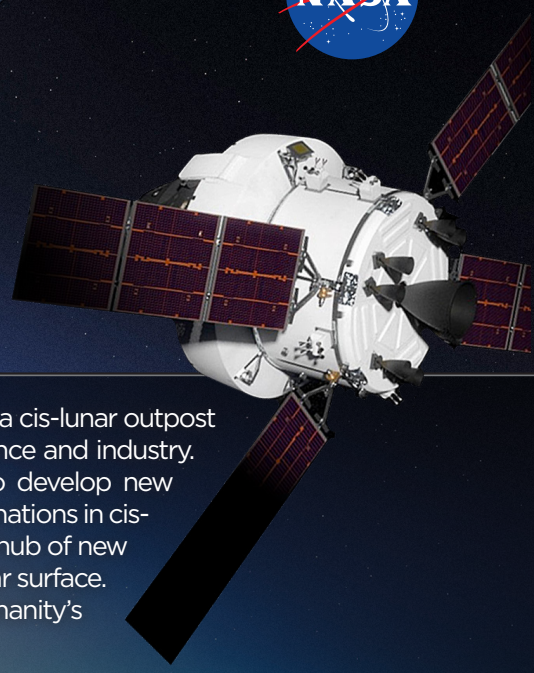
RASC-AL
Revolutionary Aerospace Systems Concepts Academic Linkage

NASA



2019 RASC-AL Themes
Call for Proposals

NASA is working with commercial and international partners to develop the Gateway, a cis-lunar outpost enabling crewed missions to the Moon (and eventually Mars) that also supports science and industry. The 2019 RASC-AL Competition is seeking undergraduate and graduate teams to develop new concepts that leverage innovations that improve our ability to access and explore destinations in cis-lunar space via the Gateway. This year's themes range from using the Gateway as the hub of new science capabilities to using it as the jumping-off point for humanity's return to the lunar surface. Each team's response should address novel and robust applications to expand humanity's ability to live and explore beyond Earth.

Special Note: These are abbreviated theme descriptions and guidelines. Please visit the RASC-AL website, http://rascal.nianet.org for additional theme information, constraints, and requirements.

I | Gateway Logistics as a Science Platform

NASA's Gateway depends on resupply of consumables and spares through the launch of multiple logistics modules. These modules may spend up to 200 days in transit from launch to arrival at the Gateway, and are assumed to enter into a heliocentric disposal orbit. During transit, the logistics module is responsible for maintaining its payload; however, there are opportunities for the module to also host science payloads. These payloads can perform valuable science that takes advantage of a platform with existing power, communications, and attitude control capabilities. These capabilities could also be utilized in the disposal orbit.

This theme challenges teams to propose use cases for the logistics module as a science platform. Teams should review the science objectives, targeted observables, and measurables from the National Academy of Sciences' Decadal Surveys in Earth Science, Planetary Science, Astrophysics, and/or Heliophysics. Teams should identify measurements that could be retrieved using the capabilities of the logistics module. Teams should also identify potential instrument concepts that could be supported by the logistics module to perform the desired science.

The logistics module is constrained to a total mass of 6,000 kg (including 2,500 kg of logistics mass). From that logistics mass, up to 500 kg are available to be used for instrument and support systems (e.g. data storage and processing, expanded communications capabilities). In addition, the logistics module will possess approximately 1 kW of solar array capability; of this, 250 W are available to be used for instrument and support systems. Science payloads may be located on either the external or internal parts of the logistics module; however, the internal pressurized volume of the module cannot be opened to deploy any part of the science payload or support systems. Logistics modules will begin flying to the Gateway in 2024.

Teams should describe the concept of operations for their science payload, from launch to arrival at the Gateway, as well as any relevant operations after the logistics module leaves the Gateway. Teams should identify the science that will be performed and why it was selected. Teams should describe how their science payload fits within the provided capabilities of the logistics module. Teams should identify what new technical capabilities are required to enable their science payload, keeping in mind the 2024 operational date of the logistics module and NASA's human exploration strategic principle of fiscal realism.

II | Gateway-based Cis-lunar Tug

As a hub for cis-lunar activity, the Gateway provides a destination where payloads can be aggregated. Commercial launch vehicles are capable of delivering greater than 10,000 kg to the Gateway, while payloads that are co-manifested with Orion aboard the SLS can reach 9,000 kg. One broad application for the Gateway is to serve as the point-of-origin for payloads to be transferred to low Lunar orbit or other destinations in cis-lunar space.

This theme challenges teams to design a reusable cis-lunar tug to transport payloads between the Gateway and low Lunar orbit. The tug should be reusable and refuelable at the Gateway. It should be capable of transporting non-crewed payloads, to include lunar sample return payloads, other science platforms, landers, and commercial assets.

The tug should be capable of being launched either on a single commercial launch vehicle, or co-manifested on a single flight of the SLS. It should be refuelable from supplies delivered via commercial launch vehicles to the Gateway. It should have the capability to perform one-way transfers of payloads either from Gateway to low Lunar orbit, or from low Lunar orbit to Gateway; in either mode, it should be capable of returning itself to Gateway for refueling. The tug should be ready to begin operations in 2025.

Teams should describe the concept of operations for their tug, from initial deployment, to payload transfer modes, including identifying capabilities to transfer payloads to other destinations besides low-Lunar orbit (e.g. Lagrange points). Teams should describe the design of the tug, including mass, power, geometry, and necessary technical capability developments, keeping in mind the tug's 2025 operational date and NASA's human exploration strategic principle of fiscal realism. Teams should also identify relevant use cases for the tug, and the frequency with which the tug can support those use cases. Teams should describe the concept of operations for refueling the tug, and determine the likely lifetime of the system prior to needing replacement.

NATIONAL INSTITUTE OF AEROSPACE

RASC-AL is managed by the National Institute of Aerospace on behalf of the National Aeronautics and Space Administration

III | Gateway-based Human Lunar Surface Access

The Gateway is being built to enable sustained human missions beyond Low-Earth Orbit (LEO). NASA plans to use the Gateway to enable human access to the surface of the Moon and eventually to support human missions to the Mars system. The Gateway will operate in a Near Rectilinear Halo Orbit (NRHO) about the Moon. This orbit can facilitate human access to the lunar surface given the propulsive performance limitations of the Orion crew vehicle currently under development, while minimizing station-keeping requirements for the Gateway.

RASC-AL respondents are challenged to come up with concepts for crewed lunar surface access and a campaign that allows repeated surface missions to establish a research station at or near one of the Moon's poles. The architecture should leverage current NASA capability investments, as well as existing or anticipated (near-term) commercial and international launch vehicles, in space propulsion capabilities, and lunar surface systems. Architectures cannot be dependent on lunar-derived in-situ resources at the beginning, but should be capable of evolving into an architecture that could leverage some lunar developed propellants if/when they become available.

Primary Constraints:

- Crew is delivered from Earth to the Gateway via NASA's Space Launch System (SLS) and Orion
- Crew returns to Earth from Gateway via Orion
- A reusable ascent/descent cabin/vehicle is based at the Gateway, where it is resupplied and refueled between lunar missions
- The lander must accommodate two mission modes (near polar location at a minimum):
  - 6 days on the surface with 2 crew and 500 kg of cargo – no pre-deployed support infrastructure
  - 2 days on the surface with 4 crew and 100 kg of cargo – longer stays enabled by pre-deployed infrastructure (rovers, habitats, etc.)
  - Both above mission modes must also accommodate the crew during their transit to and from the lunar surface
- Initial architecture and program model that is not "dead-ended" and facilitates evolution from initial capability to a model that leverages commercial services in order to reduce costs for sustained crew access to the lunar surface.
- Open for trade:
  - Distribution, number, location, and staging of propulsive elements (single stage, braking stages, descent modules, ascent modules, etc.)
  - Types of propellant and propulsion systems
  - Propellant resupply strategy (anticipated launch vehicles, depots, etc.)
  - System procurement mechanisms
  - Evolution path of NASA and commercial capabilities
- Considerations:
  - Impact of elements on the Gateway (controllability, power, thermal, etc.)
  - Number of SLS launches (ideal would be one per human lunar mission once the reusable ascent/descent vehicle is delivered to the Gateway with the remaining launches provided by commercial or international partners)
  - Technology readiness and cost to support a crewed lunar mission from the Gateway in 2028

NOTES FOR ALL RASC-AL PROJECTS:

Attention should be given to the following:

- Synergistic applications of NASA's planned current investments.
- Unique combinations of the planned elements with new innovative capabilities/technologies to support crewed and robotic exploration of the solar system
- Realistic assessment of costs for technology maturation, system development, and production and operations.

IV | Gateway Uncrewed Utilization & Operations

The Gateway is envisioned as a small lunar orbiting outpost designed to support four visiting crewmembers about once/year (for 30 days) with construction beginning in 2022. The Gateway is likely to include two habitation/utilization elements and an airlock during the latter stages. When the crew is not present, the Gateway will be used to continue experiments or technology demonstrations designed to improve Gateway performance and/or prepare for designs necessary to support Mars missions. There are concepts for returning lunar and Mars samples to the Gateway for transfer to Earth by the SLS/Orion systems and potentially refueling small lunar landers for reuse. NASA also hopes to provide the Gateway as a platform for commercial or international entities seeking achievement of their own goals, outside of NASA's needs, including periodic occupancy by their own astronauts.

The Gateway will include an external robotic arm for inspections, berthing and external experiment management. Uncrewed logistics flights are expected to provide crew/Gateway resources and utilization payloads (about 1-2 per year) and the external arm may be employed to exchange externally-mounted Gateway experiments from similar logistics vehicle locations to avoid exposure from internal Gateway contaminants or due to experiment size. NASA, international and domestic partners will design, build and deliver elements of the Gateway, much of which will conform to interoperability standards now in development with those same communities. Contingency EVA by crewmembers is possible, but not expected for regular operations – the plan is to mainly rely on the robotic arm. While the majority of science experiments are expected to be externally mounted, the internal experiments are likely to be human research in nature as well as technology experiments.

Given the Gateway's need for automation for continuous operations when the Gateway is uncrewed (~11 months/year), opportunities exist to optimize the internal designs for crew interaction, robotic interaction, science/payload experiment packaging, standardized experiment interfaces and overall logistics systems for both when the crew is at the Gateway and in uncrewed mode.

RASC-AL respondents are asked to come up with utilization scenarios and systems concepts addressing those scenarios for the 11 month uncrewed Gateway period. These scenarios should address automated logistics management, critical fault detection and maintenance, supportable science, technology demonstration and commercial applications in the absence of crew being on the Gateway. Respondents can derive their systems from existing experiment facilities used on Shuttle and ISS or develop their own as needed to address Gateway-unique operations. Implications on Gateway systems such as environmental control, computing, robotics, communications, power and thermal need to be assessed. Crew activities just prior to leaving the Gateway and upon initially returning to the Gateway needed to support the uncrewed period should also be assessed. Respondents can assume approximately one month of Gateway reconfiguration/stabilization/system evaluation preceding the crew arrival while two weeks are necessary to return to uncrewed operational status.

PARTICIPATION AWARDS / STIPENDS

Teams presenting at the Forum will receive up to $6,000 to facilitate full participation in the RASC-AL Forum.

IMPORTANT DATES

- Notice of Intent Deadline: October 15, 2018
- Proposal Deadline: January 17, 2019
- 1st Down-select: February 4, 2019
- Mid-Point Review Submission: March 28, 2019
- 2nd Down-select: April 15, 2019
- Technical Paper Deadline: May 30, 2019
- 2019 RASC-AL Forum: June 17-20, 2019

Full competition details can be found on the RASC-AL website: http://rascal.nianet.org