SF254-D1202: Space-Based Interceptors for Boost-Phase Missile Defense in the Endo-Atmospheric Region

ADDITIONAL INFORMATION
N/A

TECHNOLOGY AREAS:
Space Platforms

MODERNIZATION PRIORITIES:
Space Technology

KEYWORDS:
AFWERX/SpaceWERX; Space-Based Interceptor; SBI; Booster; Seeker; Endo-atmospheric

OBJECTIVE:
The U.S. Space Force (USSF) is seeking innovative solutions to advance the development of space-based interceptors (SBIs) capable of conducting boost-phase missile defense within the endo-atmospheric region (below 120 km altitude). This effort aims to close critical capability gaps in early intercept technologies by maturing compact, high-performance platforms that enable rapid, precise, and survivable endo-atmospheric engagements from space-based assets.

The desired outcome is to develop and integrate high-G propulsion systems, advanced seekers, and low-SWaP interceptors integrated into space vehicles for an SBI architectures that support fast detection-to-intercept timelines. Emphasis is placed on scalable designs, manufacturability, miniaturization, and end-to-end system integration suitable for future demonstrations on distributed space-based platforms.

This initiative supports the Space Force's broader strategy to establish a layered missile defense architecture, leveraging space as a vantage point for intercepting evolving missile threats during their most vulnerable phase of flight. Technologies developed under this topic are expected to contribute directly to national security priorities and long-term deterrence capabilities.

ITAR:
The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

DESCRIPTION:
Given the extreme engagement conditions and compressed decision timelines required for boost-phase missile intercept, Space Systems Command – Space Combat Power (SSC/SZ) is soliciting novel concepts and matured subsystems to enable space-based interceptors capable of endo-atmospheric intercept. Submissions should focus on enabling technologies across three key areas:
- Highly capable boosters and propulsion systems that deliver large delta V, high thrust and maneuverability,
- Advanced sensor suites and seekers capable of reliable target discrimination in hypersonic or cluttered environments,
- Fully integrated space vehicle and interceptor architectures that meet size, weight, and power (SWaP) constraints suitable for deployment in distributed satellite constellations.

Proposed concepts should emphasize rapid manufacturability, reduced system complexity, and miniaturization to enable scalable deployment. Solutions must be capable of withstanding the thermal, mechanical, and

navigational challenges associated with endo-atmospheric engagement (<120 km altitude) from space-based interceptors. This effort is a critical part of the U.S. Space Force's broader strategy to develop and demonstrate SBIs that provide layered missile defense capabilities. The project will involve close collaboration with key stakeholders across SSC, the Missile Defense Agency (MDA), and other strategic partners.

The technologies matured through this topic will play a pivotal role in establishing a credible, rapid-response missile defense layer from space, helping deter adversaries and secure the nation's advantage in the evolving threat environment.

PHASE I:

This topic is intended for technology proven ready to move directly into Phase II. Therefore, Phase I awards will not be made for this topic. The applicant is required to provide detail and documentation in the Direct-to-Phase-II (D2P2) proposal which demonstrates accomplishment of a "Phase I-type" effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-mission fit between the proposed solution and a potential U.S. Air Force (USAF) and/or USSF stakeholder. The applicant should have defined a clear, immediately actionable plan with the proposed solution and the U.S. Department of Air Force (DAF) customer and end-user. The feasibility study should have:

1. Clearly identified the potential stakeholders of the adapted solution for solving the USAF and/or USSF need(s).
2. Described the pathway to integrating with DAF operations, to include how the applicant plans to accomplish core technology development, navigate applicable regulatory processes, and integrate with other relevant systems and/or processes.
3. Describe if and how the solution can be used by other U.S. Department of Defense (DoD) or Governmental customers.

PHASE II:

The proposed solutions should develop and demonstrate innovative technologies to support space-based endo-atmospheric interceptors for early-phase missile defense as part of the Space Force's space-based interceptors initiative. Solutions should address one or more of the following technology categories: (1) high-performance propulsion and boosters, (2) advanced seekers and target discrimination systems, and (3) integrated space vehicle architectures for space-based endo-atmospheric interceptors.

TECHNICAL AREA 1: High Performance Booster and Propulsion Technologies

Proposals should target systems capable of delivering rapid thrust and large delta-v to meet the demanding timelines of boost-phase intercept. Desired characteristics include dual-pulse or throttleable motors, high-grain solid or hybrid propellants, and thrust vector control compatible with form factors that can be scaled both in manufacturing and into the operational domain.

Focus areas of interest can include but not limited to: high-performance propellants (high grain or hybrid propellants) that demonstrate increased burn rates, improved specific impulse, tailored burn profiles, rapid reignition/thrust termination; throttleable and restartable hybrid propulsion systems (addressing ignition, throttling, and grain regression rate control); advanced manufacturing for solid and hybrid rocket motors; and low-power, high-response Thrust Vector Control (TVC) systems compatible with high-G loading.
Performance objectives include large delta-v (typically ≥ 6 km/s), high acceleration, and burn durations capable of targeting within the region of interest. Current state-of-the-art interceptors demonstrate high performance but are significantly larger and not optimized for rapid deployment or distributed constellations. Proposed solutions should demonstrate how comparable or greater performance can be achieved in a significantly smaller package.

TECHNICAL AREA 2: Advanced Seekers and Sensor Suite

Proposers should address compact, resilient sensor suites capable of acquiring and tracking targets under hypersonic/plasma environments or cluttered conditions. Innovative seeker architectures should consider fusing multiple sensing modalities, including active and passive IR, EO, and LADAR, with real-time data fusion and onboard discrimination as well as utilizing external RF links for in-flight target updates (IFTU) while in a plasma environment.

Advances in seeker technology should be considered such as miniaturization, optical window protection under hypersonic conditions, angular resolution, and real-time processing latency. Proposed solutions should advance

the current state-of-the-art with respect to guidance, navigation and control that enhances interceptor flight path and terminal trajectories. Successful solutions will also consider survivability under extreme conditions experienced during atmospheric re-entry including the extreme temperatures from aero-thermal heating. Approaches that reduce cost and complexity for scalable production are encouraged.

TECHNICAL AREA 3: Endo-Atmospheric Interceptor and Space Vehicle Integration

Proposed solutions should demonstrate how subsystems such as propulsion, sensors, comms, and GNC, can be combined into a low-SWaP architecture suitable for rapid manufacturing and deployment. Solutions should provide details for an end-to-end solution for a SBI capable of endoatmospheric engagement. This includes appropriate avionics, onboard autonomy for execution, and manufacturing methods that support fast iteration and production. Proposed solutions should provide details regarding host vehicle design requirements (mass, power, comms, orbit configuration, etc). The USSF is particularly interested in concepts that minimize interceptor mass, enable intercept timelines of less than 180 seconds from detect to intercept, and can mature to TRL 6. Past programs such as the Atmospheric Interceptor Technology/Endo-LEAP2 experiments offer starting points, but these efforts have yet to be scaled for deployment on proliferated, space-based platforms.

This topic supports the strategic missile defense to achieve layered defense by leveraging rapid innovation and dual-use commercial capabilities for national security space. Proposed technologies must demonstrate feasibility through modeling, benchtop testing, or subcomponent validation by the end of Phase II. A clear pathway to subsystem integration and flight testing in Phase II and beyond is strongly encouraged. Submissions should outline details for timelines needed to build, integrate, and launch SBIs in an on-orbit point-in-space demonstration. Proposed solutions should include annual program management reviews at the sponsoring organization facility in Huntsville, Alabama.

PHASE III DUAL USE APPLICATIONS:

Successful solutions from Phase II are expected to transition into Phase III, with a focus on operationalization, demonstration, and dual-use scalability. Phase II efforts that demonstrate technical maturity, integration feasibility, and mission alignment may be selected for continued development toward flight-capable prototypes and deployment in relevant operational environments. During Phase III, performers will:
- Advance System Readiness: Mature and integrate subsystems into complete interceptor prototypes capable of system-level testing and demonstration.
- Demonstrate Operational Capability: Prepare and deliver space-based endo-atmospheric interceptor systems for evaluation through ground testing and demonstrations in relevant environments (e.g., point-in-space trials).
- Support Transition Planning: Collaborate with SSC/SZ and other DoD stakeholders to define mission use cases, delivery timelines, and potential acquisition pathways for future deployment.
- Enable Cross-Service Application: Explore adaptation of the core technology to support other defense agencies or military services with similar needs in missile defense or high-speed intercept technologies.
- Pursue Dual-Use Commercialization: Identify and pursue commercial applications for high-performance propulsion, compact sensor suites, or integrated aerospace systems in areas such as hypersonics testing, responsive launch, atmospheric sensing, or high-speed autonomous systems.

Phase III work may be performed with non-SBIR/STTR funding and can include further government-sponsored prototyping, operational transition activities, or commercialization via strategic partners in the defense and aerospace sectors.

REFERENCES:

1. TRL Guide - https://www.gao.gov/assets/gao-20-48g.pdf
2. ENDO LEAP FLIGHT TEST PLANNING - https://apps.dtic.mil/sti/tr/pdf/ADA344784.pdf

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