NASA SBIR 2008 Phase I Solicitation

X5 Lunar Operations

This call for technology development is in direct support of the Exploration Systems Mission Directorate (ESMD) Technology Development Program. The purpose of this research is to develop component level technologies to support the Constellation Programâ€™s human lunar return missions.Â These initial missions will be heavily engaged in construction methods, establishing self-sustaining power generation, and producing life support consumables in situ in order to establish continuous operational capability via Earth based and lunar based assets.

The objective is to produce new technology that will reduce lunar operations workloads associated with crew extra-vehicular activities (EVA) and intra-vehicular activities (IVA), and reduce the total mass-volume-power of equipment and materials required to support both short and long duration Lunar stays. The proposals must focus on component technologies to maximize the operations of exploration hardware allowing for less expensive, more productive and less risky missions.Â

Lunar operations are a stepping stone toward higher exploration goals. This research focuses on technology development for the critical functions that will secure an extended human presence on the Lunar surface and ultimately enable surface exploration for the advancement of scientific achievements. Surface exploration begins with short duration missions to establish extensible functional capabilities.Â Successive buildup missions establish a continuous operational platform from which to conduct scientific research while on the lunar surface.Â Reducing risk and ensuring mission success depends on the coordinated interaction of many functional systems including life support, power, communication infrastructure, and transportation.Â This topic addresses technology needs associated with Lunar surface systems, interaction of humans and machines, and extended operational life-cycles of resources by way of eliminating environmental contamination of mechanisms.

Subtopics

X5.01 Lunar Surface Systems

Lead Center: JSC

Participating Center(s): ARC, GRC, GSFC, JPL, KSC, LaRC, MSFC

The objective of this subtopic is to address projected technology needs for surface system elements supporting lunar operations. Communication integrity between lunar assets is essential during crewed translation across the lunar surface as well as during uncrewed autonomous translation of mobile assets. Navigation is essential to performing many lunar surface tasks, including exploration traverses, site surveys, material/payload transport, etc. The current lunar architecture plan for lunar surface navigation focuses on a deployed infrastructure-based solution (fixed radiometric towers, comm/nav orbiters, etc.) Although this approach is appropriate for outpost-centric operations, it is insufficient for operations in rough and steep terrain (e.g., inside deep craters) or when activity is temporarily required in regions without coverage. Commodities distribution systems (including umbilicals/connectors) will be employed to route communication and power lines to remote equipment and surface assets. These new capabilities are required to make planetary surface missions more reliable, safer, and affordable.

Maximizing the useful life of surface assets is essential to a successful lunar program. Material components must be robust and tolerate extreme temperature fluctuations and endure harsh environmental effects due to solar events, micrometeorite bombardment, and abrasive lunar dust.

Proposals are sought which address the following technology needs:

- Electrical connectors that can be repeatedly mated and de-mated (5000+ cycles) without failure in a contaminating environment consisting of regolith grain size ranging from 100um down to 10um. Capable of carrying 10kw of power transmission. Automated mating and de-mating is required.
- Lunar wireless network. Must support 15 simultaneous users with aggregate bandwidth of 80mbs at extended ranges to at least 5.6km. Must support minimum data rates of 16kbs and maximum data rates of 20mbs. Must be able to convert conventional IP stacks to SN stacks.
- Navigation and communication infrastructure technologies for use on the Lunar surface to support surface mobility and communication between lunar base, EVA astronaut and mobile rover/robotic assistant. Communication infrastructure not limited to surface-based assets but could include orbiting communication assets as well. Line of site communication must be maintained at all times. Redundant communication paths assure constant communication link and reduce the possibility of loss of communication. Data rates in excess of 200 Mbps for comm network. Less than 100W system power. Coverage area on the order of 100 km radius from a central point.
- Passive navigation sensors to improve surface vehicle operation: collision avoidance, hazard detection, relative positioning (to artificial and natural objects). Emphasis is placed on sensors that can function in a wide range of lunar conditions (illumination, temperature, etc.)
- Flight vehicle sensors repurposed for surface use. Numerous flight sensors (low light imager, star tracker, 3D flash & scanned lidar) may be suitable for lunar surface operations if modified appropriately.

X5.02 Surface System Dust Mitigation

Lead Center: GRC

Participating Center(s): GSFC, JPL, JSC, KSC, LaRC, MSFC

Lunar lander and surface systems will likely employ common hatch and airlock systems for docking, mating, and integration of spacecraft, habitat, EVA, and mobility elements. The large number of EVAs will require hatches that are safe if non-pressure assisted, and do not have to be serviced or replaced regularly.

Lunar lander will require materials and mechanisms that do not collect dust and do not abrade when in contact with lunar regolith. Technologies are also needed to remove lunar regolith, including dust, from materials and mechanisms.

Lunar Surface systems will require EVA compatible connectors for fluid, power, and other umbilicals for transfer of consumables, power, data, etc. between architecture elements that will maintain functionality in the presence of lunar regolith, including dust.

Lunar surface systems (power, mobility, etc.) will require gimbals, drives, actuators, motors, and other mechanisms with required operational life when exposed to lunar regolith, including dust.

Radiators and other thermal control surfaces for lander and surface systems must maintain performance and/or mitigate the effects of contamination from lunar regolith, including dust.

X5.03 Extravehicular Activity (EVA)

Lead Center: JSC

Participating Center(s): GRC

Proposals are sought which address the following technology needs of the advanced extravehicular activity (EVA) system:

Space suit pressure garment radiation and puncture protection technologies, dust and abrasion protection materials, flexible thermal insulation suitable for use in vacuum and low ambient pressure, and space suit low profile bearings. Technology development is needed for minimum gas loss airlocks providing quick exit and entry, suit port/suit lock systems for docking a space suit to a dust mitigating entry/hatch, and active and passive space suit and equipment dust removal technologies.

Portable life support system (PLSS) technologies that are robust, lightweight, and maintainable. PLSS technologies require a minimum of 100 EVAs x 4 life cycles (3200 hrs). High-capacity chemical oxygen storage systems for an emergency supply of oxygen, low-venting or non-venting regenerable individual life support subsystem concepts for crew member cooling, heat rejection, and removal of expired water vapor and CO_2; lightweight convection and freezable radiators for thermal control with a mass usage of water not to exceed 1.9 kg; innovative garments that provide direct thermal control to crew member.

Space suit displays, cameras, controls, and integrated systems technologies for gathering, processing, and displaying various types of information to the suited crew member, using low mass, low volume, low power, radiation hardened or tolerant equipment. Technology development is needed in the area of suit health and crew health sensors; cameras; and displays, mounted both inside and outside the space suit. Research is also needed for lightweight, low power general purpose computing platforms, such as processors or FPGAs to allow the use of on-suit software applications such as biomedical advisory algorithms, procedure displays, navigation displays, and voice recognition applications. Low computational overhead voice recognition processing systems capable of performing on lightweight radiation tolerant embedded computing platforms are also desired.

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