and refining lunar water-ice deposits into liquid hydrogen and rocket propellants for cislunar operations and Mars missions.

ESA

In late 2019, Luxembourg joined with the European Space Agency to establish the European Space Resources Innovation Center to further the effort, addressing the legal aspects as well as commercial and government partnerships.

At this point, the lack of knowledge about geological environments at potential mining sites on other planetary bodies remains a "strong barrier" to the extraction of resources for import to Earth, according to Mousel.

"Prospecting exploration is the key thing we want to focus on in the beginning," said Kyle Acierno, CEO of Tokyo-based startup iSpace USA, who offered the forum a commercial perspective: "Our focus is starting small and conducting frequent trips. We want to be in the mode where we go to the Moon two to three times a year."

iSpace is raising investor funding to develop a Moon lander and rover capabilities to identify sources of lunar ice as well as deliver cargo including science instruments to the lunar surface.

The company has ties with the Draper Laboratory of Cambridge, Massachusetts. It is one of 14 U.S. companies selected by NASA's Commercial Lunar Payload Services initiative to bid on a variety of small robotic lunar lander missions with a range of science and technology payloads and objectives, including further identifying and sampling water ice deposits.

iSpace's planned initial Hakuto-R missions include a 2022 lunar soft-lander mission and a 2023 lander/rover mission.

"In regards to prospecting campaigns, we think Brazil and South America are experts in mining on Earth and so can also extend their operations and help us in our operations on the Moon," Acierno said.

Fleet Snapshot

Venezuela Air Force

Family	Type	Sub-Mission	In Service
Fighter			
F-16	F-16A Block 1-15	Multi-role	10
	F-16B Block 1-15	Multi-role	3
Su-27	Su-30MKV	Multi-role	22
Trainer & Light Combat Aircraft			
JL-8 (K-8)	K-8W	Light Attack Aircraft	24
DA42	DA42-VI	Basic Trainer	6
EMB-312/314	EMB-312A Tucano	Basic Trainer	13
DA40	DA40NG	Intro Trainer	24
SF.260	SF.260E	Intro Trainer	12
Quad Challenger	Challenger II	Intro Trainer	11
Cessna 180	Cessna 182N	Intro Trainer	1
C4ISR			
Metro	C-26 [SIGINT]	SIGINT	1
Transport			
737	737-200	VIP	1
Citation	Cessna 500 (Citation I)	VIP	1
	Cessna 550 (Citation II)	VIP	5
An-12	Y-8F-200W	General	8
C-130	C-130H	General	4
Cessna 206	Cessna T206H	General	8
Cessna 208	Cessna 208B	General	4
Do 228	Do 228NG	General	1
King Air	Beech 200	General	4
	Beech 350	General	2
	Beech B200	General	2
Metro	C-26B	Medevac	1
Queen Air	Beech B80	General	1
Short 330	SD3-60	General	2
Rotary Wing - Transport			
Enstrom 280/480	Enstrom 480B	Trainer	7
	F280FX	SOF	2
H225	AS.332B1	CSAR	3
	AS.532AC	CSAR	6
	AS.532UL	VIP	3
Mi-8/14/17	Mi-172	VIP	2
	Mi-17V-5	SOF	6
Total Fleet			200

Source: Aviation Week's Fleet Discovery Database. To learn about our fleet data products and services, go to: pgs.aviationweek.com/FleetDataServices

Prepared by Sam Archer and Nate Taylor

Calendar

To list an event, send information in calendar format to Amy Hardcastle at amy.hardcastle@informa.com. For a complete list of Aviation Week Network's upcoming events, and to register, visit www.aviationweek.com/events (Bold type indicates new calendar listing.)

[Virtual Event] Biweekly ongoing mini sessions—Bombardier Safety Standdown 2020, https://safetystanddown.com/en

[Virtual Event] Aug. 24-26—AIAA Propulsion and Energy Forum. For more information go to https://www.aiaa.org/propulsionenergy#

[Virtual Event] Aug. 25-26—SpeedNews Aerospace Manufacturing Conference. For more information go to https://amc.speednews.com

[Virtual Event] Aug. 25-28—UAS West Virtual Symposium. For more information go to asdnews.com/news/defense/2020/06/26/uas-west-virtual-symposium

[Drive-In Format] Aug. 29-30—New York International Air Show, NY Stewart Int'l Airport, Hudson Valley, NY. For more information go to https://airshowny.com

[Virtual Event] Aug. 31-Sept. 3—2020 Humans to Mars Summit, For more information go to https://www.exploremars.org/summit

[Virtual Event] Sept. 2-3—Military Robotics and Autonomous Systems 2020 Conference. For more information go to http://www.smi-online.co.uk/defence/uk/conference/robotic-autonomous-systems

[Virtual Event] Sept. 3-4—Military Space Situational Awareness Conference 2020. For more information go to https://smi-online.co.uk/defence/uk/milspace

[Virtual Event] Sept. 10—Women In Defense National Leadership Symposium. For more information go to https://www.womenindefense.net/events/2020/9/10/women-in-defense-virtual-leadership-symposium

[Virtual Event] Sept. 15-16—SpeedNews Commercial Aviation Industry Suppliers Conference. For more information go to https://ace.speednews.com

[Virtual Event] Sept. 15-17—Commercial UAV Expo Americas. For more information go to https://www.expouav.com

[Virtual Event] Sept. 22-24—Modern Day Marine. For more information go to https://www.marinemilitaryexpos.com/modern-day-marine/home

[Virtual Event] Sept. 22-24—Full Spectrum Air Defence Digital Conference. For more information go to https://www.marinemilitaryexpos.com/modern-day-marine/home

[Virtual Event] Oct. 12-14—IAC 71st International Astronautical Congress - The CyberSpace Edition. For more information go to http://iac2020.org

Oct. 19—Aviation Week Network's 63rd Annual Laureate Awards, The Ritz-Carlton Tysons Corner, McLean, VA. For more information go to https://laureates.aviationweek.com/en/home.html

[Virtual Event] Oct. 19-29—SPACECOM, For more information go to https://spacecomexpo.com

Oct. 20-21—Aviation Week DefenseChain Conference, The Ritz-Carlton Tysons Corner, McLean, Virginia. For more information go to https://defensechain.aviationweek.com/en/home.html

Oct. 21—Aviation Week Program Excellence Awards and Banquet, The Ritz-Carlton Tysons Corner, McLean, Virginia. For more information go to https://defensechain.aviationweek.com/en/home.html

[Postponed until 2021] Oct. 27-28—Mexico's Aerospace Summit, Querétaro Congress Center, Santiago de Querétaro , Mexico. For more information go to https://www.mexicoaerospacesummit.com

[Virtual Event] Oct. 27–29—Aviation Week MRO TransAtlantic. For more information go to https://mrotransatlantic.aviationweek.com/en/home.html

Oct. 28-30—Inter Airport China, Shanghai New International Expo Center, Shanghai, China. For more information go to https://www.interairportchina.com/en-gb/home/postpone.html

[Postponed until 2021] Oct. 31-Nov. 2—36th Space Symposium, The Broadmoor Hotel, Colorado Springs, Colorado. For more information go to https://www.spacesymposium.org