NASA SBIR 2014 Phase I Solicitation

H3.03 Human Accommodations and Habitation Systems for Future Exploration Missions

Lead Center: JSC

Participating Center(s): ARC, KSC, MSFC

Habitation systems that are dispersed throughout a spacecraft volume need to be investigated as a system to improve future human accommodations. Current spacecraft interiors exceed acoustic limits from a wide range of equipment; have manual inventory tracking and no capability for assistance of lost items; and require substantial crew time and wipes for cleaning common crew surfaces (hand rails and panels) and water/solids hygiene surfaces. Future spacecraft interiors will need to be reconfigurable to meet changing crew needs as a mission moves from launch, transit, and exploration-destination phases. Adaptable distributed habitation technologies are needed in the following areas.

- *Quiet Crew Cabin Environments* - Smaller future vehicles will unlikely have dedicated quiet volumes for crew rest so maintaining a quiet cabin is required. Crew cabin acoustic noise mitigation needs to control noise levels to enable improved voice communication, alarm signal to noise ratio, and reduce crew fatigue from long duration noise exposure. There is need for non-wearable active and passive noise cancellation/reduction strategies for open crew cabin environment that do not impede voice or alarms. Need for adaptive broad coverage area to accommodate changing crew cabin layout and volume.
- *Crew Item Location Capability* - Significant crew time is lost in tracking or locating items at the piece part level in space habitat environment that serves both as living quarters and laboratory. Items are sometimes misplaced or simply float away in the microgravity environment. Innovative approaches are sought for automatic location and tracking of a large number of individual crew items as they move from their original launch configuration to any area in the crew cabin. Crew items range in size from pill size, hand tools, clothing, and spare equipment and vary in material composition from non-metallic, metallic, to fluid containing. There is a need for low-power, and miniature Radio Frequency Identification (RFID) readers for dense storage and sparse tag environments. Flexible reader deployment that allows individual item autonomous logistics management tracking and precise 3-D locating are desired. Solutions providing enhanced localization utilizing the EPCglobal UHF reader-tag protocols (Class 1 Gen2 or advanced classes) are of high interest. Similar types of reader-tag communication protocols at higher frequencies that enable more accurate spatial localization are also of interest. Innovative algorithmic solutions for finding lost items, based on RFID or similar sensory information, are also of interest. All solutions must accommodate a highly reflective and complex scattering environment such as a conductive habitat cylindrical volume of ~ 3.5 m diameter ~6 m in length.
- *Crew Cabin Surfaces* - Crew activity and surface contact of fabric and solid surfaces result in generation and accumulation of particulate, moisture, organic, and salt. Surface treatments for fabrics and solid surfaces to prevent this accumulation of contaminants are needed to reduce crew time and the large number of wipes used for cleaning. Innovative low out gassing, super hydrophobic, super hydrophilic, antistatic, and antimicrobial treatments are needed for crew hygiene areas and waste collection hardware is needed. Non-mechanical fastener/non-particle generating removable physical connections are needed for repeated reconfiguring of interior volumes on longer missions. Examples of the types of temporary and

reversible physical connections include crew restraints (e.g., hand rails), close out panels, and the hook-and-loop type fasteners present on most crew items.

Phase I Deliverables - Detailed analysis, proof of concept test data, material test coupons, key algorithms/ subroutines, and predicted performance comparison to industry state of the art.

Phase II Deliverables - Comparison of analysis to prototype test data in representative environment, sufficient material samples/components for independent evaluation, functional software, functional breadboard component hardware and/or system, and operations documentation.