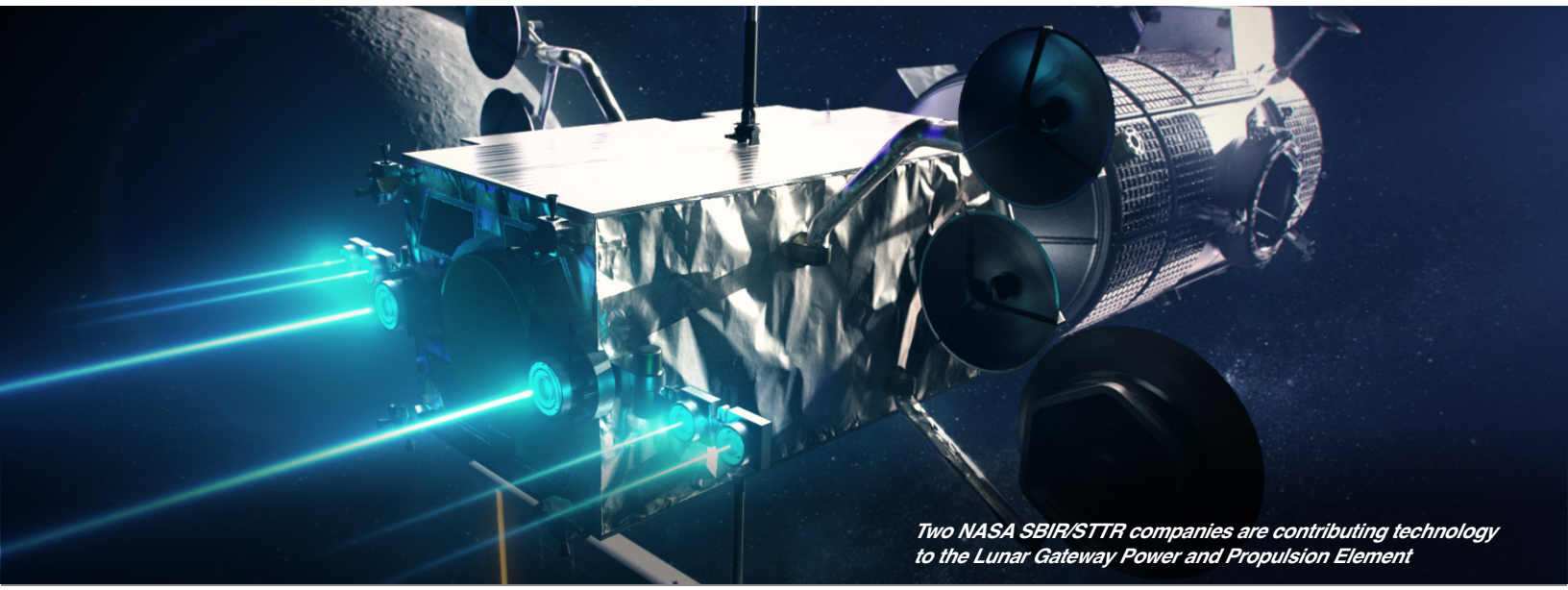
National Aeronautics and Space Administration



Two NASA SBIR/STTR companies are contributing technology to the Lunar Gateway Power and Propulsion Element

Power and Propulsion for Gateway: A NASA SBIR/STTR Success Story

Gateway is an apartment-sized spacecraft NASA is developing as part of the Artemis program, which aims to land the first woman and next man on the Moon by 2024. It will serve as a temporary habitat, laboratory, and staging area for missions to the lunar surface. It will also be a port for deep space transportation such as landers en route to the lunar surface or spacecraft embarking to destinations beyond the Moon.

The Power and Propulsion Element (PPE) for Gateway, along with the Habitation and Logistics Outpost (HALO), will be the first Gateway elements to launch. The PPE will be the most powerful electric propulsion spacecraft ever launched, and it will provide Gateway with power, high-rate communications, attitude control, and orbital transfer capabilities. To support the development of the PPE, in 2019 NASA awarded a $375 million contract to Maxar Technologies, an Earth Intelligence and Space Infrastructure company based in Westminster, Colorado, to develop, build, and support an in-space demonstration of the element. Gateway will also be supported by Deployable Space Systems (DSS)—a Redwire subsidiary—and Busek Company, Inc, two companies that have roots in the NASA Small Business Innovation Research / Small Business Technology Transfer (SBIR/STTR) program. Both DSS and Busek are key contributors in power and propulsion, respectively, with technologies they developed through NASA SBIR/STTR program awards—including post-Phase II initiatives as well as through other NASA technology development and demonstration opportunities.

Projects

Roll-Out Solar Array and Hall-Effect Thrusters for the Power and Propulsion Element for Gateway

Mission Directorates

- Human Exploration and Operations
- Science
- Space Technology

Snapshot

NASA's Gateway in lunar orbit will play a critical role in the Artemis program, which aims to land the first woman and the next man on the Moon by 2024. The development of the Power and Propulsion Element for Gateway is being led by Maxar Technologies, a mid-size organization, with contributions from two NASA SBIR/STTR awardees—Deployable Space Systems and Busek Company, Inc, both of which initially developed their Gateway contributions with support from the NASA SBIR/STTR program.

Deployable Space Systems – Solar Arrays

DSS, a small business based in Goleta, California, is responsible for providing the Roll Out Solar Array (ROSA) technology to supply power as part of the PPE. The company was founded in 2008 and began developing ROSA with an Air Force SBIR award before proposing to advance the technology with NASA. Since its first NASA SBIR award in 2009, DSS has enhanced ROSA with funding and support from NASA SBIR and STTR awards, contributing to the technology's flight readiness for Gateway.

DSS is contributing its Roll Out Solar Array technology to supply power to Gateway

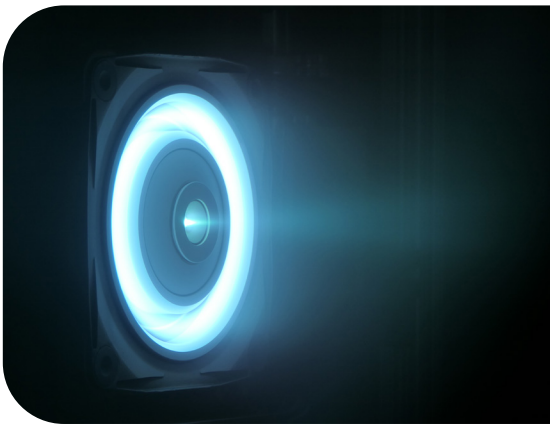
While solar arrays that convert solar energy into usable power are not new concepts, ROSA is unique for its ability to roll up, in contrast to the standard accordion fold, allowing for huge solar array sizes to be packaged for launch very compactly. Unlike other state-of-the-art solar arrays, ROSA is simple, as it does not require a motor to deploy; when ROSA is rolled up, it acts like a spring and uncoils when it is released for deployment. This design is efficient in terms of cost, complexity, and packaging efficiency. It also keeps ROSA lightweight, which is important for a spacecraft that has a limited mass capacity, so that the available mass can instead be occupied by scientific instruments and resources. This is especially important for Gateway, as a long-duration lunar outpost, which will require very high solar array power (greater than 50 kW) and will need the mass savings provided by ROSA for hardware and scientific equipment that will be used to test and establish a long-term sustainable habitat on the lunar surface.

With the help of NASA SBIR awards, DSS developed many of ROSA's unique functionalities, including construction of its photovoltaic blanket, which converts light into electricity, and a hinge enhancement that enables ROSA to fold in half, allowing for a much larger ROSA that is as compactable as a single-layer array. The developments made with SBIR awards advanced ROSA to a technical readiness that began to attract the attention of investors. The spacecraft and communication systems company Space Systems Loral (now a subsidiary of Maxar) contracted DSS to integrate ROSA on one of its satellites. DSS and Maxar began environmental tests, but these required additional time and funding to complete. In 2019, DSS received NASA STTR funding from the **Commercial Civilian Commercialization Readiness Pilot Program (CCRPP)**, which provided approximately $890,000 in funds to DSS, matching Maxar's investment and allowing the team to complete validation testing. With the success of ROSA, in 2021 DSS was acquired by Redwire, a developer of next generation space systems and infrastructure.

Steve White, vice president of DSS, says, "the NASA SBIR/STTR program was essential to DSS being able to do what we did. It gave us exposure in the industry and funding to be able to develop and test this technology."

Busek – Solar Electric Propulsion

One group of Hall-effect thrusters for Gateway is supplied by Busek, a woman-owned small business based in Natick, Massachusetts, with a history of successfully developing Hall thrusters for satellites. These Hall thrusters (named after the physicist Edwin Hall) will provide Maxar's PPE with high-efficiency propulsive capability by converting the solar energy harnessed by ROSA into thrust. The main benefit of solar electric propulsion is that missions can be conducted with a small fraction of propellant when compared to traditional chemical thruster systems. Electric propulsion provides critical maneuvering capabilities for Gateway.



Busek develops Hall thrusters that will provide Gateway with high-efficiency propulsive capability

Gateway will be propelled by several Hall thrusters requiring multiple kilowatts of power. While they only produce a fraction of a pound of thrust

each—less force than would be used to lift a cell phone—these propulsion systems create this small 'push' very efficiently over long durations of time, cumulatively speeding the Gateway along at 1,600 miles per hour in low lunar orbit. This type of thruster enables Gateway's unique orbit—one that allows spacecraft easy access as a staging point for lunar missions and deep space exploration. The Hall thrusters will assist in altitude changes and orbit maintenance of the Gateway throughout its lifespan.

According to Vlad Hruby, president of Busek, "The SBIR program seeded the thruster technologies which are to propel Gateway." The company first participated in the SBIR/STTR program in the late 1990s to develop Hall thrusters, starting from the core fundamentals. Subsequent awards over the years have helped to mature the company's technologies towards commercial viability and flight readiness. In 2012, Busek received Phase I and II awards to develop an 8kW Hall thruster to demonstrate high power solar electric propulsion. Due in part to these awards, Busek and Maxar formed a relationship to develop scaled-down (5-6kW) class Hall thrusters for commercial and civil applications. In 2017, Busek received approximately $465,000 in SBIR funding from CCRPP with matching contributions made by Maxar. The Maxar-Busek team also received $2 million in funding from **NASA Tipping Point**—an opportunity that funds technologies at the crucial "tipping point" of final development to benefit future NASA missions—to continue developing its electric propulsion system for Gateway. "The heights we strive to reach would not be possible without the SBIR program, the ongoing support from NASA's Space Technology Mission Directorate, and our collaboration with NASA's Glenn Research Center and NASA's Jet Propulsion Laboratory," added Hruby.

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>
> – Steve White
> DSS vice president

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> – Vlad Hruby
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Partnerships that Drive Innovation

What started as seed fund investments with the NASA SBIR/STTR program are now mission-critical technologies helping establish a sustainable presence at the Moon. Both DSS and Busek formed partnerships with Maxar through the NASA SBIR/STTR program, and through their collaboration with NASA, the success of Gateway's PPE could support future human, science, and technology demonstration missions. By supporting NASA's Artemis program, these industry partners play an integral role in the agency's mission to conduct lunar science to benefit human life.