



## NASA SBIR 2017 Phase I Solicitation

### Z4.01 In-Space Structural Assembly and Construction

Lead Center: LaRC

Participating Center(s): GSFC, MSFC

Technology Area: TA12 Materials, Structures, Mechanical Systems and Manufacturing

Spacecraft that use modularity can be adaptable to changing needs particularly when open architectures with common interfaces are employed in the design. The ability to join spacecraft components autonomously in-space allows for the assembly of vehicles (perhaps aggregated from multiple launches) and for re-use of vehicle subsystems. Modular "plug and play" interfaces permit rapid assembly, upgrade and reconfiguration of spacecraft subsystems and instruments. The joining technology used for module interfaces should be reversible for maximum flexibility and utilize simple approaches (electro-mechanical or other) amenable to robotic assembly and disassembly. In addition, the joining technology must provide for mechanical, electrical and optionally thermal load transfer.

This subtopic seeks innovative spacecraft open architectures enabled by modularity and common interfaces that can be joined using autonomous robotic operations. Innovative joining technologies and capabilities are sought for in-space assembly, disassembly, and re-use of space exploration vehicles. Additionally, joint designs that support modular "plug and play" interfaces for upgrade and reconfiguration of spacecraft subsystems are sought. In-space joining of structural trusses that support multiple solar arrays for solar electric propulsion is one class of needed joint technology. The assembled truss must provide power connections either integral to the structural joint or as a non-mechanical load bearing harness with connectors. The second class of in-space joining is for modular subsystems nominally three-dimensional platforms (square or rectangular) with power, data, and mechanical load carrying connections. While these modules could represent orbital replacement units (ORUs), the modules could serve to construct an entire space vehicle.

Specific Research Objectives include:

- Innovative connection approaches/architectures that enable on-orbit geometry adaptation. Areas of interest include structural connections, electrical connections, fluid connections, thermal connections or combinations of these.
- Methods for in-situ connection verification (smart joints).
- Innovative reversible joining systems for robotic operations that minimize mass, energy and complexity while maximizing assembled stiffness, strength, stability, heat transfer, power density, etc.

Application orbits include LEO/GEO/Lunar. Nominal mechanical joining requirements are:

- Class 1: Structural Truss Joints.
  - Strength: 100N to 500N axial target

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- Class 2: Module Joints.
    - Strength: > 0.4 g (Mars Extensible) with 0.25 meter cubic module connected on one face with uniform density of 640 Kg/m<sup>3</sup>.
  - Current from milliamp to amps per contact.
    - Voltage 28 to 100V DC
  - Assembly/Disassembly: 20-50 times.

*References:*

- Barnhart, David; Will, Peter; Sullivan, Brook; Hunter, Roger; and Hill, Lisa: "Creating a Sustainable Assembly Architecture for Next-Gen Space: The Phoenix Effect," 30th Space Symposium, May 2014, Colorado Springs CO.
- Erkorkmaz, Catherine; Nimelman, Menachem; and Ogilvie, Andrew: "Spacecraft Payload Modularization for Operationally Responsive Space," 6th Responsive Space Conference, April 28-May 1, 2008, Los Angeles, CA.
- Troutman, Patrick A.; Krizan, Shawn A; Mazanek, Daniel D.; Stillwagen, Frederic H.; Antol, Jeffrey; Sarver-Verhey Timothy R.; Chato, David J.; Saucillo, Rudolf J.; Blue, Douglas R.; and Carey, David: "Orbital Aggregation and Space Infrastructure Systems (OASIS)", IAC-02-IAA.13.2.06, 53rd International Astronautical Congress, 10-19 Oct. 2002, Houston Texas.