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Hypersonic Missile Defense: Issues for Congress

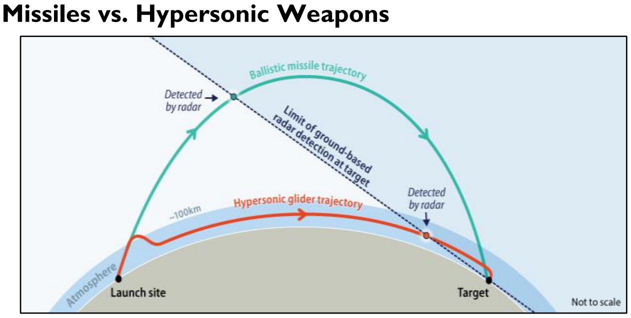
The Missile Defense Agency (MDA) and Space Development Agency (SDA) are currently developing elements of a hypersonic missile defense system to defend against hypersonic weapons and other emerging missile threats. These elements include the tracking and transport layers of the National Defense Space Architecture (NDSA) and various interceptor programs. As MDA and SDA continue to develop these systems, Congress may consider implications for oversight and defense authorizations and appropriations.

Background

Hypersonic weapons, like ballistic missiles, fly at speeds of at least Mach 5, or roughly 1 mile per second. Unlike ballistic missiles, hypersonic weapons do not follow a ballistic trajectory and can maneuver en route to their target. Russia reportedly fielded its first hypersonic weapons in December 2019, while some experts believe that China fielded hypersonic weapons as early as 2020. The United States is not expected to field hypersonic weapons before 2023. (For an overview of hypersonic weapons programs in Russia, China, and the United States, see CRS Report R45811, *Hypersonic Weapons: Background and Issues for Congress*, by Kelley M. Sayler.)

The maneuverability and low flight altitude of hypersonic weapons could challenge existing detection and defense systems. For example, most terrestrial-based radars cannot detect hypersonic weapons until late in the weapon's flight due to line-of-sight limitations of radar detection. This leaves minimal time for a defender to launch interceptors that could neutralize an inbound weapon. **Figure 1** depicts the differences in terrestrial-based radar detection timelines for ballistic missiles versus hypersonic weapons.

Figure 1. Terrestrial-Based Detection of Ballistic Missiles vs. Hypersonic Weapons



Source: CRS image based on an image in "Gliding missiles that fly faster than Mach 5 are coming," *The Economist*, April 6, 2019, https://www.economist.com/science-and-technology/2019/04/06/gliding-missiles-that-fly-faster-than-mach-5-are-coming.

U.S. defense officials have stated that both existing terrestrial- and space-based sensor architectures are insufficient to detect and track hypersonic weapons; former Under Secretary of Defense for Research and Engineering Mike Griffin has noted that "hypersonic targets are 10 to 20 times dimmer than what the U.S. normally tracks by satellites in geostationary orbit."

National Defense Space Architecture

SDA developed the National Defense Space Architecture to "unify and integrate next generation capabilities across [the Department of Defense (DOD)] and industry." The NDSA aims to be a "single, coherent proliferated space architecture with seven layers," which include the data tracking and transport layers depicted in **Figure 2** and discussed below. Other layers include the *custody layer* to support the targeting of mobile ground assets; the *battle management layer* to provide space-based command and control; the *navigation layer* to provide "alternate positioning, navigation, and timing for potential GPS-denied environments"; the *deterrence layer* to detect potentially hostile actions in deep space; and the *support layer* to facilitate satellite operations for the other NDSA layers. Once fully fielded, the NDSA is to include 550 satellites and provide full global coverage.

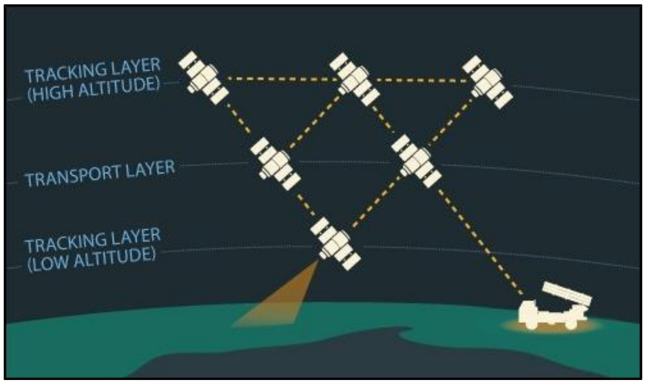
Tracking Layer

The tracking layer is to "provide global indications, warning, tracking, and targeting of advanced missile threats, including hypersonic missile systems." As part of this layer, SDA is developing an architecture of Wide Field of View (WFOV) satellites, which are to eventually provide global coverage. SDA requested $81.3 million for Tranche 0 tracking activities in FY2023 and $499.8 million for Tranche 1 tracking activities (also known as Resilient Missile Warning Missile Tracking - Low Earth Orbit).

Working in tandem with the SDA's tracking satellites will be the Hypersonic and Ballistic Tracking Space Sensor (HBTSS), previously known as the Space Sensor Layer, which is being developed by MDA in collaboration with SDA and the U.S. Space Force. HBTSS is to provide more sensitive, but more limited (or Medium Field of View [MFOV]) coverage, compared to WFOV. For this reason, WFOV is intended to provide cueing data to HBTSS, which could then provide more specific, target quality data to a ground-based interceptor. By 2023, SDA plans to expand the tracking layer to include 70 WFOV and MFOV satellites, which, according to SDA director Dr. Derek Tournear, "will give us enough coverage in low-Earth orbit so that we can have essentially regional persistence." MDA requested $89.2 million for HBTSS in FY2023.

Section 1682 of the FY2020 NDAA (P.L. 116-92) tasks the director of the Missile Defense Agency to "develop a hypersonic and ballistic missile tracking space sensor payload." Section 1645 of the FY2021 NDAA (P.L. 116-283) affirms the MDA director's responsibility for the development and procurement of the sensor payload—in coordination with the director of SDA—"through, at minimum, fiscal year 2022." Section 1645 additionally requires that on-orbit testing of the sensor payload begin no later than December 31, 2023, and that integration of the sensor payload into the SDA's broader space-based sensor architecture begin "as soon as technically feasible thereafter." Finally, Section 1662 of the FY2022 NDAA (P.L. 117-81) prohibits the director of MDA from "[authorizing] or [obligating] funding for a program of record for the production of satellites or ground systems associated with the operation of such satellites." The Assistant Secretary of the Air Force for Space Acquisition and Integration may waive this limitation with respect to HBTSS if certain conditions are met, including a determination that "that such limitation would delay the delivery of an operational [HBTSS] because of technical, cost, or schedule factors."

Figure 2. Selected Elements of the NDSA



Source: CRS image; not to scale.

Transport Layer

SDA has stated that the NDSA's transport layer, which is intended to connect the tracking layer to interceptors and other weapons systems on the ground, will "enhance several mission areas including missile defense." According to DOD, SDA has awarded three prototype agreements for Tranche 1 of the transport layer, "a mesh network of 126 optically-interconnected space vehicles" that is to begin launching in September 2024. The transport layer is to eventually consist of a constellation of approximately 300-500 satellites. SDA requested $816.4 million for "the data transport layer, sensor capabilities, and alternate position, navigation, and timing capabilities" in FY2023.

Interceptors

MDA has explored a number of options for neutralizing hostile hypersonic weapons, including interceptor missiles, hypervelocity projectiles, directed energy weapons, and electronic attack systems. In January 2020, MDA issued a draft request for prototype proposals for a Hypersonic Defense Regional Glide Phase Weapons System interceptor. This program was intended to "reduce interceptor key technology and integration risks"; however, according to then-MDA director Vice Admiral Jon Hill, it would not have been ready to transition into development until sometime in the 2030s. MDA instead shifted focus to nearer-term solutions and, in April 2021, initiated the Glide Phase Interceptor (GPI), which is to be integrated with the Aegis Weapon System and notionally provide a hypersonic missile defense capability by the mid- to late 2020s. Lockheed Martin, Northrop Grumman, and Raytheon Missiles and Defense have been awarded contracts for the "accelerated concept design" phase of the GPI.

In addition, Section 1664 of the FY2022 NDAA (P.L. 117-81) grants the director of MDA "the authority to budget for, direct, and manage directed energy programs applicable" for hypersonic missile defense. The Defense Advanced Research Projects Agency (DARPA) is also working on a program called Glide Breaker, which is to "develop critical component technology to support a lightweight vehicle designed for precise engagement of hypersonic threats at very long range." DARPA requested $18.3 million for Glide Breaker in FY2023. Overall, MDA requested $225.5 million for hypersonic defense in FY2023—down from its $247.9 million FY2022 request and $287.8 million appropriation.

Issues for Congress

Some analysts have suggested that space-based sensor layers—integrated with tracking and targeting systems to direct high-performance interceptors or directed energy weapons—could theoretically present viable options for defending against hypersonic weapons. The 2019 Missile Defense Review notes that "such sensors take advantage of the large area viewable from space for improved tracking and potentially targeting of advanced threats, including hypersonic [weapons]." Other analysts have questioned the affordability, technical feasibility, and/or utility of hypersonic weapons defense. In addition, some analysts have argued that the United States' current command and control architecture would be incapable of "processing data quickly enough to respond to and neutralize an incoming hypersonic threat."

Some analysts have also questioned the current division of labor between the SDA and MDA on hypersonic missile defense. SDA director Tournear has previously responded to criticisms of potential redundancies between the two agencies, stating that both report to the Under Secretary of Defense for Research and Engineering. However, as of October 1, 2022, SDA is to instead report to the Assistant Secretary of the Air Force for Acquisition and Integration. Congress may monitor the implications of this new reporting structure for efficiency and efficacy.

Potential Questions for Congress

- Is an acceleration of research on hypersonic missile defense options both necessary and technologically feasible? Does the technological maturity of hypersonic missile defense options warrant current funding levels?
- How are SDA and MDA collaborating on various elements of hypersonic missile defense? Are their current roles increasing or decreasing costs and the speed and efficiency of technology development?
- Does DOD have the enabling capabilities, such as adequate command and control architectures, needed to execute hypersonic missile defense?

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