NASA SBIR 2010 Phase I Solicitation

O2.01 Secondary/Auxiliary Payload-to-Launch Vehicle Interface Technologies

Lead Center: KSC

Participating Center(s): AFRC

This subtopic includes two major technology areas:

(1) Small payload standard interface technologies (SPSIT)

(2) Entry and ascent experimental platform technologies (EAEPT)

Proposals will be accepted for either area.

Many expendable launch vehicle (ELV) launches do so with excess capacity. The utilization of specific excess volumes within a launch system must be accomplished at a low cost with minimal to no additional risk to the primary payload or launch vehicle. This subtopic seeks to develop commercial solutions that will allow and encourage new enabling launch capabilities and standardization of key payload-to-launch vehicle processes and interface standards with the goal of producing a low cost, low risk platform or process for integrating secondary or auxiliary payloads on existing NASA ELV launches.

The goal is to develop new launch vehicle capabilities such as adapters/platforms, processes, and/or avionics interface standards that can be collectively used to:

- Minimize integration tasks and/or duration of integration efforts to install secondary/auxiliary payloads onto NASA ELV launches
- Facilitate secondary/auxiliary spacecraft and subsystem design while reducing testing duration and complexity
- Impose no additional risk to the primary mission
Enable novel mission concepts for secondary/auxiliary payloads

Small Payload Standard Interface Technologies

Currently, the Poly-Picosatellite Orbital Deployer (PPOD) provides a cost-efficient standard interface and deployment system for CubeSats in the 1 to 3 kg mass range. In addition, the Evolved ELV (EELV) Secondary Payload Adapter (ESPA) provides a standard structural interface for secondary payloads up to 180 kg and is designed for interface into Atlas V and Delta IV launch vehicles. A smaller version of the ESPA ring has been conceptualized for smaller launch vehicles. Both the ESPA and the small ESPA are most cost effective when they accommodate 6 payloads. In addition, for the most part, the avionics and electrical power interfaces are unique to each launch vehicle fleet. This subtopic seeks to develop commercial solutions that could allow the cost effective launch of one or more secondary/auxiliary payloads via an interface (structural, avionics and electrical) that is standard or expandable/upgradable to be compatible with the maximum number of domestic launch vehicles. NASA currently has Pegasus XL, Taurus XL, Falcon 1, Falcon 9, Atlas V and Delta IV on contract.

A significant fraction of mission costs are typically unique designs and approaches to perform relatively routine functions such as launch accommodations and subsystem-to-subsystem interface and communications. By standardizing many of these approaches, spacecraft and payload developers can design their systems with an expectation of a predictable, low-cost integration flow. Launch service providers can mitigate mission risk through the use of predictable and proven interfaces standardized to streamline analytical/physical integration processes and test flows.

This subtopic will focus on new interfaces for payloads in the mass range of 3 to 180 kg, which can be grouped as needed for any modularization concepts. A range of 11 to 100 kg has been specifically identified as a region where critical technology demonstrations and new space technologies could use affordable orbital launch opportunities to increase their TRL, potentially reducing their overall cost and risk to development. Enabling affordable launch capabilities in these ranges could also allow scientific and educational spacecraft (s/c) developers the ability to design to a specific mass range that will result in on-orbit research.

The technologies in this subtopic are highly desirable because although adapters that could support most missions exist, having multiple systems across multiple launch vehicles fleets will contribute to higher integration costs. Standards amongst the s/c and adapter community will reduce integration cost and therefore the per-kilogram cost-to-orbit.

Areas of interest (SPSIT):

- Launch adapters and systems and associated spacecraft standards
- Standardized spacecraft and/or payload integration test flows, processes and qualification techniques
- Standardized electrical interfaces, sometimes known as plug and play electrical power and data bus standards for streamlined subsystem integration.

The critical requirement for all areas of interest identified above is that the design, integration or implementation
shall not increase base line risk to the primary spacecraft or the launch vehicle mission success. Implementation of the above enables support for any upcoming missions needing the capability to demonstrate new technology on-orbit by using a standard interface or process.

Phase I Deliverables (SPSIT):

- Assessments of current and future spacecraft/mission/space technologies in the mass ranges will identify current adapter systems, processes and determine the TRL for each system within 3 year timeframe from award date
- Develop draft standards for both spacecraft, adapter, integration process and avionics interfaces

At the completion of phase I, the goal is to have achieved a TRL 3 or better for the adapter systems and processes

Phase II Deliverables (SPSIT):

- Finalize standards within the mass range
- Complete adapter hardware designs
- "Plug-n-play" avionics standards hardware/software
- Conduct PDR and CDR of new technologies
- Finalize standards for the integration process

Higher TRL levels at the completion of Phase II will increase the likelihood of a path for infusion into NASA missions.

Entry and Ascent Experimental Platform Technologies

Current launch capabilities for aerodynamic and hypersonic research are limited to either high cost launches as a primary payload on a launch vehicle, or small packages (typical sounding rocket payload volume and mass ~ 10 ft³, 300 lbm). Sounding rockets that provide the technology testing capabilities are also limited in the altitude and the speeds they can achieve. Therefore, the conceptual design for a new platform is being sought to fill the technology-testing gap. For example, if the vehicle configuration had spare solid rocket motor capacity, this experimental platform could launch as a secondary payload, by occupying the location of a solid rocket motor on a launch vehicle such as the Atlas V or Delta IV.

The new experimental platform would provide expanded testing capabilities to accommodate payloads with larger (2-10 times) size and weight, obtaining greater altitudes and speeds than currently provided using sounding
rockets. The platform would provide an affordable way to demonstrate and test new technologies through hypersonic, intra-atmospheric, and reentry phases. The launch vehicle can be any vehicle used by NASA (currently, Pegasus XL, Taurus XL, Falcon 1, Falcon 9, Atlas V and Delta IV are on contract) and must be integrated onto the first stage of a vehicle per the areas of interest listed in Areas of interest section below.

Usage of this experimental platform could support development of a number of advanced technologies through flight-testing in representative environments, where their TRL could be validated and advanced. Such technologies could then be considered viable options for atmospheric entry and ascent technologies for governmental and commercial applications.

Technologies that could be tested in this experimental platform include but are not limited to:

- Thermal protection materials,
- Guidance, navigation and control,
- Vehicle configuration concepts for investigation of both ascent and entry designs for earth, lunar, and Mars space vehicles under supersonic and hypersonic conditions

Objective (EAEPT): Design a cost effective experimental platform with associated payload interface that minimizes the impact to the primary payload and launch vehicle's processing and certification for flight.

Areas of interest (EAEPT): NASA seeks platform designs incorporating the following characteristics:

- Ability to integrate with the launch vehicle late in the mission integration phase,
- Ability to fly a dummy payload(s) (in case the secondary payload does not meet the launch readiness date),
- Mo required mission unique interfaces with the launch vehicle (electrical, environmental control, etc.)
- Does not impose additional risk on the success of the primary mission
- Enables maximum use of the existing design and hardware (i.e., attach structures, case design) of the launch vehicle to minimize risk
- Has minimal impact to the vehicle external mold line and mass requirements, such that the aerodynamic flight environments, dynamic load environments, and thermal environments imposed are of similar or equivalent levels as compared to the vehicles as currently flown
- Is compatible with existing launch vehicle hardware
- Is compatible with current vehicle qualification environments
• Is compatible with vehicle mass requirements
• Facilitates manufacturing and production (support multiple and repeatable flights)
• Accommodates flight specific payload modifications.

Much of this information can be found on line on the Launch Provider's public websites:

• http://www.orbital.com/NewsInfo/Publications/Taurus_fact.pdf
• http://www.orbital.com/NewsInfo/Publications/TaurusII_fact.pdf
• http://www.spacex.com/Falcon1UsersGuide.pdf

Once awarded, NASA (LSP) will facilitate the development of a Non-Disclosure Agreement (NDA) between the small business and launch provider.

Phase I Deliverables (EAEPT):

A final report containing technology design concept(s) demonstrating technical feasibility including:

• Feasibility of concept
• A draft Systems Requirements Document (SRD)
• A detailed path towards Phase II level design maturity
• Detailed report presenting the results of Phase I analysis, modeling, etc.
• Expected TRL at end of Phase I is 3

Phase II Deliverables (EAEPT):
• Preliminary Design Review (PDR) and Critical Design Review (CDR) of the aforementioned platform for use on one of the existing ELVs within NASA's fleet

• Expected TRL at end of Phase II is 5