Heliophysics TechDemo Mission of Opportunity

The Heliophysics TechDemo MO is a new approach to improve technological readiness for future HelioPhysics Division (HPD) flight programs. Reduced technology risk in Phase A of future missions can reduce overall cost and/or encourage more innovative mission concepts.

1. The Heliophysics Technology Demonstration PEA (Program Element Appendix) solicits Small Complete Mission (SCM) proposals for spaceflight demonstration of innovative medium Technical Readiness Level (mid-TRL) technologies that enable significant advances in NASA's Heliophysics Scientific Objectives and Goals.

2. Proposal merit in this PEA will be determined by the magnitude of heliophysics science advancements enabled by the proposed TechDemo investigation.

3. The timeframe to initiate a future mission achieving the science advancements enabled by the TechDemo investigation must plausibly be expected during the next 15 years.

4. This is an open solicitation in the sense that no specific technology is targeted.

   The evaluation criteria for proposal merit (#2 above) will typically result in a science lead for a responsive proposal, teamed with one or more technology providers (external or internal to the lead institution).

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The purpose of the Industry Day is to facilitate teaming arrangements. There is no *a priori* preference by NASA for teaming arrangements involving the providers presenting today.

Since this opportunity focuses on technology development, it will be critical that proposers and technology providers assess TRLs in accordance with NASA Systems Engineering Processes and Requirements NPR 7123.1B, which is available in the Program Library.

- In this PEA, NASA technologies will **not** be offered as GFE
- All technologies presented today may be proposed via **teaming arrangements** between technologists and PI-led teams
- It is the responsibility of the PI to evaluate the TRL of the proposed investigation. NASA does not guarantee the TRL of any technology presented today.
- PEA requirement is to mature systems, at WBS 3, that include new technologies to TRL 5 by PDR
  - *Back-up plans for technologies are **not** required (Section 2.2 of PEA)*
- TRL definitions can be found in NASA Systems Engineering Processes and Requirements (7123.1B) Appendix E, found in the Program Library:

TRL	Definition	Hardware Description	Software Description	Exit Criteria
1	Basic principles observed and reported	Scientific knowledge generated underpinning hardware technology concepts/applications.	Scientific knowledge generated underpinning basic properties of software architecture and mathematical formulation.	Peer reviewed publication of research underlying the proposed concept/application.
2	Technology concept and/or application formulated	Invention begins, practical applications is identified but is speculative, no experimental proof or detailed analysis is available to support the conjecture.	Practical application is identified but is speculative; no experimental proof or detailed analysis is available to support the conjecture. Basic properties of algorithms, representations, and concepts defined. Basic principles coded. Experiments performed with synthetic data.	Documented description of the application/concept that addresses feasibility and benefit.
3	Analytical and experimental critical function and/or characteristic proof-of- concept	Analytical studies place the technology in an appropriate context and laboratory demonstrations, modeling and simulation validate analytical prediction.	Development of limited functionality to validate critical properties and predictions using non-integrated software components.	Documented analytical/experimental results validating predictions of key parameters.
4	Component and/or breadboard validation in laboratory environment.	A low fidelity system/component breadboard is built and operated to demonstrate basic functionality and critical test environments, and associated performance predictions are defined relative to final operating environment.	Key, functionality critical software components are integrated and functionally validated to establish interoperability and begin architecture development. Relevant environments defined and performance in the environment predicted.	Documented test performance demonstrating agreement with analytical predictions. Documented definition of relevant environment.
5	Component and/or breadboard validation in relevant environment.	A medium fidelity system/component brassboard is built and operated to demonstrate overall performance in a simulated operational environment with realistic support elements that demonstrate overall performance in critical areas. Performance predictions are made for subsequent development phases.	End-to-end software elements implemented and interfaced with existing systems/simulations conforming to target environment. End-to-end software system tested in relevant environment, meeting predicted performance. Operational environment performance predicted. Prototype implementations developed.	Documented test performance demonstrating agreement with analytical predictions. Documented definition of scaling requirements.
6	System/sub-system model or prototype demonstration in a relevant environment.	A high fidelity system/component prototype that adequately addresses all critical scaling issues is built and operated in a relevant environment to demonstrate operations under critical environmental conditions.	Prototype implementations of the software demonstrated on full-scale, realistic problems. Partially integrated with existing hardware/software systems. Limited documentation available. Engineering feasibility fully demonstrated.	Documented test performance demonstrating agreement with analytical predictions.
7	System prototype demonstration in an operational environment.	A high fidelity engineering unit that adequately addresses all critical scaling issues is built and operated in a relevant environment to demonstrate performance in the actual operational environment and platform (ground, airborne, or space).	Prototype software exists having all key functionality available for demonstration and test. Well integrated with operational hardware/software systems demonstrating operational feasibility. Most software bugs removed. Limited documentation available.	Documented test performance demonstrating agreement with analytical predictions.
8	Actual system completed and "flight qualified" through test and demonstration.	The final product in its final configuration is successfully demonstrated through test and analysis for its intended operational environment and platform (ground, airborne, or space).	All software has been thoroughly debugged and fully integrated with all operational hardware and software systems. All user documentation, training documentation, and maintenance documentation completed. All functionality successfully demonstrated in simulated operational scenarios. Verification and validation completed.	Documented test performance verifying analytical predictions.
9	Actual system flight proven through successful mission operations.	All software has been thoroughly debugged and fully integrated with all operational hardware and software systems. All documentation has been completed. Sustaining software support is in place. System has been successfully operated in the operational environment.	All software has been thoroughly debugged and fully integrated with all operational hardware and software systems. All documentation has been completed. Sustaining software support is in place. System has been successfully operated in the operational environment.	Documented mission operational results.

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- For TRL assessment refer to the Systems Engineering Handbook, found in the Program Library
- Systems are defined as either level 3 WBS payload development or level 3 WBS spacecraft element, depending on whether they are individual instruments or spacecraft sub-systems [Refer to Figure 3-7 of NASA WBS Handbook (NASA/SP-2010-3403), found in Program Library:

Partial Project WBS Element Tree Diagram

(Recommended WBS Development Practices Highlighted)

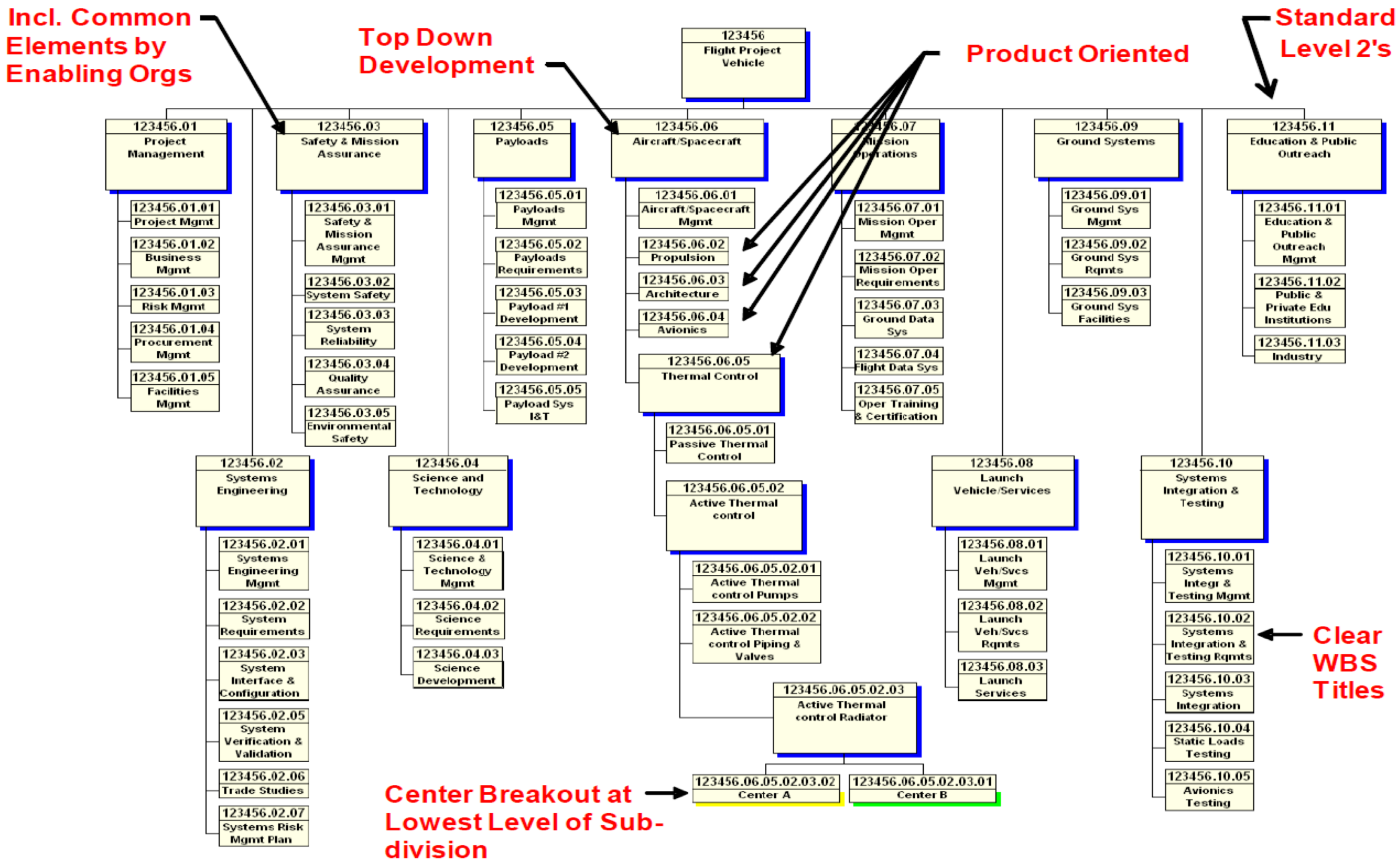

Figure 3-7: Partial WBS Tree Diagram Illustrating Recommended Practices

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Welcome	2018 Heliophysics Technology Demonstration Mission of Opportunity	R. Hakimzadeh	10:00-10:15
Solar Sail Propulsion	HIPERSail: High-Performance Small Spacecraft Solar Sail System	K. Wilkie	10:15-10:45
	Solar Sail Propulsion System	L. Johnson	10:45-11:05
Communications and Power	Optical Precision Time-transfer Instrument (OPTI)	J. Conklin	11:05-11:25
	CubeSat Laser Infrared Crosslink (CLICK) Mission	K. Cahoy	11:25-11:55
	The Lightweight Integrated Solar Array and Transceiver (LISA-T)	J. Carr	11:55-12:15
	A LEO-Based Hybrid RF-Optical Data Relay Network	J. Oliveira	12:15-12:35
Impulse Propulsion	Plasma Propulsion Systems, Ion Propulsion System, and Electrospray Reaction Control System	P. Hruby	12:35-13:05
	Micro Satellite Solar Electric Propulsion	M. VanWoerkom	13:05-13:35