NASA is embracing new paradigms in exploration that involve expanding our knowledge and leveraging resources as we extend our presence into the solar system. The 2016 RASC-AL Competition is seeking undergraduate and graduate teams to develop mission architectures that employ innovation in crafting NASA exploration approaches and strategies in response to one of the four themes below. These themes encompass timespans that range from the next decade to 30 years into the future. Space pioneering and prospecting towards Earth independence is necessary to achieve NASA’s goal of extending humanity’s reach into space. Collaboration with commercial and international partners will be required to enable this vision. Scenarios should address novel and robust applications, with an objective of NASA sustaining a permanent and exciting space exploration program.

2016 RASC-AL THEMES

1 | CREW-TENDED CO-ORBITING ISS FACILITY

In the decade of the 2020’s, NASA may require a low Earth orbit, crew-tended station/facility to serve as a transition aid for the International Space Station (ISS). This facility will serve as a test-bed for technologies and operations in preparation for future, further destinations. In particular, it will help the aerospace industry gain experience operating next gen crewed facilities in a more independent fashion. As a stepping stone to future human missions to the moon, Mars, and beyond, it is critical that the systems on board the facility be designed in ways that enhance autonomy while reducing maintenance and logistics requirements (as opposed to ISS). Teams will propose a facility that will:

- Be deployed using one or more Expendable Launch Vehicles (ELVs)
- Provide for crew access for durations up to 90 days from either the surface of the Earth or the ISS (i.e., taxi back-and-forth)
- Be commercially and internationally accessible
- Have the ability to operate un-crewed for months at a time (different than ISS)

Budget cap: No more than $3 Billion in new DDT&E (Design, Development, Test and Evaluation), including the cost of the first unit. Teams may, however, leverage existing ISS investments. Regarding launch costs, assume SLS launches are FREE (i.e., they are not included in the $3B cap) while commercial launches will come out of the $3 Billion budget.

2 | LUNAR ICE-TRAP ISRU MINING, PROCESSING AND STORAGE INFRASTRUCTURE

Given a 10-20 year timespan starting in 2015, and a flat total NASA budget of $16 Billion a year, derive a lunar ice-trap plant and associated systems. Previous studies have indicated the possible utility of lunar resources for missions to Mars. Humans may be able to mine, process, and store the ice trapped in the cold and permanently shadowed craters at the lunar poles. To enable such an architecture, it is necessary to understand the systems and operational requirements for developing, deploying and operating a resource production plant on the moon. Within the architecture, teams must design the transportation systems that deliver the In-Situ Resource Utilization (ISRU) infrastructure (i.e., the plant) to the moon, but NOT the transportation system that will ultimately utilize the products. Teams will propose a plant that:

- Is capable of producing a minimum 100t of oxygen/hydrogen propellant annually, and is scalable to significantly larger levels of production
- Has a power source capable of operating the resource collection, processing, product storage and other required systems
- Is autonomous

Systems can begin launching as early as 2025. By 2035, an infrastructure should be in place that is producing 100t of oxygen/hydrogen propellant annually.

Budget: The architecture should convey a series of missions (campaigns) over a ten year period that shows the gradual build-up of capabilities, infrastructure and risk reduction. All existing NASA programs will continue with some reduction in annual funding allowed (maintain at least 80% of their current budget) but the total NASA budget will remain flat, adjusting for inflation. Two exceptions are:

- the International Space Station – which will be fully funded to 2024
- the Space Launch System and Orion – which will be developed and operational through 2025 at their current budgets

After these points in time, the program budgets can be reduced by any level and applied towards other areas of human exploration.

Full 2016 competition details will be launched on the new RASC-AL website by August 31, 2015. For more information, visit http://rascal.nianet.org
3 | CREWED MARS MOONS MISSION

Given a 20 year timespan starting in 2015, and a flat total NASA budget of $16 Billion a year, derive an architecture that delivers a crew of four to the surface of either Phobos or Deimos (or both) for a minimum of 300 days total. Lay out a series of Mars moons surface excursions driven by science, technology demonstration, ISRU and possible future human exploration site reconnaissance on Mars. The architecture will convey a series of missions, both robotic and crewed, that will capture the exploration of one or both of the Martian moons, and must include tele-operating Mars surface assets (i.e., rovers, ISRU production plants, infrastructure cameras, small Mars flyers, deployment of power and support systems, etc.) while the astronauts are not conducting Extravehicular Activities (EVAs). All existing NASA programs will continue with some reduction in annual funding allowed (maintain at least 80% of their current budget), but the total NASA budget will remain flat, adjusting for inflation. Two exceptions are:

- the International Space Station – which will be fully funded to 2024
- the Space Launch System and Orion – which will be developed and operational through 2025 at their current budgets

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4 | EARTH-INDEPENDENT 1G SPACE STATION

Although the moon and Mars appear to be incredible destinations for exploration and pioneering, we still do not understand the implications of partial-G on mankind’s ability to thrive over multiple generations (i.e., successfully reproduce). Because our long-term goal is extending human presence in space, we will one day need an option to facilitate reproduction should we be unable to do so on the moon or Mars. If this is indeed the case, one potential option is to produce large-scale facilities in deep space capable of providing a 1G environment. Given a 20-30 year timespan starting in 2015, and a flat total NASA budget of $16 Billion a year, derive an architecture that has 16-24 people continuously living in a 1G space station. The start date of operation should be between 2030 and 2040, and the facility will be completely independent from Earth resupply after 5 years of operation. Non-Earth ISRU is acceptable (but must be accounted for in the budget, too). The architecture will convey a series of missions (campaigns) over the 20-30 year period that shows the gradual buildup of capabilities, infrastructure and risk reduction. All existing NASA programs will continue with some reduction in annual funding allowed (maintain at least 80% of their current budget), but the total NASA budget will remain flat, adjusting for inflation. Two exceptions are:

- the International Space Station – which will be fully funded to 2024
- the Space Launch System and Orion – which will be developed and operational through 2030 at their current budgets

After these points in time, the program budgets can be reduced by any level and applied towards other areas of human exploration.