2.1 *Payloads to Demonstrate Space technologies:*

NASA OCT recognizes that NASA has made a substantial resource investment in a wide range of advanced technologies that can't be infused into the planning for future missions due to lack of testing and verification in relevant environment. In addition, many potentially highly valuable technologies already exist in a lower state of readiness that would also benefit by such testing to acquire needed engineering knowledge for further advancement.

NASA OCT intends to address this difficulty through the future solicitation of proposals that define R&D projects to develop such payloads for test flights on both parabolic aircraft and suborbital reusable launch vehicles (sRLVs). NASA OCT intends to initiate this effort by first focusing on a sub-set of technology development areas as defined in the draft Space Technology Roadmaps.

The Flight Opportunities Program in conjunction with the Game Changing Technology Division seeks to mature technologies that will: 1) improve or enable new spacecraft capabilities for future space missions, and 2) be matured from testing aboard parabolic and commercial reusable suborbital vehicle flights. Potential technology demonstration topics include but are not limited to the following (applicable Roadmap Technology Area identified in brackets):

2.1.1 Microfluidic systems for small spacecraft propulsion [TA-02]

Microthruster concepts for small spacecraft that employ microfluidic systems and that can benefit from flight testing in the microgravity environment aboard reusable suborbital research vehicles.

2.1.2 Microfluidic systems for small spacecraft active thermal control [TA-02]

Active thermal control concepts for small spacecraft that employ microfluidic systems and that can benefit from flight testing in the microgravity environment aboard reusable suborbital research vehicles.

2.1.3 Microgravity fluid systems for in-space propellant management and storage [TA-02]

Systems to manage propellant transfer and/or long-term storage of propellant in space and that can benefit from flight testing in the microgravity environment aboard reusable suborbital research vehicles.

2.1.4 Microgravity fluid systems for spacecraft fuel cells [TA-03]

Systems that manage liquid reactants and oxidants in spacecraft fuel cells and that can benefit from flight testing in the microgravity environment aboard reusable suborbital research vehicles.

2.1.5 Miniaturized attitude control systems for small spacecraft [TA-02]

Miniaturized versions of systems, such as control moment gyroscopes, that manage attitude control on small spacecraft and that can benefit from flight testing in the microgravity environment aboard reusable suborbital research vehicles.

2.1.6 Planetary autonomous landing and hazard avoidance systems [TA-09]

Autonomous systems that control landings on other planetary bodies and that can benefit from flight testing during the descent of reusable suborbital research vehicles that perform vertical landings.

2.1.7 Propellantless formation control systems for small spacecraft [TA-05]

Propellantless systems, such as electromagnetic formation flight systems, that manage formations of multiple small spacecraft in space and that can benefit from flight testing in the microgravity environment aboard reusable suborbital research vehicles.

Microgravity fluid systems for life support [TA-06] Systems that manage water, coolant, or other life support fluids and that can benefit from flight testing in the microgravity environment aboard reusable suborbital research vehicles.

2.1.8 Water Recovery Systems [TA-06]

Systems that can support fundamental and applied research into improving water recovery processes in microgravity, including understanding of microgravity reduced performance of existing water processing flight hardware; the effect of variable gravity on multiphase flow systems; reduced buoyancy driven mixing on membranes and other mass transport limited processes; and molecular mixing in nanoprous materials.

2.1.9 Waste Management Systems [TA-06]

Systems that can support fundamental and applied research into improving waste management processes in microgravity, including three phase separation; microgravity combustion; boiling across a porous membrane surface; heat transfer across heating surfaces and multi-phase materials; salt and mineral fouling of heat transfer surfaces, material transport surfaces, and porous membranes; and multiphase flow in open and porous media.

2.1.10 Atmosphere Revitalization [TA-06]

Systems that can support fundamental and applied research into improving atmosphere revitalization processes in microgravity, including nano-scale gas diffusion; gas/liquid separation across porous media; and gas sensing via carbon nano-tubes.

2.1.11 Science Instruments, Observatories, and Sensor Systems [TA-08]

Technology concepts that advance remote Sensing Instruments/Sensors, Observatories, and In-situ Instruments/Sensors. Remote Sensing Instruments/Sensors includes components, sensors, and instruments sensitive to electromagnetic radiation including photons, as well as any other particles, electromagnetic fields, both DC and AC, acoustic energy, seismic energy, or whatever physical phenomenology the science requires. Observatory includes technologies that collect, concentrate, and/or transmit photons. In-situ Instruments/Sensors includes components, sensors, and instruments sensitive to fields, waves, particles that are able to perform in-situ characterization of planetary samples.

2.2 *Demonstration of Vehicle Technology Enhancements:*

NASA OCT seeks to mature commercial reusable suborbital vehicle technologies that will improve or enable the use of these vehicles for various science research and/or technology demonstration applications. Enhancements that support more than one user and/or more than one commercial vehicle developer are desirable. Potential technology demonstration topics include but are not limited to the following (applicable Roadmap Technology Area identified in brackets):

2.2.1 Data Handling, Storage, and Telemetry [TA-13]

Systems for routing, storing, transmitting, and receiving data from payloads in flight or on the ground.

2.2.2 Payload recovery systems [TA-13]

Systems for recovering payloads from normal operations, as well as from aborted flights.

2.2.3 Engine and control system enhancements [TA-01]

Changes or additions to commercial reusable suborbital vehicle engines, controls, and other systems that allow alternate altitudes or trajectories that are enabling for specific research applications.

2.2.4 External instrument booms [TA-08, TA-12]

Booms for atmospheric collection, magnetic field instruments, testing outside the vehicle's airflow, or other research applications.

2.2.5 Instrument pointing, tracking, and stabilization systems [TA-08]

Systems for controlling, pointing and vibration stabilization of instruments, sensors or observatories (e.g. telescopes, observational instruments for astrophysics, solar physics, or Earth observation applications).

2.2.6 Microgravity monitoring and control [TA-08]

Systems for monitoring and recording the microgravity environment onboard commercial reusable suborbital vehicles during flight and/or providing information to pilots or instrument and vehicle control systems to better control the microgravity environment.

2.2.7 Pre- and/or post-flight systems processing [TA-13]

Systems for handling samples or instruments before and after flight.

2.2.8 Dedicated small satellite launch [TA-01]

Upper stages deployed from commercial reusable suborbital vehicles in flight to provide dedicated launch capabilities for small satellites.

2.2.9 Transparent surfaces and structures [TA-08, TA-12]

Viewports, windows, or other transparent surfaces that provide external access for telescopes or other observational instruments for astrophysics, solar physics, or Earth observation applications.

2.3 *Deployment of Onboard Research Facilities for Technology Testing and Demonstration:*

NASA OCT seeks to mature facilities for fundamental or applied research onboard commercial reusable suborbital vehicles. Facilities are intended to support or contain experiments onboard the vehicle. Facilities should support research priorities consistent with the report of the National Research Council's Decadal Survey on Biological and Physical Sciences in Space, Recapturing a Future for Space Exploration: Life and Physical Sciences Research for a New Era. Facilities that support more than one user and/or more than one vehicle are desirable. Where cost-effective, these systems may make use of Shuttle- or International Space Station-heritage systems or other

spacecraft standards, such as cubesat standards. Respondents should not assume that NASA will take ownership and provide for maintenance and operations costs. Potential technology demonstration topics include but not limited to the following (applicable Roadmap Technology Area identified in brackets):

2.3.1 Combustion

Facilities that can support fundamental and applied research into combustion processes in microgravity, especially processes involving larger scales, new fuels, and practical aerospace propulsion system experiments.

2.3.2 Fluids

Facilities that can support fundamental and applied research into the behavior of complex fluids and soft matter in microgravity, including matter near critical phase transitions, multiphase flows and system stability, interfacial flows and phenomena, induced and spontaneous multiphase flows with or without phase change, cryogenics and heat transfer, phase change heat transfer, and pressure drop.

2.3.3 Biological

Facilities that can support and isolate biological research for short sRLV mission durations, including pre- and post-flight ground handling and flight in microgravity.

2.3.4 Microgravity Vibration Isolation

Facilities that can reduce or eliminate the influence of vehicle vibrations on sensitive microgravity experiments during flight.