NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)
HEADQUARTERS

SPACE TECHNOLOGY MISSION DIRECTORATE

300 E Street, SW

Washington, DC 20546-0001

SMALL SPACECRAFT TECHNOLOGY PROGRAM

UNIVERSITY SMALLSAT TECHNOLOGY PARTNERSHIPS (USTP) APPENDIX

to

NASA Research Announcement (NRA):

Space Technology Research, Development, Demonstration, and Infusion-2023 (SpaceTech-REDDI-2023), 80HQTR23NOA01

APPENDIX NUMBER: 80HQTR23NOA01-23USTP-S1

Appendix Issued: April 25, 2023

Mandatory Preliminary Proposal Due: May 16, 2023, 5:00 pm Eastern Time (ET)

Full Proposal Due: July 18, 2023 5:00 pm Eastern Time (ET)

NASA Assistance Listing Number 43.012

OMB Approval Number 2700-0092

Offerors are Reminded:

Per Section 4.3.1 of the umbrella NRA solicitation 80HQTR23NOA01 and the requirements of this Appendix, all proposals submitted via email or any means other than the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) will not be accepted. Additionally, this section states:

"All proposals submitted in response to this solicitation must be submitted in electronic form by the AOR [Authorized Organizational Representative] at the proposing PI's [principal investigator's] organization who is authorized, and identified within NSPIRES with this role, to make such a submission; electronic submission of the proposal by the AOR serves as the required original signature by an authorized official of the proposing organization. No hard copy of the proposal will be accepted. Proposals submitted via email or any means other than NSPIRES . . . will not be accepted . . .

The proposal submission process is complex and involves multiple steps to be carried out by all participants in the proposal. Therefore, proposers are strongly encouraged to familiarize themselves with the system and begin the submittal process early, well in advance of the deadline. While every effort is made to ensure the reliability and accessibility of submission systems and to provide a help center via email and telephone, difficulties may arise at any point, including the user's own equipment."

Difficulty in registering or using the NSPIRES proposal submission system is not a sufficient reason for NASA to consider a proposal submitted after the deadline. ***Proposals received after the deadline will not be reviewed.***

NASA support service contractors may have access to the Mandatory Preliminary Proposal, Full Proposal, and subsequent proposal information. Information received in response to this solicitation that is marked 'Proprietary' will be handled and protected accordingly. NASA support service contractors are obligated to protect third-party proprietary information. By submitting a proposal the responder is deemed to have consented to release of proprietary information to such NASA support service contractors.

NOTE: To ensure receipt of all NSPIRES email notifications, it is recommended that offerors add "nasaprs.com" to the "never block" or "safe senders" domain list in their email client.

SUMMARY OF KEY INFORMATION

Appendix Name: “University Smallsat Technology Partnerships (USTP)”, hereafter called “Appendix” to the SpaceTech-REDDI-2023 umbrella NRA, hereafter called “NRA”.

Goal/Intent: This Appendix supports the development and/or demonstration of new technologies and capabilities for small spacecraft by U.S. colleges and universities in collaboration with NASA through award of Cooperative Agreements. Projects may be for ground-based technology development or development of spacecraft or payloads for suborbital, balloon or orbital space flight technology demonstrations.

Eligibility for Submitting a Proposal: Eligibility is limited to U.S. college and university teams, including faculty, undergraduate and/or graduate students. The Principal Investigator (PI) submitting a proposal and leading a university team shall be affiliated with a U.S. college or university (including community colleges), accredited in and having a campus located in the U.S.

Partnering between the university team and a NASA center or Jet Propulsion Laboratory (JPL) is required in all funded USTP projects. The NASA team member must be either a civil servant or a member of the technical staff from JPL. NASA contractors (except for JPL employees) may not be funded partners or collaborators on USTP projects.

Each proposal submitted for this Appendix must specify a single Technology Topic Area. An individual is limited to being the PI on a single proposal. A team member, including any individual who is the PI on another proposal, may be a team member on more than one proposal. Proposing U.S. colleges or universities or NASA centers may submit more than one proposal, provided that, if selected, the offeror can carry out all proposed efforts.

Key Dates:

Appendix Issued:	April 25, 2023
Mandatory Preliminary Proposals Due:	May 16, 2023, 5:00 pm ET
Mandatory Preliminary Proposal Downselect Date:	June 9, 2023 (TARGET)
Full Proposals Due:	July 18, 2023, 5:00 pm ET
Selections Announcement:	August 11, 2023 (TARGET)
Awards Issued:	September 11, 2023 (TARGET)

Proposal Submission & Selection Process: Competitive proposals with independent peer reviews using a two-step process:

- Mandatory Preliminary Proposals (MPP) must be completed by all proposers
- Full Proposals will be by invitation only, based on the MPP review

Proposers must use NSPIRES (https://nspires.nasaprs.com) and conform to the requirements of the NRA and this Appendix. Late submittals will not be accepted.

The selection process involves independent peer reviews, programmatic considerations, and review by NASA officials.

Technology Readiness Level (TRL): At the time of the MPP submission, the technology shall be at system-level TRL 3 or higher and no more than 5. Advancement of at least two TRL levels is expected by the end of the period of performance. Advancement to at least system-level TRL 6 is desired and greater weight will be given to a technology that reasonably aims to achieve such a status in its proposed work plan by means of the assembly of a system prototype or 'protoflight' system, and/or ground testing in a relevant environment (such as the performance of Thermal Vacuum or Sinusoidal Sweep Vibration testing per NASA General Environmental Verification Standard (GEVS) for space-bound technologies, as applicable). TRL definitions can be found in Attachment 2 of the NRA, with the overall TRL of the system determined by the TRL of the lowest TRL subsystem.

Award Details:

Award Type: Cooperative Agreements will be issued to the selected college or university partner and will be between NASA and the primary proposing U.S. college or university. Cost-sharing is not required. NASA will fund the NASA center or JPL team member separately.

Award Duration: Maximum period of performance of the basic USTP Cooperative Agreement is two years, with continuation to the second year contingent on progress achieved during the first year and the availability of funds. Additional details may be found in Section 2.1 of the Appendix.

The Small Spacecraft Technology (SST) program may approve requests within a limited time period of the USTP effort for a funded extension of the basic USTP Cooperative Agreement to cover specific activities in support of a technology demonstration flight, if the USTP project is selected for subsequent launch through the CubeSat Launch Initiative (CSLI) or the Flight Opportunities (FO) program, or other opportunity the project may have worked out on its own (contingent upon respecting all applicable U.S laws and SST guidelines) or in coordination with the SST program. The funded

extension may extend the Cooperative Agreement up to an additional 12 months (subject to qualifying conditions described in Section 1.5 below).

Anticipated Number of Awards: Approximately 8 awards total across all Technology Topic Areas. NASA reserves the right to alter the number of awards based on funding availability and quality of proposals received in response to this Appendix.

Anticipated Award Amounts: Maximum of $225,000 each year for up to two years ($450,000 maximum) per award. In addition, a NASA civil servant or JPL employee labor allocation of up to 0.5 full-time equivalent (FTE) per award, per year will be available to support NASA partner(s) involvement. Proposal teams can also request up to $30,000 of procurement funding for the NASA partner(s) to cover NASA expenses in the collaboration. This procurement funding may be used by the NASA partner(s) to purchase hardware or for use of NASA test facilities that support the partnership. Subject to approval, USTP projects that are selected for a subsequent flight demonstration through CSLI or FO or other means may receive supplemental funds, through a funded extension of the basic Cooperative Agreement, to support the launch as described in Section 1.5 below. NASA reserves the right to negotiate the scope and magnitude of the proposed effort, cost/price terms, and any other terms, as appropriate with selected offerors.

Selection Official: The Selection Official will be the Space Technology Mission Directorate (STMD) Associate Administrator or designee.

Point of Contact: Christopher Baker, Program Executive, Small Spacecraft Technology (SST) and Flight Opportunities (FO) programs

Space Technology Mission Directorate, NASA Headquarters, HQ-STMD-SST-Partnerships@nasaprs.com

Questions and Comments: Questions pertaining to this appendix should be submitted via email to the Point of Contact, Christopher Baker, HQ-STMD-SST-Partnerships@nasaprs.com no later than later than May 4, 2023 (5:00 pm Eastern). Questions of a general nature will be added to the FAQs for this Appendix and posted on NSPIRES. Please refer to the NSPIRES site for FAQ updates.

General References and Resources Available related to this Appendix can be found in Section 9 of this document.

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Small Spacecraft Technology Program
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1. SOLICITED RESEARCH/TECHNOLOGY DESCRIPTION

1.1 Introduction/Overview

The U.S. Space Priorities Framework directs the National Aeronautics and Space Administration (NASA) to lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities, as well as help address the challenges of climate change here on Earth. Beginning with missions in low-Earth orbit and beyond, the United States will lead the return of humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations.

The mission of the NASA Space Technology Mission Directorate (STMD) is to rapidly develop, demonstrate, and transfer revolutionary, high-payoff space technologies driven by diverse ideas to transform NASA missions and ensure American global leadership in space technology. STMD achieves this, in part, by stimulating the commercial space industry and academia through collaborative partnerships that foster the development of technologies and capabilities needed for future missions for NASA, commercial, and government sectors. STMD employs a merit-based competition model with a portfolio approach spanning a range of technical discipline areas and technology and market readiness levels.

The Small Spacecraft Technology (SST) program within STMD is chartered to expand the ability to execute unique missions through rapid development and demonstration of capabilities for small spacecraft applicable to exploration, science and the commercial space sector. To that end, the SST program seeks to:

- Enable the execution of missions at much lower cost than previously possible.
- Substantially reduce the time required for development of spacecraft, from authority to proceed until initial launch capability.
- Enable and demonstrate new mission architectures that small spacecraft are uniquely suited for.
- Expand the capability of small spacecraft to execute missions at new destinations and in challenging new environments.
- Enable the augmentation of existing assets and future missions with supporting small spacecraft.

For this solicitation, the SST program, in cooperation with the Flight Opportunities (FO) program, seeks the development of projects and demonstration missions that are small, affordable, rapid, and transformative. All efforts will focus on small spacecraft capabilities that are relevant to NASA's missions in science and exploration, including those with crosscutting applications to the needs of the broader small spacecraft

community in industry, academia, and other government agencies. See Section 9 for more information on STMD and its various programs, including the SST and FO programs.

Definition of Small Spacecraft

For the purpose of this Appendix, small spacecraft are defined as those with a mass of 180 kg or less and capable of being launched into space as an auxiliary or secondary payload. Although the term “Smallsats” is used as a synonym, small spacecraft are not limited to Earth orbiting satellites, but might also include interplanetary spacecraft, planetary re-entry vehicles, and landing craft.

1.2 Appendix Goals and Objectives

This USTP Appendix issued by the SST program, in cooperation with the FO program, aims to:

- Engage the unique talents and fresh perspectives of the university community to develop new technologies and capabilities for small spacecraft.
- Share NASA experience and expertise in relevant university projects.
- Increase support to university efforts in small spacecraft technology through funding and collaboration with NASA, to foster a new generation of innovators for NASA and the nation.
- Engage NASA personnel across the agency in the rapid, agile, and cost-conscious small spacecraft development approaches that have evolved in the university community.

The goals of this Appendix include collaboration with university teams that have experience in small spacecraft development and the extension of support to colleges and universities that have little or no previous involvement in this field. Colleges and universities with experience in small spacecraft development are encouraged to team with other college and universities to address these dual goals.

1.3 NASA Partnership Requirements

Collaboration with a NASA Center or NASA’s JPL is a requirement for this Appendix. College and university teams are required to coordinate with a NASA Center or JPL during the proposal development phase and to establish a collaborative partnership arrangement with NASA or JPL prior to the submission of their Final Proposal (for the Mandatory Preliminary Proposal the NASA partner(s) may be listed as To Be Determined (TBD) if they haven’t been identified or confirmed yet). Proposers may involve multiple NASA Centers/JPL and multiple NASA partners. In order to develop a partnership, university teams preparing proposals should contact NASA personnel through the points of contact listed below. Areas of expertise for each NASA Center and JPL are listed along with the points of contact.

NASA Center Points of Contact

Center	Contact	Expertise
Ames Research Center (ARC) Moffett Field, CA	Scott Richey scott.richey@nasa.gov 650.963.6223	Ames has decades of experience in developing and operating cutting-edge technology for small spacecraft in near-Earth and cislunar environments. Areas of expertise are focused on aero-sciences, robotics, autonomy, intelligent systems, instrument development, payload integration, environmental testing, flight dynamics, and small spacecraft design and operations.
Armstrong Flight Research Center (AFRC) Edwards, CA	Danielle McCulloch danielle.mcculloch@nasa.gov 661.303.4425	Armstrong has expertise in aeronautics; dynamics and controls; aerostructures; instrumentation; autonomy; and flight test across aeronautic, suborbital, and orbital platforms.
Glenn Research Center (GRC) *(including Neil A. Armstrong Test Facility)* Cleveland, OH	Tim Smith timothy.d.smith@nasa.gov 216.409.8477	Glenn has expertise in areas that include power technology, electric propulsion systems, and cryogenic fluid systems.
Goddard Space Flight Center (GSFC) *(including Wallops Flight Facility (WFF) and Katherine Johnson Independent Verification and Validation (IV&V) Facility)* Greenbelt, MD	Luis H. Santos Soto Luis.H.Santos@nasa.gov 240.419.7574	Goddard has smallsat expertise including but not limited to avionics, software, AI/ML, communications, navigation, control, thermal, and scientific instrumentation.
Jet Propulsion Laboratory (JPL) Pasadena, CA	Andrew Gray andrew.a.gray@jpl.nasa.gov 818.354.0128	JPL has expertise in areas that include communications and navigation, robotics, avionics technology, and instrument development.
Johnson Space Center (JSC) *(including White Sands Test Facility (WSTF))* Houston, TX	Linda Ham linda.j.ham@nasa.gov 281.483.6881	Johnson has expertise in areas that include crewed systems, in-situ resource utilization technology, and robotics.

Kennedy Space Center (KSC) Kennedy Space Center, FL	Jose Nunez jose.l.nunez@nasa.gov 321.867.5922	Kennedy has expertise in areas that include ground systems, launch services, and payload processing.
Langley Research Center (LaRC) Hampton, VA	Chris Giersch christopher.e.giersch@nasa.gov 757.864.6590 William “Chris” Edwards william.c.edwards@nasa.gov 757.864.1555	Langley has expertise in areas that include aerosciences, entry descent and landing, vehicle structures and materials technology, instrument development, and a full smallsat integration and test capability.
Marshall Space Flight Center (MSFC) *(including Michoud Assembly Facility (MAF))* Huntsville, AL	John Carr john.a.carr@nasa.gov 256.763.2043	Marshall has core expertise in areas that include chemical propulsion, advanced manufacturing, cryogenic fluid systems, instrument development, thermal control systems, gossamer structurers for propulsion, power, and comm, space environmental effects testing and more.
Stennis Space Center (SSC) Stennis Space Center, MS	Anne Peek anne.h.peek@nasa.gov 228.342.5057	Stennis has expertise in areas that include rocket propulsion testing and autonomous systems.

For additional information, the following website lists all of the NASA Centers and provides links to individual websites for each center that describe the work that they do: http://www.nasa.gov/about/sites/index.html

The NASA team member(s) must be either a civil servant or a member(s) of the technical staff from JPL. NASA contractors (except for JPL employees) may not be funded partners or collaborators on USTP projects.

Establishing a partnership with NASA or JPL collaborators is the responsibility of the university proposer. Teams that fail to establish a partnership will not receive a Cooperative Agreement award. Commitments made by NASA or JPL as part of proposal preparation shall only be valid if the proposal is selected and a Cooperative Agreement is established.

NASA Centers and JPL may exercise their own discretion in considering potential partnerships based on the level of interest and availability of appropriate expertise at their center. NASA Centers and JPL may limit their proposed collaborations to technical fields for which their center has specific experience, expertise, and future interest and to topic areas that are consistent with their center’s core competencies.

Responsibilities and commitments of the NASA or JPL partner shall be clearly indicated in the proposal, including: specific project milestones, deliverable end-items, services to be performed (such as analysis, test, etc.), provision of government-furnished equipment, or provision of government-operated facilities (such as test labs).

NASA commitments/responsibilities are finalized after selection, through issuance of a Cooperative Agreement.

Since the prospective NASA and JPL partners will need time to coordinate approval and obtain the required statements of commitment and support, university proposers should contact them as early as possible during the proposal process.

NASA Commitment Agreements (Required for Full Proposal)

For Full Proposals submitted via NSPIRES, a NASA collaborator acknowledges his/her intended participation in the proposed effort by identifying himself/herself as a participant on the proposal's cover page (they may also do so for the MPP). Digitally signing off in NSPIRES indicates acceptance of this role and is a preliminary commitment by the Center to collaborate in the proposed effort. NASA employees should coordinate with their management prior to making a commitment to collaborate (management signature is not required). No further statement or letter of commitment is required when submitting via NSPIRES.

1.4 Target Operational Domains and Technology Topic Areas

Small spacecraft are assuming increasingly important functions throughout the space industry, from enabling, supporting, and performing science and deep space exploration, to providing space situational awareness and national security-oriented capabilities, as well as an increasing range of services to people on Earth for greater economic growth and societal benefit.

Within the Cislunar and Deep Space domain, small spacecraft are expected to be more extensively used in the development of supporting infrastructure – such as communications relays and position, navigation and time beacons – and in acting as precursors for human exploration – such as resource prospectors and landing site surveyors, as well as enabling new science.

Within the Earth orbital domain, small spacecraft already represent a more than $4 billion economy as of 2023 – forecasted to triple in size by the end of the decade – spanning commercial, military, scientific and other civil endeavors, and are expected to play a key role in addressing the challenges of climate change.

Several new capabilities are needed for small spacecraft to reach their full potential in support of all these functions and mission types, which this USTP solicitation aims to address. To be eligible for this solicitation proposing teams will need to address six key items, summarized below, and described in further detail in Sections 4.1 and 4.2 for the respective MPP and Full Proposals:

- Describe a specific capability or service needed for either one of the two Target Operational Domains (see Section 1.4.1), identifying which one is the primary one for the proposal. The capability should be an extension or represent an improvement over the performance of missions that NASA or industry already

plan to execute by 2025 for the primary domain. Explain how small spacecraft – or cooperative groups of small spacecraft – can offer a unique, cost-effective solution for the identified capability or service. Execution of the mission is not considered part of the proposed effort but the needed mission capabilities serve to gauge technology gaps and advancements to performance measures proposed.

- Identify one of the Technology Topic Areas from the list (see Section 1.4.2) where the state-of-the-art (as projected for the 2023-2025 timeframe) will prevent/inhibit small spacecraft from achieving the previously described solution. Specify an advancement of that technology – your proposed technology – that will contribute to enabling small spacecraft successfully accomplishing the mission. Contrast the advancement with the state-of-the-art, with this difference identified as the “technology gap”.
- Describe the alignment of the technology with the Technology Topic Area, linking the proposed effort with the goals and objectives of that topic.
- Propose a two-year development effort within the constraints of the allowable budget (see Section 2.1) that will lead to a solution that will fill the identified technology gap.
- Identify target form factor (e.g., 1U, ESPA-class) and approximate expected end-dimensions if not clear from the graphic(s), as well as applicability/scalability potential to other form factors.
- Identify whether the technology is also applicable/extensible to the secondary Target Operational Domain, and the context in which it is.

It follows that for use with small spacecraft, these technologies must be made compatible with the inherent size, weight, power, and cost constraints of these platforms (see Section 1.1 for the definition of what consists small spacecraft for this solicitation). See the document link in Section 9 for the NASA Small Spacecraft Systems Virtual Institute (S3VI)’s State-of-the-Art of Small Spacecraft Technology Report 2022 for a current view of the State-of-the-Art (SoA) of various small spacecraft technologies.

The following are not within the scope of this Appendix: science investigations, operational science missions and conceptual design projects. Appropriate technologies for the topics in this Appendix must have a starting system-level TRL of at least 3 and no more than 5 at the time of the MPP submission. Advancement of at least two TRL levels is expected by the end of the period of performance. Advancement to at least system-level TRL 6 is desired and greater weight will be given to a technology that reasonably aims to achieve such a status in its proposed work plan by means of the assembly of a system prototype or ‘protoflight’ system, and/or ground testing in a relevant environment (such as the performance of Thermal Vacuum or Sinusoidal Sweep Vibration testing per NASA General Environmental Verification Standard (GEVS) for space-bound technologies, as applicable). TRL definitions can be found in Attachment 2 of the NRA, with the overall TRL of the system determined by the TRL of the lowest TRL subsystem.

1.4.1 Target Operational Domains

Target Operational Domain A: Enabling Cislunar and Deep Space Exploration with Small Spacecraft

Small spacecraft are expected to play an enabling role in cislunar and deep space exploration. As outlined in NASA's Small Spacecraft Strategic Plan "sustainable human activity in deep space requires exploration capabilities that can be fielded faster and at lower cost" with "Small spacecraft afford[ing] an increasingly capable platform to precede and accompany human explorers to the Moon, Mars, and other destinations to scout terrain, characterize the environment, identify risks, and prospect for resources. Distributed systems of small spacecraft can responsively provide cost-effective communications, monitoring, and inspection of infrastructure for human exploration missions and cis-lunar commercial activity." This is further reinforced by NASA's 2022 Strategic Plan which aims to "extend human presence to the Moon and on towards Mars for sustainable long-term exploration, development, and utilization" and the White House's 2021 United States Priorities Framework that states that "the United States will remain a global leader in science and engineering by pioneering space research and technology that propels exploration of the Moon, Mars, and beyond." Of particular importance is cislunar exploration and the "development of new cislunar technologies" and "support[ing] research and development to enable long-term growth in Cislunar space" per the White House National Science & Technology Council's November 2022 National Cislunar Science & Technology Strategy.

Target Operational Domain B: Improving the Performance and Resiliency of Future Civil and Commercial Small Spacecraft in Earth Orbit

Small spacecraft are expected to play an increasingly important role within Earth's orbital domain, with particular importance in improving the performance and resiliency of future assets, for what is an increasingly competitive and contested environment. NASA's Small Spacecraft Strategic Plan specifically calls out support for small spacecraft-enabled "high priority innovative science" in Earth orbit, and for "disruptive technology innovation" through "collaborat[ion] on emerging commercial small spacecraft and systems to reduce risk on NASA missions" and "partner[ing] with industry and academia to aggressively adapt innovative emerging technology capabilities to meet NASA's unique small spacecraft needs". This is reinforced by NASA's 2022 Strategic Plan which aims to "catalyze economic growth and drive innovation to address national challenges" by means of "innovat[ing] and advanc[ing] transformational space technologies". Lastly the White House's 2021 United States Priorities Framework specifically calls for "enhanc[ing] the […] resilience of space systems that provide or support U.S. critical infrastructure from malicious activities and natural hazards" and "advance the development and use of space-based Earth observation capabilities that support action on climate change".

Links to national space priorities, strategic frameworks, and plans mentioned in the prior sections and pertinent to this Appendix can be found in Section 9.

1.4.2 Technology Topic Areas

<u>Topic 1</u>: Earth- and Global Navigation Satellite System-Independent Position Navigation and Timing for Small Spacecraft

Further expansion of small spacecraft usage into deep space will require highly accurate position knowledge and precision timing that does not depend on Global Navigation Satellite Systems (GNSS) – such as the United States' Global Positioning System (GPS) – or other Earth-centric aids. Exploration missions that involve multiple elements, distributed mission architectures that may involve tens to hundreds of spacecraft, and the general expansion of the number of cislunar and deep space missions will significantly stress or exceed the current capacity of the Deep Space Network (DSN). Furthermore, access to DSN ranging and similar assets may not be available for multiple concurrent missions, be blocked by terrain for surface operations, or unavailable through challenging environments or circumstances, and/or limited by communications and power limitations for smaller missions.

As such, future small spacecraft missions will need to autonomously determine and transmit relative and absolute orbital states as well as maintain and exchange precise timing. These capabilities are required for small spacecraft to act as infrastructure for other missions, for distributed missions comprised of small spacecraft, and for standalone small spacecraft missions beyond Earth. Navigation technologies and techniques may include inertial navigation combined with enhanced visual navigation capabilities (e.g., dual use of star tracking instruments for relative navigation using surface features or other nearby spacecraft), X-ray emissions (from pulsars), and laser range finding with other spacecraft or surface landmarks. Onboard image and data processing would also likely be required to allow for autonomous navigation. In addition, developments in quantum and photonic sensors and technologies (such as inertial measurement units, magnetometers, gravimeters, or clocks) may make it possible to sense physical phenomena effects presented by atoms, electrons, and photons, to allow for greater precision, smaller sized packages, and/or lower cost. At planetary destinations, small spacecraft could provide relative ranging or triangulation to aid surface navigation, in concert with other available signals of opportunity and landed beacons. Increasingly autonomous navigation capabilities may also enable landing and possibly aerial vehicle operation in areas lacking GNSS-like and/or magnetic compasses.

Precise timekeeping and timing exchange is not only required for navigation but is fundamental to science data collection. Internetworked small spacecraft can help synchronize timing across multiple mission assets using an external timing source. Improvements in chip scale atomic clocks that can be carried by the small spacecraft themselves can augment this capability to reduce the accumulation of errors over time

or serve as the primary clock when other larger but more accurate references sources are not available, or access is not feasible. Cislunar Positioning, Navigation, and Timing (PNT) capabilities should also be made scalable and interoperable as specifically called out within the White House's National Cislunar Science & Technology Strategy.

In the Earth orbital domain, similar applications and needs are required but assets also having to contend with malicious adversarial denial, degradation, interference, deception, or corruption of GNSS signals (e.g., through jamming, spoofing, or possibly even outright destruction of such infrastructure), and need to be made resilient to such threats. Increased performance of existing Earth/GNSS-independent PNT systems may also open up new commercial and scientific opportunities through complementarity and augmentation of such systems, and/or enabling precise, reliable, and resilient PNT beyond the Medium Earth Orbits (MEO)-based GNSS systems. For instance, MEO orbits may enable better observation of Earth's polar regions than typically used LEO, GEO and Molnyia orbits with a better persistence, latency, and radiation-exposure combination – polar regions playing a key role in global weather patterns and climate change. They may enable also better science with more precise timing, as well as when spun-off to ground applications, enable more precise ground-truthing when in line-of-sight with satellites. Such technologies may also make use of Earth-based phenomena (e.g., magnetic fields, gravity, etc.), or comprehensive databases (such as terrain databases) that may not be readily available for deep space and cislunar applications.

<u>Topic 2</u>: Edge Computing and Machine-Learning Architectures, Software, Platforms, and Devices for Small Spacecraft

As small spacecraft have become increasingly capable and used in critical functions across various mission profiles there has been an increasing need for onboard high-performance processing to be able to store and process the increasingly large amounts of data generated by sensors, some of which exceed the bandwidth of available data return links. Of particular importance are "Edge Computing" architectures, which enable the computation of data into more meaningful sets locally – close to their originating source, typically in near-real time – for increased performance, enhanced capabilities where information is integrated/collated from different datasets, improved system response times, and/or bandwidth savings. At the "exploration edge" they may allow for more autonomous systems for when communications with Earth may be limited, unavailable for extended periods of time, and/or involve significant delays. At the "commercial" or "scientific edge" they may allow for more relevant information to be transmitted faster to the end-user, and near-real time observation or response to events without the ground in the loop. At the "tactical edge" they may allow for greater resiliency of systems in a contested environment, and ensure successful secure delivery of the necessary information to end users through autonomous reconfiguration and re-routing of data across the available network(s).

Likely key to these architectures are Machine Learning (ML) tools and platforms that can be used to enable autonomous systems to adapt to changing environments and conditions without explicit re-programming, using knowledge collected from the past or

from other systems' experiences and sources, as well as an ability to interpret and reduce/combine/collate data into more meaningful actionable information. To support many NASA scientific, civil and commercial mission Design Reference Missions (DRMs), there is a need for the development of ML methods and models that can effectively utilize lower volume datasets and be trained in-situ, and can be run on space-rated computing platforms (rad-hard or rad-tolerant). Space applications are uniquely challenging for ML due to: (1) existing state-of-the-art ML requires large training datasets and models that are not available for new space destinations; (2) terrestrial models and data are not necessarily representative of space targets; (3) data across assets and missions requires human intervention for calibration/co-registration in order to be usable; (4) current onboard computers are limited in computing performance, lagging behind Earth-based systems.

As such, Edge Computing architectures and Machine Learning processor devices are needed to accelerate onboard autonomy applications, with sufficient performance, radiation tolerance, and reliability to enable onboard autonomy for long duration missions in harsh environments. Functions that could be supported include: environmental 3D mapping, pose estimation, hazard assessment, motion planning and execution, scientific target identification, activity/resource management, system health and fault management/tolerance, etc. DRMs that could be considered include: autonomous commercial or scientific missions, such as an asteroid rendezvous and characterization mission; intravehicular robotics; in-situ resource utilization; entry, descent and landing on planetary bodies; on-orbit servicing; or in-space manufacturing, assembly, and reconfiguration applications.

It is expected that task planning and execution software will enable autonomous systems (crew, robots, spacecraft) with limited communication to the Earth to complete longer duration and more complex mission tasks. Current SoA task planning software is capable of searching for valid sequences of actions required to achieve a goal specification while respecting constraints for scenarios with a limited number of objects and constraints, as well as simple optimization to minimize time or resource use. However, existing SoA algorithms are too slow and lack the capability to handle problems of practical complexity for space applications. Significant development is required to extend and adapt academic proof-of-concept task planning software for space use, especially in the areas of plan execution reliability (ability to recover from failures), integration of perception with planning (world modelling and interpretation) and reducing the computational cost of planning (using heuristics, etc.). Other desired capabilities include: algorithms for online replanning (or plan repair) in case of changing conditions or failures, development of interfaces for autonomous systems (vehicles, robots, power systems, etc.).

With respect to cislunar exploration, specific interest exists with respect to applications that would enable greater space situational awareness within cislunar space, including coordination and data-exchange of networks of diverse sensors, as outlined in the White House's National Cislunar Science & Technology Strategy. In the Earth orbital domain, of particular interest are applications that enable more responsive systems to unplanned events with reduced reliance on human-in-the-loop interaction, in particular

with respect to climate change and disaster management, and which could subsequently be infused into commercial or NASA Earth observation missions. For example, technologies that can reliably autonomously detect and interpret events or objects of interest, such as a forest fires; communicate relevant data to other orbital, airborne, or ground-based assets; optimize the data collection across the multiplatform system with reduced reliance on the ground; and be resilient to intermittent or loss of contact with such assets.

Topic 3: High Specific Power Systems and Thermal Control for Small Spacecraft

Small spacecraft platforms impose area and volume constraints on deployable power generation systems and power storage systems, which are oftentimes more challenging than on traditional “big satellites”. Future small spacecraft missions will require more power for electric thrusters, active sensors, and communications systems, while simultaneously expanding into more challenging environments further from Earth and for longer duration missions.

In the near term, it is expected that 100s Watts of power will be needed for electric thrusters to address the increased operational capability demand of the burgeoning LEO industry. Increased power will also be needed to meet deep space exploration objectives, for which distance to the Earth and Sun will compound to the challenges. For example, solar arrays intended to generate at least 100 W at Mars and other similar distance destinations – for sensors, communications, and other applications – will need 250 W beginning of life power at 1AU with a specific power generation of 300 W/kg and a stow rate of 350 kW/m^3. Outer planet missions would require capabilities significantly beyond the current state-of-the-art including solar cells with unprecedented specific power generation paired with large flexible solar arrays based on solar sail or rollout designs, or small nuclear power sources.

In particular, new power systems are needed to meet the future mission requirements for small spacecraft missions to the Moon such that the long-term growth in Cislunar space envisioned by the White House’s National Cislunar Science & Technology Strategy can materialize. These new requirements include electric thrusters that require voltages in the kV range and communications systems that need power in the tens of watts to be able to communicate as far as the Earth. These powers and voltages can be obtained with new photovoltaic efficiencies, larger deployable, retractable and gimbaled solar arrays, new low loss high power conversion systems, and new power storage systems with higher power density.

As advancements in power systems increase power generation in the small densely packed CubeSat form factor, improved thermal control and waste heat rejection will become increasingly critical. These systems will also be required to sustain long-term, sustained mission operations and higher operating duty-cycles in what would most likely be more challenging thermal environments. Additionally, the thermal environment of the Moon presents its challenges, as the heat flux from the Sun and Moon combined are close to doubling the heat seen in Earth orbit. This difficult thermal environment combined with extra power dissipated from the spacecraft high power systems require

new thermal solutions. These include new heat rejection systems, which could include deployable radiators. They also include new heat transport systems, heat storage systems, and new small cryogenic systems for instrumentation.

In the Earth domain, with the near-exponential growth in the small spacecraft industry and the significant increase in the power density of smallsats to meet all the new envisaged applications, there is a complimentary need to advance power and thermal control systems. This is expected to be case too for assets that aim to address climate change, as increasingly more numerous and power-hungry instruments are flown aboard. With thermal issues identified as one of the leading causes of small spacecraft failures in LEO, it is important that thermal architectures also be made more resilient, especially as the energy-density of small spacecraft increases. As smallsats are increasingly being sent to more eccentric and outer orbits, they are expected to see temperatures with greater extremes than traditional LEO small spacecraft.

1.5 Flight Demonstration Opportunities

All partnership teams should propose to demonstrate progress toward targeted Key Performance Parameters (KPPs) or Measures of Performance (MOP) values for the technology they develop under this USTP within the two-year basic period of performance, at least in the laboratory environment. Optionally, partnership teams may choose to propose to demonstrate their USTP-developed technology through CSLI or the FO program, or any other opportunity the project may have worked out on its own (contingent upon respecting all applicable U.S laws and SST guidelines) or in coordination with the SST program.

Funded Extensions to Support Flight Demonstration Activities

To support CSLI or FO flight demonstration activities, USTP projects may, within a limited time period of the basic USTP effort, request through the USTP Cooperative Agreement Technical Officer a funded extension of their Cooperative Agreement. If selected for launch by CSLI or FO, or any other flight opportunity, the SST program may grant an extension of the USTP Cooperative Agreement by up to 12 months and may award additional funds to the USTP project to support the proposed integration, launch cost, operations and limited post-flight analysis. The amount of additional funds will be determined at negotiation of the proposed USTP Cooperative Agreement extension. Approval of the funded extension would be contingent on satisfactory performance throughout the USTP Cooperative Agreement two-year period of performance, and on the availability of funding resources.

The USTP project must submit a funded extension request to the USTP Cooperative Agreement Technical Officer at least three months in advance of the expiration date of their Cooperative Agreement. The Cooperative Agreement extension request must state to which program – CSLI or FO or both or other – the flight demonstration is proposed. The request for funded extension must include: the objectives and measurable success criteria of the flight demonstration(s), the milestone schedule and work to be performed

leading to, during, and after the flight demonstration, and the additional funds requested. If the USTP project requests suborbital or hosted-orbital flight services from a qualified flight provider currently under contract through NASA's FO program, the USTP project must show that the proposed flight service provider is well suited to execute the flight(s) and must provide a cost and schedule quote from the flight provider.

The SST program shall not grant a Cooperative Agreement funded extension before the USTP project is selected by CSLI or FO for flight/demonstration or as-yet-to-be-specified other opportunity is confirmed. However, the SST program may provide a conditional letter of support to projects in their request to these opportunities as a means to aid their proposal and selection process, when deemed necessary and feasible by the SST program.

Proposers should note that funding for these funded extensions by the SST program is limited, and that they are encouraged to seek alternative funding from other sources, and/or prioritize less expensive, albeit technologically relevant opportunities. For example, funding of suborbital or hosted-orbital opportunities is likely to have a higher chance of approval over the funding of a stand-alone CubeSat mission when the demonstration on these less expensive platforms is possible and technologically relevant.

> **Flight Opportunities (FO) Program:** The goal of NASA's Flight Opportunities program is to demonstrate space exploration and utilization technologies in relevant space-like environments using currently available U.S. commercial suborbital rockets, rocket-powered lander vehicles, high-altitude balloons, aircraft following reduced-gravity flight profiles, and hosted-orbital platforms.
>
> Projects are encouraged to demonstrate the technology developed under their USTP effort on a suborbital or hosted-orbital flight. If the USTP project requests suborbital or hosted-orbital flight services from a qualified flight provider currently under contract through NASA's FO program, the USTP project must show that the proposed flight service provider is well suited to execute the flight(s) and must provide a cost and schedule quote from the flight provider.
>
> See the prior section above for the possibility of a funded extension of the basic USTP Cooperative Agreement to support proposed integration, launch cost, and operations.
>
> The SST program will assess the technical feasibility of the request, and if the funded extension is approved funds may be used to purchase suborbital or hosted-orbital flight services from a qualified flight provider currently under contract through NASA's FO program and to cover pre- and post-flight preparations and operations. USTP projects are not required to submit a proposal in response to an open FO solicitation to take advantage of this opportunity and may contact SST or FO at anytime after USTP award to discuss the possibility of FO sponsored suborbital or hosted-orbital testing.

For more information about the FO program and a list of qualified flight providers and services that are under contract see Section 9.

CubeSat Launch Initiative (CSLI): NASA's CSLI provides access to space for CubeSats developed by NASA Centers and programs, educational institutions and non-profit organizations to conduct research in the areas of science, exploration, technology development, education or operations. USTP projects that involve development of CubeSats are encouraged to propose to the annual NASA CSLI solicitation for an orbital flight opportunity when a stand-alone CubeSat mission is thought to be a necessity for adequate demonstration of a technology.

See the preceding section for requesting a possible funded extension of the basic USTP Cooperative Agreement to support proposed integration, launch cost, and operations.

The SST program can facilitate the independent Feasibility Review that is required by CSLI prior to proposal submittal to CSLI and may provide a letter demonstrating financial support if required, as well as conditional letter of support when deemed necessary and feasible by the SST program. An USTP project's USTP Cooperative Agreement may also be used as an indicator of merit for a CSLI proposal.

The USTP project may use any USTP funds to cover additional launch costs not already covered by CSLI (such as for costs to launch a CubeSat larger in size than 3U). Given that funding from the SST program is limited, projects are encouraged to seek alternative funding from other sources to enable such opportunities.

For further information on CSLI, and links to past and current CSLI announcements of opportunities, see Section 9.

For spaceflight demonstration of technologies other than CubeSats and hosted-orbital platforms, USTP projects are encouraged to investigate NASA International Space Station (ISS) opportunities. Although separate and distinct from this Appendix, researchers would propose technology demonstrations separately under that program. An USTP Cooperative Agreement funded extension is not offered for ISS flight demonstrations.

International Space Station (ISS) Research, Development, and Demonstration Opportunities: The ISS provides offerors with a national laboratory resource with unique environments for the development of space technologies. The ISS program provides transportation to and from the ISS and standard experiment integration activities free of charge to approved, sponsored technology development investigations. Research, development, and demonstration opportunities include accommodation inside the pressurized habitable volume of the station, on external platforms outside the station, and accommodation within resupply/cargo vehicle pressurized and unpressurized volumes. Deployable options are also available.

More information on accommodations for ISS research, development, and demonstration can be found in the ISS Utilization Reference Guide as well as in the series of Researcher's Guide publications (see Section 9 for document links).

For STMD and other NASA funded efforts including both scientific and general engineering research, development, or demonstration proposals, the ISS point of contact is:

Ms. Jennifer Scott Williams: Manager, Applications Client Support Office, 832.205.4910, jennifer.j.scottwilliams@nasa.gov

2. AWARD INFORMATION

2.1 Funding and Period of Performance Information

Award Type: Cooperative Agreements will be issued to the selected college or university partner. The Cooperative Agreement award resulting from this Appendix will be between NASA and the primary proposing U.S. college or university. Cost-sharing is not required. NASA will fund the NASA center or Jet Propulsion Laboratory (JPL) team member separately.

Award Duration: Maximum period of performance of the basic USTP Cooperative Agreement is two years, with continuation to the second year contingent on progress achieved during the first year and the availability of funds.

The SST program may approve requests within a limited time period of the USTP effort for a funded extension of the basic USTP Cooperative Agreement to cover specific activities in support of an orbital or suborbital technology demonstration flight, if the project has also been selected for subsequent launch through CSLI or FO. The funded extension may extend the Cooperative Agreement up to an additional 12 months (subject to qualifying conditions described in Section 1.5 above).

Anticipated Number of Awards: Approximately 8 awards total across all Technology Topic Areas. NASA reserves the right to alter the number of awards based on funding availability and quality of proposals received in response to this Appendix.

Anticipated Award Amounts: Maximum of $225,000 each year for up to two years ($450,000 maximum) per award. In addition, a NASA civil servant or JPL employee labor allocation of up to 0.5 full-time equivalent (FTE) per award, per year will be available to support NASA partner(s) involvement. Proposal teams can also request up to $30,000 of procurement funding for the NASA partner(s) to cover NASA expenses in the collaboration. This procurement funding may be used by the NASA partner(s) to purchase hardware or for use of NASA test facilities that support the partnership. Subject to approval, USTP projects that are selected for a suborbital, hosted-orbital, or orbital flight demonstration through FO or CSLI or other yet-to-be specified opportunity may receive supplemental funds, through a funded extension of the basic Cooperative Agreement, to support the launch as described in Section 1.5 above. NASA reserves

the right to negotiate the scope and magnitude of the proposed effort, cost/price terms, and any other terms, as appropriate with selected offerors.

Award Information	First Year	Second Year
Period of Performance	Up to 12 months	Up to 12 months
University Team Award	Up to $225,000	Up to $225,000
Available NASA Civil Servant or JPL Labor Allocation	Up to 0.5 FTE	Up to 0.5 FTE
NASA or JPL Procurement Allocation	Up to $30,000 total over 2 years	

2.2 Availability of Funds for Awards

The Government's obligation to make award(s) is contingent upon the availability of the appropriated funds from which to make payments, and the receipt of high-quality proposals that are determined acceptable for NASA award under this Appendix. NASA reserves the right to alter the number of awards, as outlined in Section 2.1, based on funding availability and quality of proposals received in response to this Appendix. NASA reserves the right to negotiate the scope and magnitude of the proposed effort, cost/price terms, and any other terms, as appropriate with selected proposers.

NASA's goal is to initiate new awards within two months after the selection of proposals to this solicitation is announced. However, this period may be longer based on the number of proposals selected, the availability of appropriated funds, and any necessary post-selection negotiations.

2.3 Award Reporting Requirements / Meetings / Deliverables

The following reports and presentations will be required from all teams selected for award, and will have to be sent to the NASA Technical Monitor via email, or other appropriate equivalent secure method of communication, as applicable. All university and NASA collaborators should participate to meetings and contribute to the preparation of materials, with the university PI responsible for all submissions.

- **Quarterly Reports**
  Due at the end of each three-month period beginning from the project start date. Two or more pages describing the status of the project with publicly releasable text and images for NASA websites and publications, as well as tracking of certain statistics pertinent to NASA to track the success of the initiative (such as number of students involved, papers published, conference presentations, and numbers of invention disclosures and patents). A template will be provided by NASA soon after award.

- **Inputs for inclusion in NASA internal- and external-facing technology showcase database systems**
  Due 6 months after the project start date. Projects are expected to provide necessary inputs for inclusion in NASA's internal- and external-facing technology

showcase database systems, such as NASA's TechPort web-based database (https://techport.nasa.gov/about). Such systems showcase NASA's portfolio of active and completed technology projects in order to facilitate opportunities for collaboration and partnerships, analyses of how the Agency is meeting mission needs, and data visualizations of technology drivers that enable key decisions.

- **Content for Generation of a NASA Fact Sheet for the USTP project**
  Due 6 months after the project start date. A two-page NASA Fact Sheet shall be generated for each of the USTP projects using publicly releasable text and images. The fact sheet will be available to use by both NASA and the PI to promote the technology.

- **Technology Transition Plan**
  Due 18 months after the project start date. A Technology Transition Plan for the USTP project shall be generated following a template that will be provided by NASA after project kickoff. It is a document that describes the project's plans for successful demonstration of the technology (e.g., on the ground, and/or on a suborbital, and/or orbital flight), its infusion in an upcoming mission, and/or its commercialization. Document appendices also to be submitted include a Technology Interface Summary Matrix (TISM), a Technology Demonstration Traceability Matrix (TDTM), and a Mission Traceability Matrix (MTM), per templates that will be provided by NASA after project kickoff.

- **Project Annual Reports and Project Final Report**
  Project Annual Reports are due at 12 months after the project start date and at every 12 months increment after that if extended beyond the original 24 month period of performance. In addition, a Project Final Report is due at project completion. If those two dates are less than three months apart, only a Project Final Report is required. The primary university PI and the NASA partner(s) shall co-author the Project Annual and Final Reports. The reports must include a complete summary of accomplishments and the relevant design documentation, test data, results, and analyses, including recommendations and conclusions based on the experience and results obtained. The final report should include algorithms, tables, graphs, diagrams, plots, images, and drawings in sufficient detail to explain comprehensively the results achieved under the Cooperative Agreement. This report shall comply with the requirements stated in NPR 2200.2E "Requirements for Documentation, Approval, and Dissemination of NASA Scientific and Technical Information" (see link in Section 9).

- **End of Project Abstract**
  Due at project completion. A 250-500 word abstract on the scope of the project and results using publicly releasable text and images. The abstract will be available to use by both NASA and the PI to promote progress of the technology, such as on NASA websites.

- **Content for an updated NASA Fact Sheet for the USTP project**
  Due at project completion. An updated two-page NASA Fact Sheet that takes into consideration the project's final results shall be generated for each of the USTP projects using publicly releasable text and images. The fact sheet will be available to use by both NASA and the PI to promote the technology.

- **NF 1679 Disclosure of Invention and New Technology Forms**, as applicable. The university team is required to participate with their NASA partner(s) in the completion of NF 1679 Disclosure of Invention and New Technology forms filed with a NASA Commercialization Office for each invention and new technology developed as part of the project.

The meetings listed below are required of all project teams, with each project's NASA partner(s) expected to participate and provide inputs to the meetings. Awardees may elect to hold meetings at the university, at the NASA center, or via teleconference. Choice of physical location or teleconference for meetings and reviews may be negotiated after selection.

- **Kickoff Meeting** within 15 days of project start date.
- **Quarterly Reviews** by teleconference conducted in conjunction with each of the other current USTP teams.

Under this Appendix, no additional deliverables from the university team to NASA are expected to be required beyond the reports, deliverables, meetings, and reviews stated above. However, additional documentation may be required to be in compliance with applicable law (see Section 6.0 of the NRA and Appendix F "Required Publications and Reports" of the NASA Grant and Cooperative Agreement Manual (GCAM) dated October 31, 2022 (see document link in Section 9)).

In some instances, a project team may arrange to transfer spacecraft or other equipment to NASA for inclusion in a flight or ground demonstration conducted by NASA or others.

In addition, NASA is implementing a process to collect demographic data from Cooperative Agreement applicants and significant contributors upon award for the purpose of analyzing demographic differences associated with its award processes and Science, Technology, Engineering, and Mathematics (STEM) engagement. Information collected will include name, gender, race, ethnicity, disability status, and citizenship status. Submission of the information is voluntary and is not a precondition of award or continued funding.

2.4 Renewal Proposals and Resubmission

Renewal Proposals and Resubmission are allowed. No change from Section 2.3 in the NRA

2.5 Use and Disclosure of Research Resulting from Awards

No change from Section 2.4 in the NRA.

2.6 Intellectual Property Resulting from Awards

No change from Section 2.5 in the NRA.

2.7 Export Control

No change from Section 3.4 in the NRA.

2.8 Restriction on the Use of Classified Material

No change from Section 3.5 in the NRA.

2.9 Cost-Sharing or Matching

Cost-sharing is not required. No change from Section 3.6 in the NRA.

3. ELIGIBILITY INFORMATION

3.1 Eligibility and Limitation of Number of Proposals

Eligibility is limited to U.S. college and university teams, including faculty, undergraduate and/or graduate students. The Principal Investigator (PI) submitting a proposal and leading a university team shall be affiliated with a U.S. college or university (including community colleges), accredited in and having a campus located in the U.S.

Partnering between the university team and a NASA center or JPL is required in all funded USTP projects. The NASA team member must be either a civil servant or a member of the technical staff from JPL. NASA contractors (except for JPL employees) may not be funded partners or collaborators on USTP projects.

Each proposal submitted for this Appendix must be limited to a single Technology Topic Area and the PI must specify the Technology Topic Area when proposing. An individual is limited to being the PI on a single proposal. A team member, including any individual who is the PI on another proposal, may be a team member on more than one proposal. NASA civil servants and/or JPL employees may be team members on more than one proposal. Proposing U.S. colleges or universities may submit more than one proposal, provided that, if selected, the proposer can carry out all proposed efforts.

3.2 Other Eligibility Limitations

No change from Section 3.2 in the NRA.

3.3 Foreign Participation

Proposals will only be accepted from teams affiliated with a U.S. college or university accredited in and having a campus located in the United States. University teams may include non-U.S. persons, but proposers are reminded of ITAR and EAR requirements (see Section 2.7).

3.4 China Funding Restriction

No change from Sections 3.3 and 4.3.7 in the NRA.

Proposals shall not include bilateral participation, collaboration, or coordination with China or any Chinese-owned company or entity, whether funded or performed under a no-exchange-of-funds basis. Proposals involving bilateral participation, collaboration, or coordination in any way with China or any Chinese-owned company, whether funded or performed under a no-exchange-of-funds basis, will be ineligible for award. See aforementioned sections of the NRA for more details.

4. PRELIMINARY AND FULL PROPOSAL SUBMITTAL INFORMATION

The following information supplements, where applicable, the information provided in Section 4.1 through 4.6 of the NRA.

This Appendix uses a two-step process. All offerors must submit a Mandatory Preliminary Proposal (MPP). Invitations by NASA to submit a Full Proposal will be made to offerors based on MPP submissions, and only those invitees are eligible to submit a Full Proposal. The submission of an MPP is not a commitment to submit a Full Proposal.

Step 1 – Mandatory Preliminary Proposal (MPP): Proposers shall develop an MPP addressing each of the items listed in Section 4.1. The MPP evaluation criteria are provided in Section 5.2 below.

Step 2 – Full Proposal: Upon receipt of an invitation to submit a Full Proposal, proposers must develop their Full Proposal addressing the items listed in Section 4.2. The Full Proposal must be submitted for the same technology as the MPP and involve the same technological approach described in the MPP. Full Proposals that introduce material changes to the technological approach previously submitted in the MPP will be declared non-compliant and will not be reviewed. The evaluation criteria listed in Section 5.3 below will be utilized to evaluate the Full Proposals.

All information needed to apply to this Appendix is contained in this Appendix and in the REDDI NRA. The following information supplements the information provided in Section 4.0 of the NRA. Where there are differences between this Appendix and the NRA, this Appendix has precedence.

All proposals in response to this Appendix must be submitted in fully electronic form. Proposers shall submit MPPs and Full Proposals via NSPIRES **only** (https://nspires.nasaprs.com)**.** Submissions through Grants.gov will not be possible for this Appendix. See 4.3.1 of the NRA. No hard copy or emailed copy of the proposal is required or permitted.

All proposals submitted under a funding opportunity are required to submit a Data Management Plan (DMP), however this is completed as part of the preparation of NSPIRES Cover Page for submissions.

NOTE: The proposal submission process through the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) is complex and involves multiple steps to be carried out by all participants in the proposal. Therefore, proposers are strongly encouraged to familiarize themselves with the NSPIRES proposal submission system and begin the submittal process early, well in advance of the deadlines. ***Proposals received after the deadline will not be reviewed.*** *While every effort is made to ensure the reliability and accessibility of the submission system and to provide a help center via email and telephone (see Section 7), difficulties may arise at any point, including problems with the user's own equipment. Difficulty in registering or using the proposal submission system (NSPIRES) is not a sufficient reason for NASA to consider a proposal submitted after the deadline.*

4.1 Mandatory Preliminary Proposal (MPP) Requirements

The MPP shall include the following separate documents:

1. NSPIRES Proposal Cover Page
2. Mandatory Preliminary Proposal main document – see Sections 4.1.1 through 4.1.5 below
3. Attachment 1: Summary Chart – see Section 4.1.6 and Attachment 1 below

Reviewers will use the evaluation criteria in Section 5.2 to evaluate all MPP proposals.

Note the following requirements for submission of an MPP proposal:

- The title given to the MPP must be descriptive of the proposed research
- The Authorized Organizational Representative (AOR) is required to submit the proposal plus that attachment through NSPIRES.
- All organizations requesting NASA funds for the proposed investigation must be listed on the NSPIRES Proposal Cover Page.
- The Principal Investigator (PI), AOR, and all team members (including Co-Principal Investigators, Co-Investigators, and Collaborators) must be named on the proposal's electronic Cover Page in NSPIRES, and all personnel named on the proposal's electronic Cover Page must be individually registered in

NSPIRES. All Individuals must perform the registration themselves; that is, no one may register a second party, not even the PI of a proposal. For the MPP, the NASA partner(s) does not have to be identified if they have not been identified/confirmed yet, and may be labeled as TBD within the proposal.

- Each individual team member registered in NSPIRES (e.g., PI, Co-Investigators), including all personnel named on the proposal's electronic Cover Page, must confirm their participation on that proposal (indicating team member role) and specify an organizational affiliation via NSPIRES (see NRA Section 4.3.1). The organizational affiliation specified on the NSPIRES Proposal Cover Page must be the organization through which the team member would work and receive funding (as applicable) while participating in the proposed investigation. If the individual has multiple affiliations, then this organization may be different from the individual's primary employer or preferred mailing address. Team members are asked to ensure that their contact information is up to date. Changes can be made using the "Account Management" area of the NSPIRES website.
- The MPP requires the completion of Program Specific Data (PSD) questions as part of the NSPIRES Proposal Cover Page. See Section 4.3.4 of the NRA and NSPIRES instructions. Budget information does not need to be completed on the Cover Page, as it is assumed that for the MPP that the project will meet the solicitation's budget and schedule criteria.
- The NSPIRES Proposal Cover Page shall include a Proposal Summary suitable for release through a publicly accessible archive should the proposal be selected. It should not include any proprietary or sensitive data, nor be marked as proprietary, as NASA may make it available to the public after awards are announced and may post it on the STMD website. As outlined in Section 4.3.4 of the NRA, the Proposal Summary should not exceed more than 4000 characters in length (including spaces) and contain any special characters or formatting.
- **Required Certifications**: See Section 4.3.4 in the NRA

Proposals not meeting these requirements may be declared non-responsive and not reviewed.

All offerors shall complete the electronic forms (e.g., Proposal Cover Page) required by the NSPIRES database and attach a Proposal Document, as well as one Attachment 1 (Summary Chart) that are responsive to the instructions contained in this Appendix. Proposals submitted in response to this Appendix must include the two files mentioned above with a combined file size not to exceed 20 MB.

Once the PI has completed entry of the data requested, the AOR from the PI's organization must submit the electronic proposal (NSPIRES Proposal Cover Page plus the attachments). Coordination between the PI and their AOR on the final editing and submission of the proposal materials is facilitated through their respective accounts in NSPIRES.

All proposals submitted in response to this Appendix must include any specified required electronic forms available through NSPIRES. Submission via NSPIRES may require responding to questions on the NSPIRES submission page.

Mandatory Preliminary Proposal Preparation Information

The MPP shall contain sufficient information to enable reviewers to make informed judgments regarding the factors described in Section 5.2. Required proposal sections are outlined below and must be included in the order listed. (Note: in many cases, Sections identified in the NRA document are not required or requested in preparing responses to this Appendix). Proposals shall not include web links to external information (such as photos, videos, company information, etc.).

The format of the proposal (font size, margins, etc.) shall follow the guidelines described in Section 2.6 of the 2023 NASA Proposer's Guide (see document link in Section 9). The only exception is the *Attachment 1: Summary Chart*, as outlined in the instructions for Attachment 1 at the end of this Appendix.

Proposals not conforming to the format described in this section may be declared non-responsive and not reviewed.

Reviewers will not consider any proposal material in excess of the page limits specified in the Table below. No additional sections/appendices beyond what is listed in the table are allowed. Any excess material may be removed from the proposal prior to evaluation.

All proposals are treated as proprietary and are marked accordingly in the NSPIRES Proposal Cover Page. There is no need to include proprietary marking on the Title Pages.

The **Mandatory Preliminary Proposal** shall include the following sections, in the order listed and with the page limits as listed:

Mandatory Preliminary Proposal (MPP) Page Limits

Section #	MPP Section	Maximum Length
1	Title Page and Proposal Summary	2 pages
2	Introduction	3 pages for the combined Sections 2 - 5
3	Relevance and Impact	
4	Technical Approach	
5	Qualifications and Capabilities	
---	Summary Chart (separate document uploaded on NSPIRES, see Section 4.1.6)	1 page
Maximum Size of combined documents: <u>Not to Exceed 20 MB</u>		

The U.S. Government requires unlimited data rights to the proposal content for U.S. Government use only. NASA will use the data gathered from the proposal to assist in the development of its SST and FO program requirements.

Proposers are strongly encouraged to not include ITAR/EAR information if it is not required to demonstrate the strength of alignment with evaluation criteria; however, it is recognized that some technologies may be export controlled. Any ITAR/EAR information in the proposal must be handled in accordance with Section 3.4.2 of the NRA and the "Export-Controlled Material in Proposals" section in the NASA Proposer's Guide (see document link in Section 9).

4.1.1 MPP - Title Page and Proposal Summary

The MPP shall include a Title Page and a Proposal Summary. These pages may be formatted as preferred by the offeror and shall include the same proposal title and proposal summary as the NSPIRES Proposal Cover Page. Diagrams that represent the scope of work to be performed may be included. As a reminder, the proposal title, Proposal Summary, and associated graphics must be suitable for release through a publicly accessible archive should the proposal be selected. If the proposal contains export control information in the form and to the extent permitted by this Appendix and the NRA, notice of this shall also be provided on the Title Page. All proposals are treated as proprietary and are marked accordingly in the NSPIRES Proposal Cover Page. There is no need to include proprietary marking on the Title Page.

4.1.2 MPP – Introduction

Provide a brief introduction to the proposal germane to the scope of work proposed, and as necessary to aid in its understanding.

4.1.3 MPP – Relevance and Impact

Each proposal must address a single Technology Topic Area from among the topics listed in Section 1.4.2 above, as well as identify the chosen primary Target Operational Domain in Section 1.4.1. NSPIRES will require the PI to identify the single, specific Technology Topic Area as part of the proposal submittal process (but will not be asked to identify within NSPIRES the primary Target Operational Domain as that is not a discretizing factor). All submitted proposals will be grouped by Technology Topic Area and each proposal will only be evaluated within one topic area.

For the MPP, the proposing team will need to:

- Describe a specific capability or service needed for either one of the two Target Operational Domains (see Section 1.4.1), identifying which one is the primary one for the proposal. The capability should be an extension or represent an improvement over the performance of missions that NASA or industry already plan to execute by 2025 for the primary domain. Explain how small spacecraft – or cooperative groups of small spacecraft – can offer a unique, cost-effective solution for the identified capability or service. Execution of the mission is not considered part of the proposed effort but the needed mission capabilities serve

to gauge technology gaps and advancements to performance measures proposed.

- Identify one of the Technology Topic Areas from the list (see Section 1.4.2) where the state-of-the-art (as projected for the 2023-2025 timeframe) will prevent/inhibit small spacecraft from achieving the previously described solution. Specify an advancement of that technology – your proposed technology – that will contribute to enabling small spacecraft successfully accomplishing the mission. Contrast the advancement with the state-of-the-art, with this difference identified as the “technology gap”. Describe the identified technology gap in terms using quantitative, measurable values for the Key Performance Parameters (KPPs) or Measures of Performance (MOP) (e.g., Timing Accuracy (seconds), Antenna Gain (dB), Total Ionizing Dose Radiation Tolerance (krad/SiO2), Spacecraft Power management System Specific Power (W/kg), etc).
- Describe the alignment of the technology with the Technology Topic Area, linking the proposed effort with the goals and objectives of that topic.
- Propose a two-year development effort within the constraints of the allowable budget (see Section 2.1) that will lead to a solution that will fill the identified technology gap. Explain the proposed solution for raising the capability of the technology. Explain briefly how your proposed two-year development effort will raise the performance of the technology. Identify the targeted change in value of the KPP or MOP from the beginning state-of-the-art value to the proposed targeted value of the KPP or MOP.
- Identify target form factor (e.g. 1U, ESPA-class) and approximate expected end-dimensions if not clear from the graphics, as well as applicability/scalability potential to other form factors
- Identify whether the technology is also applicable/extensible to the secondary Target Operational Domain, and the context in which it is. If it also represents an improvement over the state-of-the-art within this secondary domain, proposers may describe it in qualitative terms if quantitative terms are not easily describable for this domain within the page limitations of the proposal, or if additional investment beyond this USTP would be needed to make it applicable in this secondary domain.

Identify the potential for infusion of the technology or capability into a future space mission, commercialization, or other follow-on work if the project is successful.

4.1.4 MPP – Technical Approach

Briefly describe work on the technology to date. Provide evidence of how the proposed development effort will advance the technology towards achieving the technology development goals, TRL increase of +2, and enables the technology to advance towards spaceflight qualification and potential infusion. Address the current TRL and technology development plan to achieve the TRL increase, identifying in the process any major technical challenges and risks, as well as outlining feasible mitigation strategies.

For the MPP, the NASA partner(s) may be labeled as “To Be Determined (TBD)”, if they haven’t been identified nor have committed yet; however how the candidate NASA partner(s) would contribute to the technical approach should be listed.

4.1.5 MPP – Qualifications and Capabilities

Identify the roles, responsibilities, and contributions of the proposal lead and team members. Identify also the expected number of graduate and undergraduate students (as applicable) to be employed for the project and contributions they would be providing to the project. Educational involvement benefits may also be identified here. Identify the facilities and equipment needed to support the proposed Technical Approach and enable successful execution of the project, including their expected availability (confirmation of availability is only needed for the Full Proposal).

For the MPP, the NASA partner(s) may be labeled as “To Be Determined (TBD)”, if they haven’t been identified and/or committed yet, however candidate partners and their possible contributions and capabilities should be listed.

4.1.6 MPP – Submission of an Attachment 1: Summary Chart

A Summary Chart shall be submitted along with the MPP; see Attachment 1 at the end of this Appendix for the specifics of the Summary Chart. This will be considered a preliminary version of the Summary Chart, with an updated version to be submitted at the time of the Full proposal. For the preliminary version, the NASA partner(s) may be identified as “To Be Determined (TBD)”, if they haven’t been identified and/or committed yet. For the Full Proposal version, the NASA partner(s) shall be explicitly identified.

The purpose of the Summary Chart is to capture the top-level, critical information from the entire proposal into a single, stand-alone page (i.e., it should not require the full proposal to be understood).

Proposals that do not include a completed Summary Chart may be declared non-responsive and not reviewed. **The Summary Chart shall be uploaded to NSPIRES as a separate document.**

4.2 Full Proposal Requirements

The Full Proposal shall include the following separate documents:

1. NSPIRES Proposal Cover Page
2. Proposal Document – described in Sections 4.2.1 through 4.2.9 below
3. Attachment 1: Summary Chart – see Section 4.2.10 and Attachment 1 below

Only offerors who submit a Mandatory Preliminary Proposal (MPP) and are invited to submit a Full Proposal are eligible to submit a Full Proposal.

Reviewers will use the evaluation criteria in Section 5.3 to evaluate all proposals.

Note the following requirements for submission of a Full Proposal:

- The title given to the Full Proposal shall be the same as the MPP
- The Authorized Organizational Representative (AOR) is required to submit the proposal plus the attachment through NSPIRES.
- All organizations requesting NASA funds for the proposed investigation must be listed on the NSPIRES Proposal Cover Page.
- The PI, AOR, and all team members (Co-Principal Investigators, Co-Investigators, Collaborators, and NASA partner(s)) must be named on the proposal's electronic cover page in NSPIRES, and all personnel named on the proposal's electronic cover page must be individually registered in NSPIRES. All individuals must perform the registration themselves; that is, no one may register a second party, not even the PI of a proposal. For the Final Proposal the NASA partner(s) shall be identified.
    - Changes to personnel from what was listed in the MPP are allowed only if they are required due to extenuating circumstances, and such changes may cause a delay in the selection schedule (the exception being the NASA partner(s), which may not have been listed or only been identified as "TBD" in the MPP)
- Each individual team member registered in NSPIRES (e.g., PI, Co-Investigators), including all personnel named on the proposal's electronic cover page, must confirm their participation on that proposal (indicating team member role) and specify an organizational affiliation via NSPIRES (see NRA Section 4.3.1). The organizational affiliation specified on the cover page must be the organization through which the team member would work and receive funding (as applicable) while participating in the proposed investigation. If the individual has multiple affiliations, then this organization may be different from the individual's primary employer or preferred mailing address. Team members are asked to ensure that their contact information is up to date. Changes can be made using the "Account Management" area of the NSPIRES website.
- The Full Proposal requires the completion of Program Specific Data (PSD) questions as part of the NSPIRES Proposal Cover Page. See Section 4.3.4 of the NRA and NSPIRES instructions. Budget information does not need to be completed on the Cover Page, but should be included in the proposal as noted in Sections 4.2.6 and 4.2.7 below
- The NSPIRES Proposal Cover Page shall include a Proposal Summary suitable for release through a publicly accessible archive should the proposal be selected. It should not include any proprietary or sensitive data, nor be marked as proprietary, as NASA may make it available to the public after awards are announced and may post it on the STMD website. As outlined in Section 4.3.4 of the NRA, the Proposal Summary should not exceed more than 4000 characters in length (including spaces) and contain any special characters or formatting.
- **Required Certifications**: See Section 4.3.4 in the NRA

Proposals not meeting these requirements may be declared non-responsive and not reviewed.

All offerors shall complete the electronic forms (e.g., Proposal Cover Page) required by the NSPIRES database and attach a Proposal Document, as well as one Attachment 1 (Summary Chart) that are responsive to the instructions contained in this Appendix. Proposals submitted in response to this Appendix must include the two files mentioned above with a combined file size not to exceed 20 MB.

Once the PI has completed entry of the data requested, the AOR from the PI's organization must submit the electronic proposal (NSPIRES Proposal Cover Page plus the Proposal Document and the Attachment 1). Coordination between the PI and their AOR on the final editing and submission of the proposal materials is facilitated through their respective accounts in NSPIRES.

All proposals submitted in response to this Appendix must include any specified required electronic forms available through NSPIRES. Submission via NSPIRES may require responding to questions on the NSPIRES submission page.

Full Proposal Preparation Information

The Full Proposal shall contain sufficient information to enable reviewers to make informed judgments regarding the factors described in Section 5.3. Required proposal sections are outlined below and must be included in the order listed. (Note: in many cases, Sections identified in the NRA document are not required or requested in preparing responses to this Appendix). Proposals shall not include web links to external information (such as photos, videos, company information, etc.). **Note also that while the technical criteria presented for the Full Proposal may appear the same as for the MPP, they are more stringent for the Full Proposal.**

The format of the proposal (font size, margins, etc.) shall follow the guidelines described in Section 2.6 of the 2023 NASA Proposer's Guide (see document link in Section 9). The only exception is the *Attachment 1: Summary Chart*, as outlined in the instructions for Attachment 1 at the end of this Appendix.

Proposals not conforming to the format described in this section may be declared non-responsive and not reviewed.

Reviewers will not consider any proposal material in excess of the page limits specified in the Table below. No additional sections/appendices beyond what is listed in the table are allowed. Any excess material may be removed from the proposal prior to evaluation.

All proposals are treated as proprietary and are marked accordingly in the NSPIRES Proposal Cover Page. There is no need to include proprietary marking on the Title Pages.

The **Full Proposal** shall include the following sections, in the order listed and with the page limits as listed:

Full Proposal Page Limits

Section #	Full Proposal Section	Maximum Length
1	Title Page and Proposal Summary	2 pages
2	Table of Contents	1 page
3	Relevance and Impact	4 pages
4	Technical and Management Approach	4 pages
5	Schedule Summary	1 page
6	Budget Summary (Table)	1 page
7	Budget Justification	As needed, no page limit
8	References & Citations	As needed, no page limit
9	Letters of Commitment and Statements of Support	As needed, no page limit
---	Summary Chart (separate document uploaded on NSPIRES, see Section 4.2.10)	1 page
Maximum Size of combined documents: Not to Exceed 20 MB		

The U.S. Government requires unlimited data rights to the proposal content for U.S. Government use only. NASA will use the data gathered from the proposal to assist in the development of its SST and FO program requirements.

Proposers are strongly encouraged to not include ITAR/EAR information if it is not required to demonstrate the strength of alignment with evaluation criteria; however, it is recognized that some technologies may be export controlled. Any ITAR/EAR information in the proposal must be handled in accordance with Section 3.4.2 of the NRA and the "Export-Controlled Material in Proposals" Appendix A in the NASA Proposer's Guide (see document link in Section 9).

Funding of Related, Essentially Equivalent, and Duplicate Proposals and Awards

While it is permissible with proper notification to submit identical proposals or proposals containing a significant amount of essentially equivalent work for consideration under numerous Federal program solicitations, it is unlawful to enter into funding agreements requiring essentially equivalent work.

If an applicant elects to submit identical proposals or proposals containing a significant amount of essentially equivalent work under other Federal program solicitations, a statement must be included in each such proposal indicating the following:

1) The name and address of the agencies to which proposals were submitted or from which awards were received.
2) Date of proposal submission or date of award.
3) Title, number, and date of solicitations under which proposals were submitted or awards received.
4) The specific applicable research topics for each proposal submitted or award received.

5) Titles of research projects.
6) Name and title of principal investigator or project manager for each proposal submitted or award received.

Offerors are at risk for submitting essentially equivalent proposals and therefore are strongly encouraged to disclose these issues to the soliciting agency to resolve the matter prior to award.

The proposing PI must immediately notify the NASA Program Officer for this solicitation of any proposals that are awarded for substantially the same research as proposed to NASA via this solicitation, any time after the proposal due date, and until the time that NASA's selections are announced (see contact details in Section 7.0)

4.2.1 Full Proposal – Title Page and Proposal Summary

Proposals shall include a Title Page and a Proposal Summary. These pages may be formatted as preferred by the offeror and shall include the same proposal title and proposal summary as the NSPIRES Proposal Cover Page. Graphics that represent the scope of work to be performed may be included. As a reminder, the proposal title, summary, and associated graphics must be suitable for release through a publicly accessible archive should the proposal be selected. If the proposal contains export control information in the form and to the extent permitted by this Appendix and the NRA, notice of this shall also be provided on the Title Page. All proposals are treated as proprietary and are marked accordingly in the NSPIRES Proposal Cover Page. There is no need to include proprietary marking on the Title Page.

4.2.2 Full Proposal – Table of Contents

Proposers should include a one-page Table of Contents that provides a guide to the organization and contents of the proposal.

4.2.3 Full Proposal – Relevance and Impact

Each proposal must address a single Technology Topic Area from among the topics listed in Section 1.4.2 above, as well as identify the chosen primary Target Operational Domain (Section 1.4.1). NSPIRES will require the PI to identify the single, specific Technology Topic Area as part of the proposal submittal process (but will not be asked to identify within NSPIRES the primary Target Operational Domain as that is not a discretizing factor). All submitted proposals will be grouped by Technology Topic Area and each proposal will only be evaluated within one topic area.

For the Full Proposal, the proposing team will need to:

- Describe a specific capability or service needed for either one of the two Target Operational Domains (see Section 1.4.1), identifying which one is the primary one for the proposal. The capability should be an extension or represent an improvement over the performance of missions that NASA or industry already

plan to execute by 2025 for the primary domain. Explain how small spacecraft – or cooperative groups of small spacecraft – can offer a unique, cost-effective solution for the identified capability or service. Execution of the mission is not considered part of the proposed effort but the needed mission capabilities serve to gauge technology gaps and advancements to performance measures proposed.

- Identify one of the Technology Topic Areas from the list (see Section 1.4.2) where the state-of-the-art (as projected for the 2023-2025 timeframe) will prevent/inhibit small spacecraft from achieving the previously described solution. Specify an advancement of that technology – your proposed technology – that will contribute to enabling small spacecraft successfully accomplishing the mission. Contrast the advancement with the state-of-the-art, with this difference identified as the “technology gap”. Describe the identified technology gap in terms using quantitative, measurable values for the Key Performance Parameters (KPPs) or Measures of Performance (MOP) (e.g. Timing Accuracy (seconds), Antenna Gain (dB), Total Ionizing Dose Radiation Tolerance (krad/SiO2), Spacecraft Power management System Specific Power (W/kg), etc).
- Describe the alignment of the technology with the Technology Topic Area, linking the proposed effort with the goals and objectives of that topic.
- Propose a two-year development effort within the constraints of the allowable budget (see Section 2.1) that will lead to a solution that will fill the identified technology gap. Explain the proposed solution for raising the capability of the technology. Explain in detail how your proposed two-year development effort will raise the performance of the technology. Specify the expected change in value of the KPP or MOP from the beginning state-of-the-art value to the proposed targeted value of the KPP or MOP.
- Identify target form factor (e.g.1U, ESPA-class) and approximate expected end-dimensions if not clear from the graphics, as well as applicability/scalability potential to other form factors
- Identify whether the technology is also applicable/extensible to the secondary Target Operational Domain, and the context in which it is. If it also represents an improvement over the state-of-the-art within this secondary domain, proposers may describe it in qualitative terms if quantitative terms are not easily describable for this domain within the page limitations of the proposal, or if additional investment beyond this USTP would be needed to make it applicable in this secondary domain.

Describe any plans for infusion of the technology or capability into a future space mission, commercialization, or other follow-on work if the project is successful.

All partnership teams should propose to demonstrate progress toward targeted KPP or MOP values for the technology they develop under this USTP within the two-year basic period of performance, at least in the laboratory environment.

Flight testing of the technology or capability is not required, but a path to such testing is desired. Optionally, partnership teams may choose to propose to demonstrate their

USTP-developed technology through CSLI or FO. Describe any plans for testing the technology or capability through orbital or suborbital testing.

4.2.4 Full Proposal – Technical and Management Approach

Describe the technology or capability to be developed in the proposed project and explain the scientific or engineering principles that underlie that technology or capability, including a brief description of the work done on the technology to date. Describe the overall technical approach to implementing the project. Describe any significant technical challenges or risks anticipated in developing and/or demonstrating the proposed technology or capability and explain the mitigation plans for those challenges and risks. Briefly describe the steps and milestones (including any major tests and demonstrations) in the project from start through completion. The description of the technical approach and milestones should demonstrate that the proposed effort is sound, complete and feasible within the resources and schedule of the project, and provides a reasonable pathway to project success. Include a brief description of technical measurement, test or demonstration intended to verify that the proposed quantitative measures of performance / key performance parameter has been improved or that the targeted performance has been achieved.

Provide evidence to support that the TRL of the technology or capability at the time of proposal submission meets minimum TRL requirement of 3 and that the proposed effort will increase the TRL of the technology by +2, and enables the technology to advance towards spaceflight qualification and potential infusion.

Describe the approach used in managing and coordinating project activities. Identify the roles, responsibilities, and contributions of the proposing university, the NASA partner(s), and any additional partners. Identify any prior or current work that demonstrates that the combined team has the competencies needed to execute the project. Describe any equipment and facilities needed by the project and indicate the availability of these facilities or equipment, or the strategy for gaining access to them. Proposed use of government-furnished equipment or government-owned facilities must include a statement of support from the cognizant government official that the facilities and/or property will be available for the use intended by the project within the planned schedule. Education involvement benefits may also be identified within this section.

4.2.5 Full Proposal – Schedule Summary

Provide a schedule chart for the full duration of the project including all major milestones and activities described in the Technical and Management Approach. Assume a start date no earlier than October 1, 2023.

Proposals are encouraged, but not required, to propose planned technology demonstration flights, and if so should show relevant milestones.

Note that after award of the USTP Cooperative Agreement, the SST program may approve requests within a limited time period of the USTP effort for a funded extension

of the basic USTP Cooperative Agreement to cover specific activities in support of a technology demonstration flight, if the USTP project is selected for subsequent flight opportunity through the FO program, or CSLI, or yet-to-be-determined other opportunity. The funded extension may extend the Cooperative Agreement up to an additional 12 months (subject to qualifying conditions described in Section 1.5 above).

4.2.6 Full Proposal – Budget Summary

Complete and include the following table within this section:

Budget	First Year	Second Year
Requested University Funding	*in dollars*	*in dollars*
NASA Labor Allocation*	*in FTE*	*in FTE*
NASA Procurement	*in dollars*	*in dollars*
Additional Contributions	*in dollars and/or FTE*	*in dollars and/or FTE*
Total Cost	*in dollars*	*in dollars*

**Although JPL employees are not NASA civil servants please indicate the equivalent of the FTE level for their participation in this table. The table should not include NASA and JPL labor costs in dollars.*

At its own discretion, a participating NASA center may provide additional FTE contributions and/or additional procurements (not covered by STMD). In such cases, these resources should be summarized in this proposal section. Similarly, at their own discretion, university teams may offer to contribute resources at no cost to the project. Such contributions should be summarized in this proposal section as well.

4.2.7 Full Proposal – Budget Justification

Each proposal shall provide a budget justification for the proposed effort and shall be supported by appropriate narrative material and budget details in compliance with the instructions in the NRA and Section 2.18 and Appendix C of the NASA Proposer's Guide (see document link in Section 9).

Describe the basis for the estimates. The totals of the detailed budget justification must match the budget summary specified in the preceding Section 4.2.6.

See also Section 4.3.6 in the NRA. However, this Appendix requires that NASA civil servants and JPL employees are stated as a percentage of FTE only. Proposers shall not provide fully burdened civil servant and JPL employee labor costs.

See also Appendix C - Examples of Costs Categories from 2 CFR 200 Subpart E in the NASA GCAM (see document link in Section 9).

Each proposal shall provide a Table of Personnel and Work Effort in compliance with Section 2.20 of the 2023 NASA Proposer's Guide (see document link in Section 9).

4.2.8 Full Proposal – References & Citations

Provide, as needed, the references and citations that support information provided in the Full Proposal. Use easily understood standard abbreviations for journals and complete names for books. Note that the reviewers are not required or expected to read the references; therefore, the proposals must stand alone in meeting the evaluation criteria.

4.2.9 Full Proposal – Letters of Commitment and Statements of Support

For proposals submitted via NSPIRES, a NASA collaborator acknowledges his/her intended participation in the proposed effort by identifying himself/herself as a participant on the proposal's cover page. Digitally signing off in NSPIRES indicates acceptance of this role and is a preliminary commitment by the Center to collaborate in the proposed effort. NASA employees should coordinate with their management prior to making a commitment to collaborate (management signature is not required). No further statement or letter of commitment is required when submitting via NSPIRES.

Proposed use of government-furnished equipment, government-owned facilities, and government software must include a statement in the proposal from the cognizant government official that the facilities and/or property will be available for the use intended by the proposing team within the planned schedule.

Since the prospective NASA and JPL partners will need time to coordinate approval for commitment, university proposers should contact them as early as possible during the proposal process.

4.2.10 Full Proposal – Submission of an Attachment 1: Summary Chart

A Summary Chart shall be submitted along with the Full Proposal, see Attachment 1 at the end of this Appendix for the specifics of the Summary Chart. This shall be a final version of the Summary Chart, essentially an update of the preliminary version submitted with the MPP. Whereas for the preliminary version the NASA partner(s) could be identified as To Be Determined (TBD), if they hadn't been identified and/or committed yet, for the Full Proposal version, the NASA partner(s) shall be identified.

Proposals that do not include a completed Summary Chart may be declared non-responsive and not reviewed. **The Summary Chart shall be uploaded to NSPIRES as a separate document.**

The purpose of the Summary Chart is to capture the top-level, critical information from the entire proposal into a single, stand-alone page (i.e., it should not require the full proposal to be understood).

5. PROPOSAL REVIEW INFORMATION

The following information supplements, where applicable, the information provided in Sections 5.1 through 5.8 of the NRA. If any criteria in this Appendix conflict with any other part of the NRA, the criteria identified in this Appendix take precedence.

5.1 Compliance Review

No change from NRA.

5.2 MPP Evaluation Criteria

The evaluation criteria considered in evaluating MPPs under this Appendix are listed below, with evaluators identifying for each proposal, strengths and weaknesses and a rating score. The criteria are weighted as follows:

MPP Evaluation Criterion 1 – Relevance and Impact (Weight 50%)

The extent to which the reference mission put forward is consistent with national priorities, the commercial small spacecraft industry and NASA needs and goals, as well as the extent to which the technology or capability proposed is broadly relevant to NASA and/or the small spacecraft civil and commercial industry. The extent to which technology or capability gaps to achieving the reference mission are identified and the reference mission could be feasibly implemented with small spacecraft if those gaps are addressed. The extent to which the proposed work bridges one or more of the identified technology gaps and the extent to which the proposed work is critical for enabling the reference mission. The extent to which the proposed work is relevant to the solicited Technology Topic Areas of this Appendix and the Target Operational Domains.

The overall impact of the proposed work and the extent to which evidence is provided that the project would meaningfully improve performance relative to the current state-of-the-art in small spacecraft technology or capabilities for the primary Target Operational Domain. The extent to which the work would enable or significantly enhance the execution of the reference mission and other exploration, science, or commercial missions, such as for the secondary Target Operational Domain.

The extent to which the technology has mission infusion, commercialization, or other follow-on potential.

MPP Evaluation Criterion 2 – Technical Approach (Weight 50%)

The extent to which the technology or capability is clearly described and explains the scientific or engineering principles that underlie the technology or capability. The overall merit of the technical approach and the extent to which the proposed activities represent concrete and realistic steps to accomplishing the objectives of the effort within the

period of performance and available funding, as well as enables the technology to advance towards potential mission infusion. The scientific and engineering basis of any new technology is sound and the extent to which major technical challenges and risks have been identified with feasible mitigation strategies outlined. The extent to which evidence supporting that the starting TRL is appropriate is provided for the Technology Topic Area and primary Target Operational Domain, and that the proposed activities will increase the TRL by +2, towards spaceflight qualification.

The extent to which the roles and responsibilities for all participating organizations outlined in the “Qualifications and Capabilities” section of the proposal are clearly described and address the competencies, facilities, and equipment needed to support the proposed Technical Approach and enable successful execution of the project. This includes the extent to which the needed equipment, facilities and other hardware are identified and expected to be available.

Lastly, the extent to which there are educational involvement benefits.

5.3 Full Proposal Evaluation Criteria

The evaluation criteria considered in evaluating the Full Proposals, along with their weighting, are listed below. Note that these criteria and their weighting are slightly different than for the MPP, and take into consideration the Management Approach and Cost aspects.

Full Proposal Evaluation Criterion 1 - Relevance and Impact (Weight 45%)

The extent to which the reference mission put forward is consistent with national priorities, the commercial small spacecraft industry and NASA needs and goals, as well as the extent to which the technology or capability proposed is broadly relevant to NASA and/or the small spacecraft civil and commercial industry. The extent to which technology or capability gaps to achieving the reference mission are identified and the reference mission could be feasibly implemented with small spacecraft if those gaps are addressed. The extent to which the proposed work bridges one or more of the identified technology gaps and the extent to which the proposed work is critical for enabling the reference mission. The extent to which the proposed work is relevant to the solicited Technology Topic Areas of this Appendix and the Target Operational Domains.

The overall impact of the proposed work and the extent to which evidence is provided that the project would meaningfully improve performance relative to the current state-of-the-art in small spacecraft technology or capabilities for the primary Target Operational Domain. Evidence includes quantitative measures such as KPP(s) or MOP(s), with supporting data to describe the current state of the art and how the proposed technology or capability will improve upon that state-of-the-art. The extent to which the work would enable or significantly enhance the execution of the reference mission and other exploration, science, or commercial missions, such as for the secondary Target Operational Domain.

The proposal provides a high-level plan for mission infusion, commercialization, or other follow-on potential and the extent to which to the proposed effort has a near term pathway to orbital or suborbital testing.

The proposal includes a demonstration of progress toward KPP or MOP values for the technology developed within the two-year basic period of performance, at least in the laboratory environment (such as qualification to “protoflight” levels). If a flight demonstration is optionally proposed, the extent to which the proposed flight demonstrates progress toward KPP or MOP values.

Full Proposal Evaluation Criterion 2 - Technical and Management Approach (Weight 45%)

The extent to which the technology or capability is clearly described and explains the scientific or engineering principles that underlie the technology or capability. The overall merit of the technical approach and the extent to which the proposed activities and milestones represent concrete, realistic, and specific deliverables or steps to accomplishing the objectives of the effort within the period of performance and available funding, as well as enables the technology to advance towards potential mission infusion. The scientific and engineering basis of any new technology is sound and the extent to which major technical challenges and risks are clearly identified with feasible mitigation strategies proposed. The extent to which evidence supporting that the starting TRL is appropriate for the Technology Topic Area topic area and primary Target Operational Domain, and that the proposed activities will increase the TRL by +2 towards Spaceflight qualification and mission infusion.

The overall merit of the management approach, its realism, and the extent to which the roles and responsibilities for all participating organizations, including the NASA partner(s), are clearly described and address the competences, facilities, and equipment needed to execute the project. The extent to which the needed equipment, facilities and other hardware are identified and available.

Lastly, the extent to which there are educational involvement benefits.

Full Proposal Evaluation Criterion 3 - Cost (Weight 10%)

Cost and budgetary elements will be reviewed for realism and reasonableness, as well as compliance with the stated guidelines.

5.4 Review and Selection Process for the MPP and Full Proposal

The review process will be in accordance with the STMD Organizational Conflict of Interest (OCI) Mitigation Plan dated October 8, 2015 and Appendix E of the NASA Proposer’s Guide. The NASA Space Technology Mission Directorate Deputy Associate Administrator for Programs or designee will be the final Selecting Official for the Preliminary and Full Proposals. Every effort will be made to avoid organizational

conflicts of interest. In cases where they cannot be avoided, they will be mitigated according to the STMD OCI Mitigation Plan.

5.4.1 MPP Review and Selection

The review process consists of four principal steps:

1. *Compliance Review* – The proposals are reviewed by the SST program for compliance with the solicitation requirements. Non-compliant/non-responsive proposals may be withdrawn from the review process and declined without further review. Notification to proposers of non-compliant proposals will occur as soon as practicable.
2. *Technical Panel Peer Review* – A Technical Review Panel comprised of subject matter experts will evaluate the proposals against the evaluation criteria delineated in Section 5.2 of this Appendix.
3. *Prioritized Recommendation* – Responsible NASA officials will review the results of the Technical Review Panel and consider programmatic aspects such as budget allocations, portfolio balancing, and past performance relative to NASA, SST and FO program activities (including schedule performance, mission execution, timely delivery of required technical reports). A prioritized recommendation will be developed for the Selection Official to invite proposers to submit Full Proposals
4. *Invitation for Full Proposal* – The Selection Official will make the final decision on proposals to be invited to submit a Full Proposal.

5.4.2 Full Proposal Review and Selection

The review process consists of four principal steps:

1. *Compliance Review* – The proposals are reviewed by the SST program for compliance with the solicitation requirements. Non-compliant/non-responsive proposals may be withdrawn from the review process and declined without further review. Notification to proposers of non-compliant proposals will occur as soon as practicable.
2. *Technical Panel Peer Review* – A Technical Review Panel comprised of subject matter experts will evaluate the proposals against the evaluation criteria delineated in Section 5.3 of this Appendix.
3. *Prioritized Recommendation* – Responsible NASA officials will review the results of the Technical Review Panel and consider programmatic aspects such as budget allocations, portfolio balancing, as well as past performance relative to NASA, SST and FO program activities (including schedule performance, mission execution, timely delivery of required technical reports). A prioritized recommendation will be developed for the Selection Official.
4. *Selection* – The Selection Official will make the final selection of proposals for award.

5.4.3 Partial Selections

No change from Section 5.4 in the NRA.

5.4.4 Selection Announcement and Award Dates

No change from Section 5.3 in the NRA, except as noted below.

The target Selections Announcement and Awards Issue dates are given on page iii of this document.

NASA's goal is to announce selections as soon as possible; however, NASA does not usually announce new selections until the funds needed for those awards are approved through the Federal budget process. Therefore, a delay in the budget process for NASA usually results in a delay of the selection date(s). By submitting a proposal, the proposer acknowledges that the proposal is valid for no less than twelve months from submission.

In order to announce selection decisions as soon as is practical, even in the presence of budget uncertainties, the Selection Official may decide to defer selection decisions on some proposals while making selection decisions on others. If a Selection Official uses this option, then proposals will be categorized as "selected," "not selected," or "not selected at this time." Proposals that are "not selected at this time" may be considered for a supplemental selection when circumstances allow. All offerors whose proposals are "not selected at this time" will be notified whether their proposal is selected through a supplemental selection or whether their proposal is no longer being considered for a supplemental selection when a final decision is made.

All proposers will be notified of their selection status via NSPIRES for both the MPP and Full Proposal.

Debriefings: The PI submitting a proposal may request a written summary of the peer review panel evaluation via the NSPIRES system. This is the only debriefing that will be provided.

6. AWARD ADMINISTRATION INFORMATION

No changes from Section 6.0 in the NRA, except for the supplemental Award Reporting / Meetings / Deliverables defined in Section 2.3 of this Appendix. If any criteria in this Appendix conflict with any other part of the NRA, the criteria identified in this Appendix take precedence.

For selected proposers, the proposer's business office will be contacted by a NASA Awards Officer, who is the only official authorized to obligate the Government. Proposers are reminded that they should not begin performance of any activities associated with their proposal until NASA has obligated funds through the award instrument. Award recipients may incur pre-award costs up to 90 calendar days prior to

award; however, any costs incurred in anticipation of an award are at the proposer's own risk (see NRA Section 4.3.7 for more details).

As noted in the NRA Section 6.1 all awards from this funding announcement are subject to are subject to the terms and conditions, cost principles, and other considerations described in the 2 CFR 200, 2 CFR 1800, 2 CFR 25, 2 CFR 170, 175, 182, 183 and the NASA GCAM (see document link in Section 9).

Awards from this funding announcement that are issued under 2 CFR 1800 are subject to the Federal Research Terms and Conditions (RTC) located at https://www.nsf.gov/awards/managing/rtc.jsp. In addition to the RTC and NASA-specific guidance, three companion resources can also be found on the website: Appendix A—Prior Approval Matrix, Appendix B—Subaward Requirements Matrix, and Appendix C—National Policy Requirements Matrix. See NRA Section 6.2 for more details.

If the Federal share of any award issued under this NRA is more than $500,000 over the period of performance, additional reporting requirements may apply. See 2 CFR 200 Appendix XII – Award Term and Condition for Recipient Integrity and Performance Matters (https://www.ecfr.gov/current/title-2/subtitle-A/chapter-II/part-200/appendix-Appendix%20XII%20to%20Part%20200). In addition, NASA Grant Officers will conduct a pre-award review of risk associated with the proposer as required by 2 CFR 200.206, Federal awarding agency review of risk posed by applicants. See NRA Section 5.6. for more details.

Awards of proposals related to this NRA and Appendix must comply with the National Environmental Policy Act (NEPA); thus, proposers are encouraged to plan and budget for any anticipated environmental impacts. While most research awards will not trigger action-specific NEPA review, some activities (including international actions) will. The majority of grant-related activities are categorically excluded as research and development (R&D) projects that do not pose any adverse environmental impact. A blanket NASA Grants Record of Environmental Consideration (REC) provides NEPA coverage for these anticipated activities. The NSPIRES award application cover page includes questions to determine whether a specific proposal falls within the Grants REC and must be completed as part of the proposal submission process. Activities outside of the bounding conditions of the Grants REC will require additional NEPA analysis. See NRA Section 6.2 for more details.

7. POINT OF CONTACT FOR FURTHER INFORMATION

No change from Section 7.0 in the NRA, except as noted below.

Questions pertaining to this Appendix should be submitted via email to the NASA Point of Contact, Christopher Baker, HQ-STMD-SST-Partnerships@nasaprs.com no later than later than May 4, 2023 (5:00 pm Eastern). Questions of a general nature will be added to the FAQs for this Appendix and posted on NSPIRES. Please refer to the NSPIRES site for FAQ updates.

For NSPIRES help, please contact:

NSPIRES Help Desk

E-mail: nspires-help@nasaprs.com

Phone: 202-479-9376

Awarded Work Reporting

Proposer should notify NASA of any awards for substantially the same research as proposed to NASA between the proposal due date and until the time that NASA's selections are announced. Information should be directed to:

Christopher Baker,

Program Executive, Small Spacecraft Technology and Flight Opportunities programs

Space Technology Mission Directorate, NASA Headquarters, HQ-STMD-SST-Partnerships@nasaprs.com

8. ANCILLARY INFORMATION

No change from Section 8.0 in the NRA.

9. GENERAL REFERENCES & RESOURCES AVAILABLE

The umbrella NRA (herein referred to as "NRA") Space Technology Research, Development, Demonstration, and Infusion-2023 (SpaceTech-REDDI-2023) under which this USTP Appendix falls under can be found at: https://nspires.nasaprs.com/external/solicitations/summary!init.do?solId={C5C4C0AD-F7F4-D739-CE2C-FD8D7AFF1F52}&path=open

Additional programmatic information may develop before the proposal due date. If so, such information will be added as a formal amendment to this NRA as posted at https://nspires.nasaprs.com. It is the responsibility of the prospective proposer to check this website for updates.

Any clarifications or questions and answers that are published will be posted on a FAQ page for this Appendix on NSPIRES at https://tinyurl.com/NASA-23USTP.

The latest NASA Procurement regulations and guidance can be found at:

https://www.nasa.gov/offices/procurement/gpc/regulations_and_guidance

- This includes the latest Grants and Cooperative Agreements Manual (GCAM) (October 31, 2022 version): https://www.nasa.gov/sites/default/files/atoms/files/grant_and_cooperative_agreement_manual_-_oct._2022_0.pdf
- And the latest NASA Proposer's Guide (February 28, 2023 version) https://www.nasa.gov/sites/default/files/atoms/files/2023_-_nasa_proposers_guide_-_final.pdf.

The national space priorities, strategic frameworks and plans pertinent to this Appendix can be found at the following links:

- United States Space Priorities Framework, 2021 https://www.whitehouse.gov/wp-content/uploads/2021/12/united-states-space-priorities-framework-_-december-1-2021.pdf
- National Cislunar Science & Technology Strategy, 2022 https://www.whitehouse.gov/wp-content/uploads/2022/11/11-2022-NSTC-National-Cislunar-ST-Strategy.pdf
- NASA Strategic Plan 2022 https://www.nasa.gov/sites/default/files/atoms/files/2022_nasa_strategic_plan.pdf
- STMD Strategic Framework, Envisioned Future Priorities (see Small Spacecraft Technologies) https://techport.nasa.gov/framework
- NASA Small Spacecraft Strategic Plan, 2019 https://www.nasa.gov/sites/default/files/atoms/files/smallsatstrategicplan.pdf

Information about the Space Technology Mission Directorate (STMD) and its various programs can be found at: https://www.nasa.gov/directorates/spacetech/about_us/

Information about the Small Spacecraft Technology (SST) program and resources available may be found online at the following links:

- Main website: https://www.nasa.gov/smallspacecraft
- Projects and Missions: https://www.nasa.gov/directorates/spacetech/small_spacecraft/projects-missions.html
- Small Spacecraft Virtual Institute (S3VI): https://www.nasa.gov/smallsat-institute
- S3VI State-of-the-Art of Small Spacecraft Technology Report 2022: https://www.nasa.gov/smallsat-institute/sst-soa
- SST program Guidebook for Technology Development Projects https://www.nasa.gov/sites/default/files/atoms/files/smallsattechdevguidebook_rev-508d1.pdf

Information about the Flight Opportunities (FO) program and resources available may be found online at the following links:

- Main website: https://www.nasa.gov/flightopportunities
- List of qualified flight providers and services that are under contract: https://www.nasa.gov/directorates/spacetech/flightopportunities/flightproviders
- Community of Practice: https://www.nasa.gov/directorates/spacetech/flightopportunities/community-of-practice.html
- Newsletter: https://www.nasa.gov/directorates/spacetech/flightopportunities/newsletter
- Selected technologies: https://flightopportunities.nasa.gov/technologies
- Twitter: https://twitter.com/NASA_Technology

Information about the CubeSat Launch Initiative (CSLI) and resources available can be found online at the following links:

- Main website: https://www.nasa.gov/directorates/heo/home/CubeSats_initiative
- Past and current CSLI announcements of opportunities: https://www.nasa.gov/content/announcement-of-partnership-opportunity-for-cubesat-launch-initiative
- Resources: https://www.nasa.gov/content/cubesat-launch-initiative-resources
- CubeSat 101 Guidebook: https://www.nasa.gov/sites/default/files/atoms/files/nasa_csli_cubesat_101_508.pdf

Information on accommodations for the International Space Station (ISS) research, development, and demonstration can be found at the following links:

- ISS Utilization Reference Guide: https://www.nasa.gov/sites/default/files/atoms/files/np-2015-05-022-jsc-iss-guide-2015-update-111015-508c.pdf
- Researcher's Guide: http://www.nasa.gov/mission_pages/station/research/researcher_guide

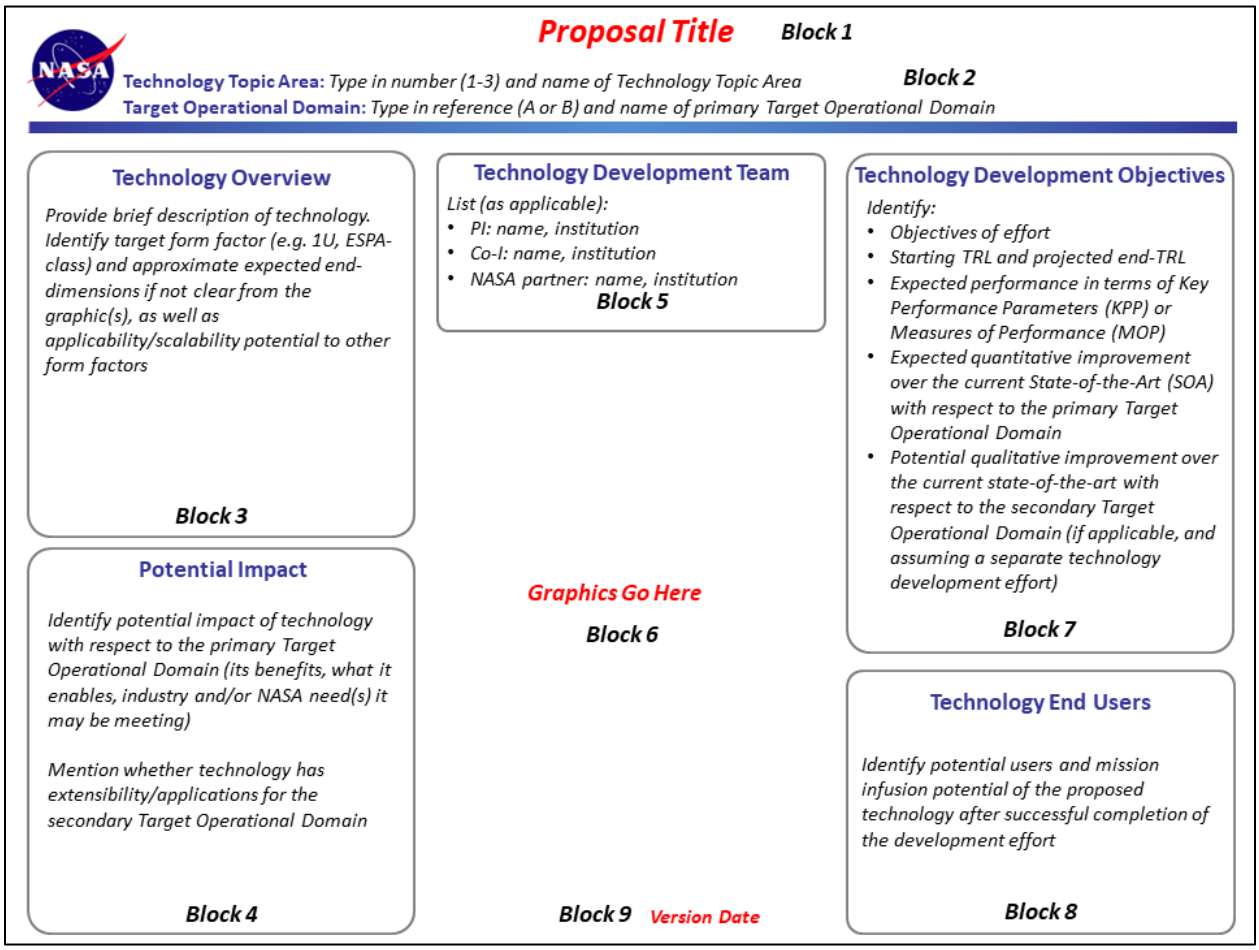
Other relevant documentation:

- NPR 2200.2E "Requirements for Documentation, Approval, and Dissemination of NASA Scientific and Technical Information" https://nodis3.gsfc.nasa.gov/displayDir.cfm?t=NPR&c=2200&s=2D

ATTACHMENT 1

A Summary Chart shall be provided for both the MPP and the Full Proposal as shown in the figure below. Proposals that do not include a completed Summary Chart may be declared non-responsive and not reviewed. **The Summary Chart shall be uploaded to NSPIRES as a separate document.**

Figure 1. Summary Chart Template*



**Note: Summary chart must be in landscape format, with the page rotated to occupy an entire 8.5" x 11" page.*

The purpose of the Summary Chart is to capture the top-level, critical information from the entire proposal into a single, stand-alone page (i.e., it should not require the full proposal to be understood). The Summary Chart shall occupy the entire 8.5" x 11" page and be in landscape format. The Summary Chart will be used for NASA internal reviews and presentations and its content may also be released publicly if the proposal is selected. **Proprietary Data and/or ITAR/EAR information shall not be included and**

all information on the chart shall include publicly releasable information. The Summary Chart may be edited for formatting and uniformity by NASA. The Summary Chart shall use the format as provided in Figure 1. A template in a commonly used presentation software format is provided for this purpose (available on the NSPIRES page where this Appendix is located); however, proposers are not required to use any particular software. The titles and layout of each block must not be changed, except for the removal of the “Proposal Title”, “Graphics Go Here” and “Version Date” titles. The size of each text block may be adjusted as needed; however, a minimum of 10-point font size is required. The information must be consistent with the information provided in the complete proposal and in the NSPIRES Proposal Cover Page. The text in each block may be provided in sentence or bullet-point format. The specific instructions for each block are given below.

Block 1 – Proposal Title

Provide the complete proposal title exactly as submitted in the NSPIRES Proposal Cover Page.

Block 2 – Identification of Technology Topic Area and Target Operational Domain

Identify the Technology Topic Area number and name, from the three presented in Section 1.4.2. Identify the Target Operational Domain reference (A or B) and name for the selected primary one, from the two presented in Section 1.4.1. There is no need to identify the secondary Target Operational Domain.

Block 3 - Technology Overview

Provide a brief description of the overall concept of the proposed technology and its purpose. Identify the target form factor for the proposed technology (e.g. 1U, ESPA-class) and approximate dimensions expected at end of project if not clear from the graphic(s), as well as its applicability/scalability to other form factors. *This shall not include Proprietary Data and/or ITAR/EAR information.*

Block 4 - Potential Impact

Describe briefly the potential impact of technology with respect to the primary Target Operational Domain, including its benefits, what it enables, and industry and/or NASA need(s) it may be meeting. Mention whether technology has extensibility/applications for the secondary Target Operational Domain

Block 5 – Technology Development Team

List, as applicable, the PI, Co-PI(s), Co-I(s) and NASA partner(s) name and institution. For the MPP version of the Summary Chart, the NASA partner(s) may be identified as

To Be Determined (TBD), if they haven't been identified and/or committed yet. For the Full Proposal version, the NASA partner(s) shall be identified.

Block 6 – Graphics

Provide photo(s), graphic(s), and/or a functional schematic(s) for the technology concept

Block 7 – Technology Development Objectives

Provide a brief overview of the objectives of the effort. Identify the starting TRL and projected end-TRL as a result of the effort. Identify the expected performance in terms of Key Performance Parameters (KPP) or Measures of Performance (MOP). Identify the expected quantitative improvement over the current state-of-the-art with respect to the primary Target Operational Domain. Identify the potential qualitative improvement over the current state-of-the-art with respect to the secondary Target Operational Domain (if applicable, and assuming a separate technology development effort).

Block 8 – Technology End Users

Identify potential users and applications of the proposed technology after completion of the development effort. This could include NASA and other government flight programs and/or commercial applications. Can be listed in terms of infusion and/or commercialization potential.

Block 9 – Version Date

Provide the date for the current version of this document