



RASC-AL

Revolutionary Aerospace Systems Concepts Academic Linkage



PIONEERING AND PROSPECTING TOWARDS EARTH INDEPENDENCE

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 2015 RASC-AL themes are looking for innovations in crafting NASA exploration approaches and strategies as they relate to extending humanity's reach beyond low Earth Orbit (LEO). These themes encompass timespans that range from near term robotic missions to 40 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.

2015 RASC-AL THEMES

1 | EARTH INDEPENDENT MARS PIONEERING ARCHITECTURE

Given a 40 year timespan starting in 2014, and a flat total NASA budget of \$16 Billion a year, derive an architecture that has 24 people continuously living on the surface of Mars. The pioneers on Mars are totally self-sufficient at year 40, with no supplies of any sort except an every other year crew rotation (4 up and 4 down) sent from Earth. The architecture will convey a series of missions (campaign) over the 40 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; and
- the Space Launch System and Orion which will be developed and operational through 2035 at their current budgets.

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

The lunar surface, asteroids, Mars moons and the Mars surface can be leveraged for In-situ Resource Utilization (ISRU), and all systems must be reusable wherever practical. All systems required to enable this architecture must be accounted for with respect to the budget. This includes development of new technologies and infrastructure necessary to enable ISRU, and transportation of those ISRU assets. The campaign should be structured so that there is a cadence of significant human activities and missions beyond low Earth Orbit.

2 | EARTH INDEPENDENT LUNAR PIONEERING ARCHITECTURE

Given a 20 year timespan starting in 2014, and a flat total NASA budget of \$16 Billion a year, derive an architecture that has 8 people continuously living on the surface of the Moon. The pioneers on the Moon are totally self-sufficient at year 20, except a yearly crew rotation (4 up and 4 down) sent from Earth along with 10t of logistics. The architecture will convey a series of missions (campaign) over the 20 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; and
- the Space Launch System and Orion which will be developed and operational through 2025 at their current budgets.

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

The lunar surface and asteroids can be leveraged for In-situ Resource Utilization (ISRU), and all systems must be reusable wherever practical. All systems required to enable this architecture must be accounted for with respect to the budget. This includes development of new technologies and infrastructure necessary to enable ISRU, and transportation of those ISRU assets. The campaign should be structured so that there is a cadence of significant human activities and missions beyond low Earth Orbit.

Full 2015 competition details will be launched on the RASC-AL website by September 1, 2014.

For more information, visit www.NIANet.org/rascal



2015 RASC-AL THEMES (CONT)

3 | MARS MOONS PROSPECTOR MISSION

The moons of Mars (Phobos & Deimos) have yet to be explored by any dedicated mission, yet they offer so much potential as a stepping stone to the surface of Mars - a potential cache of resources - and as intriguing science targets. Understanding the potential of these small moons is necessary before selecting a strategy for sending humans to Mars. Given this context, design a robotic mission that interrogates one or both moons to fill in strategic knowledge gaps in support of an ISRU driven human Mars architecture, including the moons as human destinations in themselves. The mission must be launched on a single launch vehicle in 2022, and cost no more than \$300 million, exclusive of launch vehicle. The primary mission must be completed by 2025, but extended missions are encouraged if practical.

4 | LARGE SCALE MARS ENTRY, DESCENT AND LANDING (EDL) PATHFINDER MISSION

Current state of the art for landing payloads on the surface of Mars is currently at around one metric ton. In order for humans to access the surface of Mars, landed payload masses of at least 20 metric tons are desired. Given a single SLS block 2 vehicle, design a mission that demonstrates (at required scale) the integrated technologies for landing human class payloads on the surface of Mars. This pathfinder mission will deliver a large robotic payload to the surface that should accomplish Mars-forward objectives beyond the EDL technology such as sample return or ISRU, which means the mission design may need to accommodate operations years beyond landing. Total mission cost (excluding launch vehicle) should not exceed \$1 billion.

For all RASC-AL Projects, attention should be given to the following:

- Synergistic applications of NASA's planned current investments; and
- Unique combinations of the planned elements with new **innovative capabilities/technologies** to support crewed and robotic exploration of the solar system.

Scenarios should address novel and robust applications, with an objective of NASA sustaining a permanent and exciting space exploration program.

NASA investments can be augmented by or used in conjunction with those from commercial and/or international partners.

Key elements that each RASC-AL project will be evaluated on include:

- Synergistic application of **innovative capabilities and/or new technologies** for evolutionary architecture development to enable future missions, reduce cost, or improve safety;
- Scientific evaluation and rationale of mission operations in support of an exciting and sustainable space exploration program;
- Key technologies, including technology readiness levels (TRLs), as well as the systems engineering and architectural trades that guide the recommended approach;
- Reliability and human safety consideration in trading various design options;
- Realistic assessment of project plan and execution of that plan, including inclusion of a project schedule and test plan, as well as development and realistic annual operating costs (i.e., budget); and
- Realistic assessment of partnering and cost sharing scenarios based upon commercial profitability and the ability of international partners to participate given their limited budgets.