International partners seek to keep up with NASA’s lunar ambitions

A year after NASA used the International Astronautical Congress (IAC) to encourage other nations to join its plans to return astronauts to the moon, an accelerated schedule has created both new opportunities and new challenges for those partnerships.

At 2018 IAC in Bremen, Germany, NASA Administrator Jim Bridenstine talked up NASA’s plans to establish a Gateway in orbit around the moon, with international partners contributing various modules. That facility would support human missions to the lunar surface starting in 2028.

At the time, Bridenstine said the process for incorporating partners was still being worked on, although the decadelong timeframe for assembling the Gateway gave NASA and its potential partners breathing room to figure out how to do so. By March, Canada became the first nation to sign up for the Gateway, announcing its intent to spend $1.5 billion over more than two decades to build the Canadarm3 robotic arm for the facility.

The Multilateral Coordination Board (MCB), the interagency group that handles issues involving the International Space Station, backed the Gateway in a March 5 statement. “Following several years of extensive study among the agencies culminating in a successful technical assessment, the MCB endorsed plans to continue the Gateway development,” it said, also releasing an illustration of the Gateway with potential contributions by Canada, Europe, Japan and Russia, along with NASA, highlighted.

Those plans changed later that month, though, when Vice President Mike Pence announced at a National Space Council meeting that he was directing NASA to land people on the moon by 2024, four years earlier than previously planned. That necessitated a change in plans for the Gateway, at least in its initial stages.

“The plan is still the same,” Bridenstine argued a few weeks later that the 35th Space Symposium in Colorado Springs. What’s changed, he said, is that the Gateway will now be built in two phases, first to support that initial 2024 landing and then expanded, primarily with international partner contributions.

“The first phase is speed. We want to get those boots on the moon as soon as possible,” he said then. That later second phase, he added, would emphasize sustainability.

What that means is that international partners are largely shut out of major roles in the initial phase of what NASA now calls the Artemis program. The lunar Gateway will, for that 2024 landing, feature only two modules: a Power and Propulsion Element (PPE) and a “mini-hab” module called the Habitation and Logistics Outpost (HALO). Maxar Technologies won a $375 million contract in May to build the PPE while NASA announced its intent in July to issue a sole-source contract to Northrop Grumman for the HALO, based on its work on an earlier NASA program.

There will be a few opportunities for international partners. The European Space Agency will be involved in the early Artemis missions through its existing agreement to provide the service module for the Orion spacecraft. Northrop’s decision to base the HALO module on its Cygnus cargo spacecraft means that Thales Alenia Space, which manufactures the pressurized module for Cygnus, will also be involved in the early Gateway.

The lack of early opportunities for other nations has not, for now, led to any defections. In late August, the MCB issued another statement endorsing the Gateway. “The MCB members shared the view that the Gateway will become a sustainable exploration infrastructure supporting further lunar and Mars exploration objectives when additional capabilities are
Large Inflatable Fabric Environment (LIFE™) Habitat
SNC has developed a flexible, inflatable space habitat under NASA’s Next Space Technologies for Exploration Partnerships 2 (NextSTEP-2) Habitat program that supports both crewed and autonomous operations. The reconfigurable architecture supports multiple applications including as a low-Earth orbit (LEO) destination, a full-size habitat for the Lunar Gateway to support crewed missions, a habitat on the moon to support surface operations, and as a Mars deep space transport crew compartment.

Key LIFE Habitat Design Features:
- Provides significant volume for long-duration human activity
- Flexible launch options; compatible with Space Launch Systems or five-meter fairing commercial launch vehicles
- Supports four crew members living & performing space missions
- Includes crew workstations, medical research & sick bay, sleeping quarters, hygiene station, galley, payload & cargo storage, environmental monitoring & life support systems
- Complete with SNC’s Astro Garden® plant growth system
NASA provided through the Gateway partnership,” it stated, outlining the continued interest by the ISS partners to provide modules for the Gateway in the future.

While the ISS partners will play the biggest role in any international cooperation, other nations may also participate. NASA and the Australian Space Agency signed a “joint statement of intent” Sept. 21 for cooperation on the Artemis program, which may include Australia providing technologies in areas like robotics and teleoperation to support human mission on or around the moon.

Bridenstine has been open to bringing in a larger number of “nontraditional” partners for the Artemis program. He’s publicly talked about including countries ranging from India, whose Chandrayaan-2 spacecraft is currently orbiting the moon, to the United Arab Emirates, which flew its first astronaut on a brief mission to the ISS less than a month ago.

The only country that appears to be off-limits to participation in the Artemis program is China. At last year’s IAC in Bremen, both Bridenstine and his Chinese counterpart, Zhang Kejian, administrator of the China National Space Administration, showed interest in finding new ways to cooperate. “We can share data and collaborate that way so that each country can learn more about science,” Bridenstine suggested.

Since then, though, there’s been little sign of concrete progress regarding bringing China into Artemis, or even if China, with its own lunar exploration ambitions, wants to join. Bridenstine frequently notes that language sharply restricting bilateral cooperation between NASA and China in appropriations bills — including in both the House and Senate versions of fiscal year 2020 legislation — makes any comprehensive cooperation difficult. “If that were to change, it would be above my pay grade,” he said during a news conference in Japan Sept. 25.

Difficulties for international cooperation aren’t limited to the United States. Canada’s commitment to the lunar Gateway could be tested after the Oct. 21 federal election there, where the government of current Prime Minister Justin Trudeau is facing a strong challenge from the Conservative Party. Space policy has not come up during the campaign, although one Conservative member of parliament, Erin O’Toole, told the publication SpaceQ that he expected a government led by his party would continue with Canadarm3.

The European Space Agency will soon decide its role in Artemis. The Space19+ meeting of ministers of its 22 members states, Nov. 27–28 in Seville, Spain, will debate whether and how ESA should participate in the lunar Gateway or other aspects of Artemis, including how much funding nations will contribute. JAXA, meanwhile, is working with the Japanese government to identify funding for its contributions.

Bringing together all those potential partners will be an organizational challenge. That complexity, though, could also be an advantage, one NASA official believes. “I’m starting to love complicated,” said Ken Bowersox, NASA acting associate administrator for human exploration and operations, during an Oct. 10 speech at the International Symposium for Personal and Commercial Spaceflight in New Mexico. “It is a lot more complicated than we did with Apollo, but it’s on purpose,” he added.

At this year’s IAC, Bridenstine will likely spend a lot of time with leaders of other space agencies to formalize proposed partnerships for Artemis or work to bring in new partners. His message may be the same as last year in Germany, where he emphasized the importance of international cooperation to NASA: “I am telling you that we cannot do what we do without the support of our international partners.”

A NASA artist’s concept of the 2024 lunar Gateway in orbit.
### IAC AT A GLANCE

#### MONDAY

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>09:00-11:00</td>
<td>Opening Ceremony. IAC promises a “multi-layered theatrical production” combined with welcome addresses from IAF President Jean-Yves Le Gall, NASA Administrator Jim Bridenstine, U.S. Vice President Mike Pence and others. (Grand Ballroom ABC)</td>
</tr>
<tr>
<td>13:15-14:45</td>
<td>NASA Administrator Jim Bridenstine and the heads of ESA, JAXA, ISRO, CSA, CNSA and Roscosmos speak during the Heads of Space Agencies plenary session. (Grand Ballroom ABC)</td>
</tr>
<tr>
<td>15:00-16:30</td>
<td>Planetary defense panel discussion with NASA Planetary Defense Officer Lindley Johnson, Bill Nye and more. (146A)</td>
</tr>
<tr>
<td>15:10-16:10</td>
<td>Josef Aschbacher, director of ESA’s Earth observation programs, will be joined by industry and government officials to discuss public investment in Earth observation systems. (Grand Ballroom ABC)</td>
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<tr>
<td>16:45-18:15</td>
<td>An ISS-Moon-Mars special session will explore how the space station and the moon can be used to simulate future Mars missions. NASA’s ISS division director Sam Scimemi facilitates an international gathering of space medicine and astronaut training officials. (146A)</td>
</tr>
<tr>
<td>17:40-18:10</td>
<td>Kevin O’Connell, the director of the U.S. Office of Space Commerce, and Moon Express CEO Bob Richards are joined by NASA and National Space Council official for a panel discussion on returning to the moon in the NewSpace age. (Grand Ballroom A)</td>
</tr>
<tr>
<td>18:15-19:30</td>
<td>Plenary session on the next 50 years in human spaceflight. Featuring ESA Director General Johann-Dietrich Woerner, NanoRacks CEO Jeffrey Manber and former FAA-AST AA George Nield. (Grand Ballroom ABC)</td>
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#### TUESDAY

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<th>Time</th>
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<tr>
<td>08:00-08:25</td>
<td>Fireside chat with Jeff Bezos to mark his acceptance of the 2019 IAF Excellence in Industry Award on behalf of Blue Origin. (Grand Ballroom ABC)</td>
</tr>
<tr>
<td>08:30-09:30</td>
<td>SNC Corp. CEO Fatih Ozmen moderates a plenary session on sustainability and space security with National Space Council Executive Director Scott Pace, Luxembourg Deputy Prime Minister Étienne Schneider, Thales Alenia Space CEO Jean-Louis Galle, Telesat CEO Daniel Goldberg and Lockheed Martin VP and GM Kay Sears. (Grand Ballroom ABC)</td>
</tr>
<tr>
<td>09:40-10:50</td>
<td>Industry storytelling sessions kick off with Virgin Galactic CEO George Whitesides followed by more 10-minute talks from Arianepace CEO Stéphane Israël, SpaceX COO Gwynne Shotwell, Made In Space CEO Andrew Rush and more.</td>
</tr>
<tr>
<td>09:45-11:15</td>
<td>Stephen Volz of NOAA NESDIS, Alain Ratier of Eumetsat, and ESA’s Joseph Aschbacher discuss the role of Earth observation in studying our planet. (146A)</td>
</tr>
<tr>
<td>09:45-12:45</td>
<td>Wayne Monteith, FAA associate administrator for commercial space transportation, helps kick off the two-day IAF Symposium on Commercial Spaceflight Safety Issues.</td>
</tr>
<tr>
<td>13:30-14:30</td>
<td>Blue Origin CEO Bob Smith is joined by U.S. Air Force Maj. Gen. Pamela Lincoln and Australian Space Agency deputy head Anthony Murfett to discuss building and sustaining a global space workforce. (Grand Ballroom B)</td>
</tr>
<tr>
<td>14:45-16:15</td>
<td>The EO+AI special session includes Planet CEO Will Marshall, Google Earth Director Rebecca Moore, Spire Global CEO Peter Platzer and more. (146A)</td>
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#### WEDNESDAY

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<tr>
<td>08:30-09:30</td>
<td>Mars Society President Robert Zubrin presents a “new concept in propellantless propulsion” as part of a joint session on advanced and nuclear power and propulsion systems. (Grand Ballroom B)</td>
</tr>
<tr>
<td>11:45-12:00</td>
<td>Three engineers from Aerojet Rocketdyne, Boeing and Lockheed Martin provide a broad overview of deep exploration during this “talk show” session geared to general audiences. (Grand Ballroom ABC)</td>
</tr>
<tr>
<td>13:25-14:25</td>
<td>Simonetta Di Pippo, director of the United Nations Office for Outer Space Affairs, leads a discussion about the establishment of a voluntary Space Sustainability Rating to guide good space stewardship. (Grand Ballroom A)</td>
</tr>
<tr>
<td>14:45-17:30</td>
<td>The Access to Space for Small Satellites session will include presentations from NASA, ESA, Northrop Grumman, Aerospace Corp., Astrocast, D-Orbit and others. (151B)</td>
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#### THURSDAY

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<th>Time</th>
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<tr>
<td>08:30-09:30</td>
<td>Michael Newsham of the World’s Largest Handmade Glass Blowing Facility, Blue Origin. (Grand Ballroom ABC)</td>
</tr>
<tr>
<td>11:30-12:30</td>
<td>Three engineers from Northrop Grumman, Arianespace, and Thales Alenia Space present a broad overview of deep exploration during this “talk show” session geared to general audiences. (Grand Ballroom B)</td>
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#### FRIDAY

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<th>Time</th>
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<tr>
<td>09:45-12:45</td>
<td>The Space Operations Symposium continues with a ground operations systems and solutions session including presentations from Leaf Space and others. (140B)</td>
</tr>
<tr>
<td>11:20-12:00</td>
<td>Three engineers from Aerojet Rocketdyne, Boeing and Lockheed Martin provide a broad overview of deep exploration during this “talk show” session geared to general audiences. (Grand Ballroom ABC)</td>
</tr>
<tr>
<td>11:30-12:30</td>
<td>Virgin Orbit organizes a responsive launch panel that includes U.S. Air Force Maj. Gen. Nina Armagno, Mojave Air &amp; Space Port’s Karina Dress, Spaceport Cornwall’s Miles Carden and FAA-AST’s Wayne Monteith. (146A)</td>
</tr>
<tr>
<td>13:30-16:30</td>
<td>The Cooperative and Robotic Space Systems session will include presentations from NASA, DLR, Surrey Space Centre, Thales Alenia Space, Effective Space and more. (145B)</td>
</tr>
<tr>
<td>16:45 – 17:45</td>
<td>Closing ceremony. The IAC flag is handed over to the next host country — the United Arab Emirates. (Grand Ballroom ABC)</td>
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China, Russia to cooperate on lunar orbiter, landing missions

Russia and China agreed last month to joint exploration of the moon following a meeting of heads of government in St. Petersburg.

The agreements will see cooperation in Russia’s Luna-26 orbiter spacecraft and Chang’e-7 polar landing mission, according to Roscosmos, which could involve contributions of science payloads to the respective spacecraft. Both missions are currently scheduled for the early-to-mid-2020s.

The two sides also committed to previously announced plans to create a joint lunar and deep space data center, which will consist of hubs in both Russia and China.

The documents were signed Sept. 17 by Dmitry Rogozin, director general of Roscosmos, and Zhang Keqiang, head of the China National Space Administration.

Russia assisted China’s Chang’e-4 lunar far side landing mission with the provision of a radioisotope thermoelectric generator. Preliminary research on ultrasonic drilling techniques for detecting water within extraterrestrial surfaces is also being carried out by Russian and Chinese universities.

Joan Johnson-Freese, a professor of national security affairs at the Naval War College in Newport, Rhode Island, told SpaceNews that the agreement was “another indicator that other countries see the Chinese program as the lunar program to watch.”

“China has the political will to follow through with space plans, regardless of timetables, and Russia is motivated to cooperate with them through its sole strategic purpose — make things difficult for democracies in general and the U.S. in particular,” Johnson-Freese, expressing her personal views, said.

The cooperation announcement came a day ahead of a Sept. 18 hearing of the House Science Committee’s space subcommittee in which members expressed skepticism toward NASA’s approach for returning humans to the moon by 2024. A House draft of a continuing resolution released the same day did not include any special provisions for NASA, thereby threatening to delay work on lunar landers needed for the Artemis program.

Roscosmos has been studying a series of lunar orbiter and lander missions since the 2000s. A lander named Luna-25 is, after postponements, scheduled for the 2020s. Following on will be the Luna-26 orbiter, as well as a lander and sample return missions for studying the lunar south polar regions.

NASA held discussions in 2017 regarding potential involvement in Russia’s lunar exploration missions. Roscosmos is meanwhile involved in the plans for the Gateway, a NASA-led lunar orbit space station designed to assist human exploration of the moon.

NASA is effectively prohibited from bilateral cooperation with Chinese state entities by U.S. law.

At the opening of a lunar and deep space exploration conference July 22 in Zhuhai, China, state news agency Xinhua reported that China, Russia and Europe had agreed to explore a plan to jointly establish a scientific research station on the moon.

An official with the European Space Agency told SpaceNews that while discussions regarding future lunar exploration has begun among experts, no decisions have been finalized and nothing has yet been endorsed by ESA and its member states.

China had stated it would launch the Chang’e-5 lunar sample return mission late this year. However further delays to the return-to-flight of the Long March 5 heavy lift rocket have seen that mission pushed into 2020.

The Long March 5 could still launch late this year, carrying the experimental Shijian-20 communications satellite. If successful, priority will then be given to a test launch for the planned Chinese Space Station, followed by the country’s 2020 Mars mission, which will have a short launch window in late July to early August.

Chang’e-6, which will involve France and also has 10 kilograms available for further international payloads, will be second lunar sample return around 2023. It is likely to target the lunar south pole or the far side of the moon.

China will then proceed to an extended phase of lunar exploration involving Chang’e-7 and further lunar landing missions. The aim will be to establish a robotic “research base” and carry out lunar resource tests, “bio-scientific experiments,” and test rare-gas extraction from the lunar regolith and 3D-printing.

The missions will include an orbiter, relay satellite, as well as landing and test craft, a rover and a flying vehicle, according to officials from the China Aerospace Science and Technology Corporation, the state-owned main contractor for the Chinese space program.

The expanded lunar project has not yet received official approval from the government. Approval could follow with the formulation of China’s next five-year plan, covering 2021-2025.

“China has the political will to follow through... and Russia is motivated to cooperate with them through its sole strategic purpose — make things difficult for democracies in general and the U.S. in particular.”

Joan Johnson-Freese
AMERICA'S SPACEPLANE

Known as America's Spaceplane, Sierra Nevada Corporation's (SNC) Dream Chaser ® spacecraft is a multi-mission vehicle designed to transport crew and cargo to low-Earth orbit (LEO) destinations such as the International Space Station. Inspired by the legacy of the space shuttle and the 135 missions that came before us, SNC's Dream Chaser is truly a state-of-art vehicle employing cutting-edge technology.

Customizable for both domestic and international customers through vehicle configuration, launch site, orbit, landing site, duration and a host of other variables, Dream Chaser can support a variety of LEO needs. Dream Chaser is scheduled to launch starting in late 2021 for at least six cargo missions to the space station for NASA under the Commercial Resupply Services 2 (CRS-2) contract.

Bringing Shuttle Heritage into the Future:
• Most advanced high-temperature composite aerospace structure
• Stronger, smaller, more agile, easier to maintain
• Lifting-body spacecraft
• Autonomous launch, flight & landing capabilities
• 12,000 lbs. pressurized & unpressurized cargo
• 15 + times reusability
• Low, 1.5 g atmospheric entry & runway landing compatible
• Rapid access to crew or cargo upon landing

The Dream Chaser primary structure arrived this fall at SNC's production facility in Colorado, kicking off full assembly of the spacecraft.
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NASA and JAXA reaffirm intent to cooperate in lunar exploration

NASA and its Japanese counterpart confirmed late last month their intent to cooperate on lunar exploration, including Japanese roles in the lunar Gateway and human lunar landings.

NASA Administrator Jim Bridenstine, on a visit to Japan, met with Japanese officials including Hiroshi Yamakawa, president of the Japan Aerospace Exploration Agency (JAXA) to discuss cooperation in space exploration, specifically NASA’s Artemis program to land humans on the moon in 2024.

The statement included no formal, binding agreements regarding roles JAXA would play in the Gateway or lunar landings, but instead outlined previous discussions about contributions to those programs. “The agency leaders shared their intention to seek support and commitment from their stakeholders in the United States and Japan to document proposals and to conclude the necessary arrangements between their respective agencies and governments,” the joint statement noted.

Those contributions may include a Japanese habitation module for the Gateway as well as logistics using the HTV-X vehicle, an advanced version of the H-2 Transfer Vehicle currently used to deliver cargo to the International Space Station.

“JAXA’s capabilities, and the nation of Japan’s capabilities, are significant,” Bridenstine said in a joint news conference with Yamakawa Sept. 25. “The United States and NASA would love to see Japan and JAXA working with us on building that space station in orbit around the moon.”

“A habitation module is just the beginning. It will need to be served by a logistics capability,” he continued. “The H3 rocket and the HTV-X cargo capsule could very well provide logistics to the Gateway.”

The announcement didn’t provide a timetable for providing either the habitation module or logistics services, although they would likely come only later in the 2020s, after the first landing in 2024. Those would also have to be coordinated with other potential contributions from international partners as well as commercial capabilities, such as NASA’s ongoing solicitation for commercial cargo services for the Gateway.

The two countries are also considering Japanese roles for lunar surface systems. Bridenstine said he and Yamakawa have discussed the Japanese development of a pressurized rover that could be used by astronauts on the lunar surface. JAXA is already studying the development of such a rover in cooperation with automaker Toyota.

In the near term, the two countries will collaborate on Japanese robotic missions to the moon. Yamakawa said at the news conference that NASA and JAXA will cooperate on payloads and data sharing for the Smart Lander for Investigating the Moon (SLIM) scheduled for launch in 2021. NASA will also cooperate on a joint lunar mission between JAXA and the Indian space agency ISRO in 2023 to study the lunar poles.

Bridenstine said at the news conference that NASA hopes to have all the current ISS partners involved in the Gateway and overall Artemis program. Besides JAXA’s proposed contributions, Canada has already committed to providing the Canadarm3 robotic arm for the Gateway, while both the European Space Agency and Roscosmos are weighing their own contributions, such as modules and airlocks.

“We also believe there is room for more countries to join us,” he added. He cited as an example the agreement NASA and the Australian Space Agency signed Sept. 21 to study potential Australian contributions to the Artemis program, as well as potential roles for India and the United Arab Emirates.

He hedged, though, when asked if China could participate. Existing law prohibits bilateral cooperation between NASA and China without congressional approval, he noted. “If that were to change, it would be above my pay grade,” he said.

Bridenstine’s visit, which included meetings with other Japanese officials, coincided with the Sept. 24 launch of an H-2B rocket carrying the HTV-8 cargo spacecraft to the ISS. That launch, previously scheduled for earlier in the month, was postponed by a pad fire during pre-launch preparations.

“I would like to congratulate Hiroshi, JAXA and the nation of Japan on a great launch while we were sleeping last night,” Bridenstine said. “Thank you very much, Jim,” Yamakawa responded in English.
NASA signed an agreement with its Australian counterpart Sept. 21 to cooperate on NASA’s Artemis program as Australia seeks to further boost its space industry.

In a ceremony at NASA Headquarters, the two space agencies signed a “joint statement of intent” regarding cooperation on NASA’s plans to return humans to the moon. The event was attended by leadership of the two agencies as well as Australian Prime Minister Scott Morrison and Secretary of Commerce Wilbur Ross.

What roles Australia will play in the Artemis program or other exploration initiatives remain to be determined. NASA, in a statement about the agreement, envisioned Australia contributing “in areas of mutual interest such as robotics, automation and remote asset management,” building on its capabilities in mining.

“It will give Australian businesses a chance to compete for a place in growing international space supply chains,” Morrison said in remarks at the signing ceremony. “The Australian Space Agency will work with NASA on how it can support a significant part of its mission.” That work, he added, could include lunar surface systems or capabilities for the lunar Gateway.

Morrison also used the speech to announce the Australian government will spend 150 million Australian dollars ($102 million) over the next five years in support of “the mission and related activities,” he said, hinting that funding could grow. “I expect that’s just where we’re going to begin.”

JEFF FOUST

Exactly how that money will be spent is uncertain. A statement from the Australian government said the additional funding would go “into our local businesses and new technologies that will support NASA on its inspirational campaign to return to the moon and travel to Mars.”

The Australian Space Agency, in its own statement, said the investment would, in part, support pilot projects and demonstrations of “investment-ready” Australian technologies that could support space activities, which in turn could support cooperation with NASA and other space agencies and aid Australian space companies win business.

The agreement and funding announcements are the latest signs of growing support for Australia’s space industry. The Australian Space Agency formally started operations in July 2018 after years of efforts by space industry advocates in the country to establish an agency. Among other activities, the agency recently finished work on a new set of regulations intended to make it easier for companies to perform launches in the country. SN

In Brief

Airstream, maker of the iconic “silver bullet” travel trailer, unveiled Astrovan II, an eight-seat transport vehicle Boeing will use to transport commercial crew astronauts to the CST-100 Starliner’s Cape Canaveral, Florida, launchpad. Astrovan II was built in Jackson Center, Ohio, and is based on a modified Airstream Atlas Touring Coach. Since 1984, NASA astronauts have been driven to the pad aboard a modified Airstream Excella commonly referred to as the Astrovan. That vehicle is currently on display at NASA’s Kennedy Space Center Visitor’s Complex next to the Space Shuttle Atlantis. SN
In 2018, global government space budgets totaled $70.8 billion, posting a five-year compound annual growth rate of 5.75% and continuing the last few years of recovery of space public spending. Representing the second-largest space expenditure, human spaceflight accounts for 16% of the total, with nine countries plus the European Space Agency spending on average more than $1.25 billion each, the highest across all applications. Science and exploration budgets have emerged as the third-highest application spending area, a budget entirely funded by civil agencies.

According to Euroconsult’s latest research, global space budgets for space exploration are expected to surpass $20 billion in the next decade with nearly 80 planetary exploration missions expected to be launched, 63% of which will be government-led missions. Since the beginnings of space exploration, the number of countries involved has expanded considerably, including historical space players (the United States and Russia), European countries (primarily through ESA), China, Japan, Canada and India, and relatively newer players such as the United Arab Emirates and South Korea.

Fifteen leading space programs worldwide are estimated to contribute to the global space exploration investment, with the U.S. accounting for almost 75% of the total. Global expenditures have grown in the past five years driven by programs in leading countries and new nations investing in space exploration. Yet, national investments remain constrained by their public finances’ environment, leading to realistic and pragmatic strategic planning for the future mission roadmaps.

The largest expenditure area in space exploration is transportation, forecast to reach nearly $9 billion in the next decade. The application is supported by significant investments from multiple countries and particularly in the U.S. and China to support the development of next-generation crew and/or cargo vehicles for low Earth orbit and beyond-LEO activities. Orbital infrastructure—orbital stations or outposts and their associated human spaceflight programs both in LEO and beyond LEO—is the second-largest application. While the budget has been stable over the past years, funding is expected to increase driven by investments in the ISS program and growing budget for both the development of the lunar Gateway by the International Space Stations partners as well as China’s investment in its space station.

As highlighted in the 2018 Global Exploration Roadmap, the moon is attracting converging interest from space agencies and has become a central item in the exploration strategy of most players moving forward. The budget allocated to lunar programs is expected to experience sustained growth, reaching $2.8 billion by 2027 to support ambitious government missions and commercial partnership programs. Finally, with four Mars missions set for launch in 2020—NASA’s Mars2020, ESA and Roscosmos’ ExoMars2020, China’s Mars Global and the UAE’s Hope mission—expenditures in Mars exploration are expected to peak in the near term. A funding boost in Mars programs is expected to occur as a second step once agencies shift focus from the moon to Mars.

The next decade will also see the rise of commercial exploration initiatives, with close to 30 commercial missions forecast by 2027, primarily driven by lunar initiatives. Both startups and established companies seek to exploit the commercial potential of space exploration, including through commercial space stations, crew and cargo transportation, payload services on the moon, lunar resources utilization and asteroid mining (among others). Yet, a high degree of uncertainty exists in the business models and success potential of such private initiatives, with challenges and obstacles such as the political changes in strategic priorities, governments’ indecision with regards to an anchor customer position, but also risks associated to the technological developments and the very low maturity of the targeted market.

In a domain that has historically been fully institutional, space agencies are increasingly seeking to leverage partnerships with both public partners and the private sector to achieve their goals more cost effectively while fostering a sustainable space exploration. The next decade will be marked by the emergence and consolidation of new government and private players and programs, opening new opportunities and challenges, and leading toward an era of both collaboration and competition in space exploration.
AMERICA’S SPACEPLANE™ MEETS AMERICA’S ROCKET
Known as “America's Spaceplane,” the Dream Chaser® spacecraft, owned and operated by Sierra Nevada Corporation (SNC), is a multi-mission space utility vehicle designed for transporting crew and cargo to low-Earth orbit (LEO) destinations. In 2016, NASA selected the Dream Chaser to provide cargo delivery, return and disposal service for the Space Station under the Commercial Resupply Service 2 (CRS-2) contract starting in late 2021.

Dream Chaser can be customized for both domestic and international customers through vehicle configuration, launch site, orbit, landing site, duration and a host of other variables.

“At SNC our goal is to pay it forward,” said Eren Ozmen, SNC’s owner and president. “This is about scientific discovery, and about opening space to organizations that may not otherwise have access to it, benefiting future generations of innovators like us all around the world. We’re thrilled to provide the vehicle that will make this happen.”

“Space is a bridge to bring the world and cultures together.”

~ Fatih Ozmen, SNC Owner & CEO

SNC has entered into agreements with multiple international space agencies and is developing technologies, applications and missions for Dream Chaser-based space systems, making space affordable and accessible around the globe.

“Space is a bridge to bring the world and cultures together,” said Fatih Ozmen, SNC’s owner and CEO, emphasizing the need for critical infrastructures that will enable and sustain a vibrant, U.S.-led space economy.

sncorp.com

The Long-Term Sustainability of Outerspace
Tuesday, October 22, 8:30 – 9:30 A.M. EDT