NASA SBIR 2017 Phase I Solicitation

H3.01 Habitat Outfitting

Lead Center: JSC

Participating Center(s): LaRC, MSFC

Technology Area: TA6 Human Health, Life Support and Habitation Systems

Early definition of habitat outfitting for a vehicle is important because it will influence the overall vehicle architecture and layout. Vehicle outfitting provides the equipment necessary for the crew to perform mission tasks as well as provide them a comfortable, safe and livable habitable volume. Effective and efficient human-system interfaces and interactions are critical and should be considered as an integral part of this effort and demonstrated. Integrated outfitting is often a distributed hardware set that operates in unison or independently to perform a habitation function. Outfitting includes secondary structure (e.g., floors and walls), crew structures (e.g., crew quarters, radiation storm shelters) as well as the distribution of outfitting items (e.g., crew personal items) and utilities (e.g., avionics, ventilation, lighting) to sustain the crew during a mission. Habitat features and capabilities that allow autonomous monitoring or robotic interaction of items to enable habitat outfitting (e.g., high accuracy localization systems or mounting approaches) prior to crew arrival or after crew departure are also of interest. Concepts that can reuse launch support structure for outfitting are advantageous if it can be done without significant or with no crew interaction. Concepts should be capable of outfitting habitats with diameters of 3-8 meters and lengths of 4-10 meters. Habitat atmospheric pressure may vary from 0-1 atm for launch and 0.5-1 atm during crew usage. The following habitat outfitting specific habitat outfitting areas are requested.

Interior Structures

Deployable, inflatable, 3D printable from processed launch packaging, reusable secondary structure, and crew structures for outfitting the vehicle habitable volume. Concepts should not be constrained to the ISS rack geometry or attachments. Concepts must be volumetrically and mass efficient, and have a metric less than 25 kg/m^3 for an enclosed volume. Proposed technologies that provide a surface area (e.g., floor) or utility (e.g., plumbing) should define a normalized metric (e.g., kg/ m^2 or kg/m/plumbing run). The selection of non-metallic materials is very important in a spacecraft and will need to meet off-gassing and flammability requirements. Concepts should also have surfaces that either resist the accumulation of dust and dander or are readily cleanable. Structures should include appropriate factors of safety and assumptions should be included in the proposal. Concepts should be capable of sustaining launch loads (which can be in a stowed configuration) of 6g axial and 2g lateral. Crew structures must be capable of withstanding crew kick loads of 125 lbs when fully deployed. Concepts that are also applicable to habitat and life support equipment mounting are desirable.

Autonomous Outfitting Capabilities

Development of features and systems are required that can enable habitat structures, crew equipment, logistics, and trash to be interacted with autonomously with no direct crew involvement. Requested capabilities are rapid identification, localization in 3D space (including pose or orientation), and interaction with items. The intent is to allow robotic interaction with items prior to crew arrival and after crew departure. This may include deployment of interior structures, maintenance of the habitat, or monitoring of the habitat including health and status of items. Systems may also enable or facilitate human-machine interactions by providing greater situational awareness. Development of the robotic elements themselves are excluded from this subtopic. Mechanisms, electro-mechanical, and software applications and algorithms that enable autonomous outfitting and maintenance capability are requested. Dependencies on batteries are highly undesirable. Concepts that provide significant automated vehicle health monitoring should consider submission to the 'Autonomous Systems' topic.

Additional information on NASA needs can be found in 2015 NASA Technology Roadmaps including but not limited to sections TA06 6.1.4.2 and TA07 7.2.1.3, 7.2.1.7, 7.2.1.9, 7.4.1.1, and 7.4.1.3. These roadmaps are available at the following link: (http://www.nasa.gov/offices/oct/home/roadmaps/index.html). An example of an inflatable habitat can be found at (http://www.nasa.gov/content/bigelow-expandable-activity-module). Examples of conference papers on habitat outfitting and crew structures (TransHab, ISS Crew Quarters, Waste and Hygiene Compartments, Multipurpose Cargo Bags) can be found at the Internal Conference on Environmental Systems and the AIAA Space Conference websites. Human Research Program (HRP)-related research on Habitable Volume and Habitat Design can be found at the following link: https://humanresearchroadmap.nasa.gov/risks/risk.aspx?i=162. Other related risks can be found at the following link: https://humanresearchroadmap.nasa.gov/explore/.

Phase I Deliverables - Detailed analysis, proof of concept test data, and predicted performance (mass, volume, positioning accuracy). Deliverables should clearly describe and predict how performance of targeted habitat vehicles are enhanced, improved, or integrated. Evaluation of concepts for human-system performance should be predicted.

Phase II Deliverables - Delivery of technologically mature components/subsystems that demonstrate deployments and/or automated features are required. Prototypes must be full scale unless physical verification in 1-g is not possible. Consideration of recovery from deployment failures should be included. Ability to sustain launch loads and on-orbit crew loads needs to be demonstrated. Evaluation of concepts for human-system performance should be validated with modeling as a minimum and demonstrated where possible.