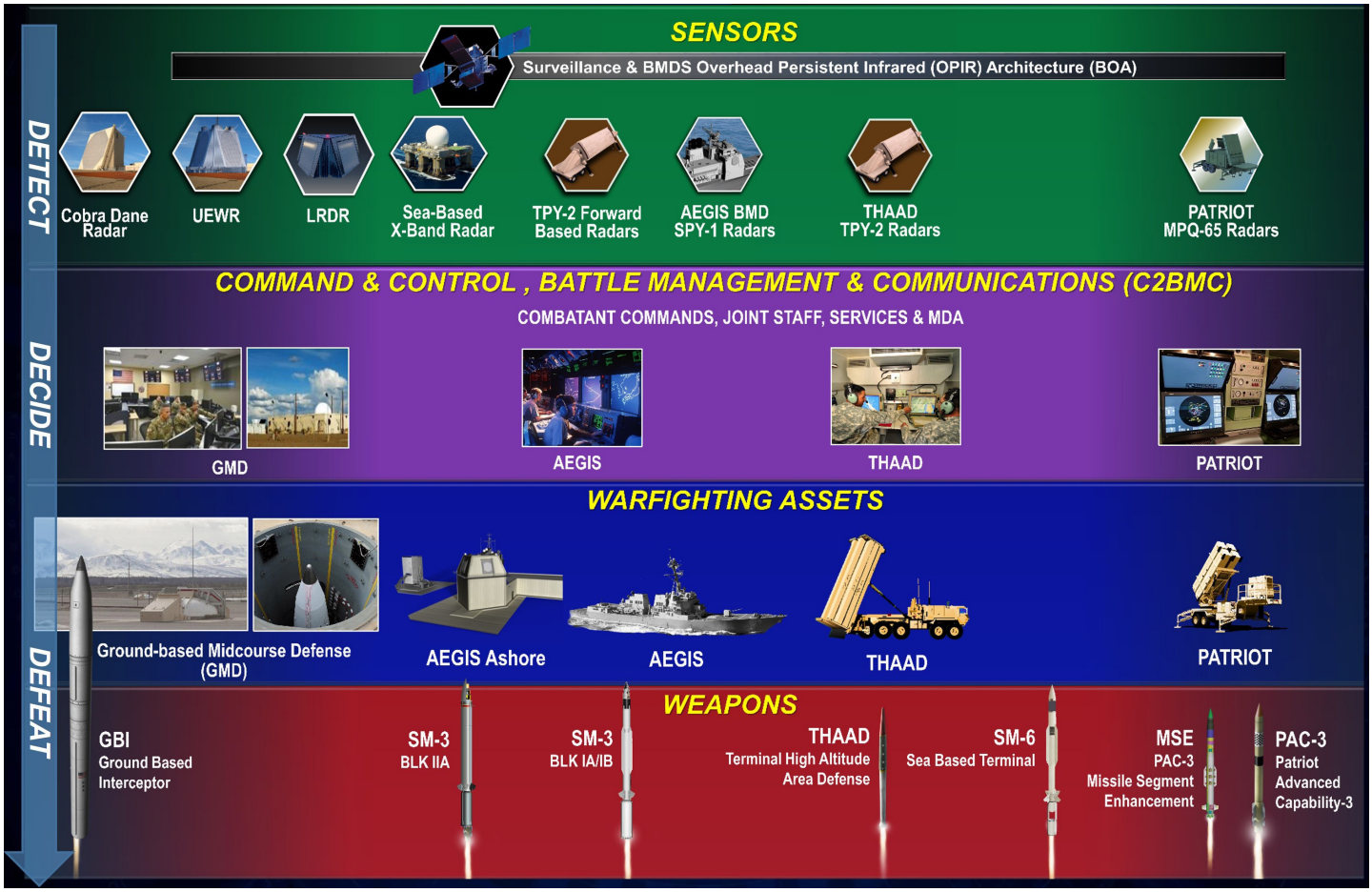
MISSILE DEFENSE SYSTEM



BMD – Ballistic Missile Defense
BLK – Block
GBI – Ground-Based Interceptor
LRDR – Long Range Discrimination Radar
MPQ – Mobile, Position Locating Special Purpose
SM – Standard Missile
SPY – Surface Ship Radar Surveillance
THAAD – Terminal High Altitude Area Defense
TPY – Transportable Radar Surveillance
UEWR – Upgraded Early Warning Radar

Missile Defense System (MDS)

The Ground-based Midcourse Defense (GMD) weapon system has demonstrated the capability to defend the U.S. homeland from a small number of ballistic missile threats employing simple countermeasures and with ranges greater than 3,000 kilometers, when supported by the full architecture of Missile Defense System (MDS) sensors. The Regional/Theater MDS has demonstrated the capability to defend the U.S. Indo-Pacific Command (USINDOPACOM), U.S. European Command (USEUCOM), and U.S. Central Command (USCENTCOM) areas of responsibility from a small number of medium- or intermediate-range ballistic missile (MRBM or IRBM, respectively) threats with ranges less than 4,000 kilometers, and from representative raids of short-range ballistic missile (SRBM) threats. DOT&E assesses that the top five challenges for the MDS remain the same as last year: (1) the need for realistic and emerging threat representations in flight and ground testing; (2) the need for an adequate, accredited federation of modeling and simulation (M&S) with well understood and documented limitations to assess MDS effectiveness; (3) cyber-attack against the MDS; (4) interoperability and maturation of engagement coordination; and (5) the need for test range infrastructure and instrumentation upgrades.

In FY25, the Missile Defense Agency (MDA) flight tested or demonstrated in real-world events four significant new MDS capabilities:

- Ability of the Long Range Discrimination Radar (LRDR) to acquire and track a ballistic missile threat complex and report those data to the Command and Control, Battle Management, and Communications (C2BMC) system
- Sustained regional/theater operations in a wartime environment during the 12-day war between Iran and Israel.
- Initial ability of the Aegis Guam System (AGS) with an AN/TPY-6 radar to detect, track, engage, and intercept a MRBM target using a Standard Missile (SM)-3 Block IIA guided missile.
- Ability of Aegis Ballistic Missile Defense (BMD) to detect, track, and conduct a simulated engagement against a maneuvering hypersonic missile using its Sea-Based Terminal (SBT) Increment 3 capability.

DOT&E will provide additional information and recommendations in the classified DOT&E FY25 Assessment Report on the MDS to be published in February 2026.

SYSTEM DESCRIPTION

The MDS is a geographically distributed system of systems that relies on element interoperability and warfighter integration for combat capability and efficient use of guided missile/interceptor inventory. As shown in Table 1, the MDS consists of seven weapon systems, a sensor architecture (i.e., terrestrial, maritime, and global sensors), and a command-and-control element.

Table 1. Elements of MDA's Missile Defense System

Type	U.S. Homeland Defense	Global Regional/Theater Defense	Hypersonic Defense
Weapon Systems	**GMD[a]:** Defends the U.S. homeland against IRBM/ICBM attacks using GBIs to defeat threat missiles during the midcourse segment of flight. The MDA is developing a Next Generation Interceptor to augment the current GBI fleet.	**Aegis BMD[a]:** Both sea- and land-based variants defend U.S. deployed forces and allies from SRBM, MRBM, IRBM, and a limited number of LRBM threats. Aegis BMD uses the SM-3 family of guided missiles against exo-atmospheric ballistic missile threats alongside SM-6 guided missiles that Aegis SBT (Inc 2 and Inc 3) uses for endo-atmospheric engagements. Aegis BMD can provide or accept target cues via C2BMC. **THAAD[a]:** Defends U.S. deployed forces and allies from SRBM, MRBM, and IRBM threats using guided interceptors in both the exo- and endo-atmosphere. For extended engagements, THAAD can provide or accept target cues via C2BMC. THAAD complements the upper-tier Aegis BMD and the lower-tier PAC-3 weapon systems. **Patriot[b]:** Defends U.S. deployed forces and allies from SRBM and MRBM threats and aircraft attack and defeats enemy air assets. It is a mobile air and missile defense system employing a mix of PAC-3 hit-to-kill interceptors and PAC-2 blast fragmentation warhead interceptors. Patriot can accept or provide target cues via C2BMC.	**Aegis SBT (Inc 3)[a]:** Provides critical asset protection at sea and for joint forces ashore against ballistic, maneuverable, and hypersonic glide threats in the terminal phase. **GPI[a]:** Will provide an additional layer of hypersonic defense augmenting Aegis SBT (Inc 3) to increase depth of fire against hypersonic threats. The MDA and its international partner, the Japan Ministry of Defense, are proceeding with the Northrop Grumman Corporation's interceptor concept to continue development of the GPI.
		AGS[a]: Land-based Aegis BMD variant that will help defend Guam from ballistic and hypersonic threats using SM-3 and SM-6 guided missiles and data from on-island radars.	
Terrestrial and Maritime Sensors	**Cobra Dane Radar[d]:** L-band fixed site phased-array radar. **UEWRs[d]:** Ultrahigh frequency fixed site phased-array radars. **SBX[a]:** X-band mobile phased-array radar located aboard a self-propelled, ocean-going platform. **LRDR[a,d]:** S-band two-face fixed site phased array radar.	**AN/SPY-1 Radar[c]:** S-band four-face radar providing Aegis long-range surveillance and track functions in addition to guided missile engagement support. **AN/SPY-6(V)1 Radar[c]:** S-band four-face radar being installed on new construction Aegis DDG 51 Flight III destroyers. It extends Aegis threat detection ranges and provides simultaneous ballistic missile and air defense support. **AN/TPY-2 (FBM) Radar[a]:** X-band single-face transportable phased-array radar that also supports U.S. homeland defense. **LTAMDS[b]:** C-band three-face multi-function, multi-mission radar interfacing with IBCS and supporting interoperability with PAC-3. **AN/TPY-6 Radar[a]:** S-band single-face transportable phased-array radar currently on Guam for potential inclusion in the Guam Defense System. Developed using the same technology as the LRDR.	Leverages U.S. homeland defense, global regional/theater defense, and global sensors.
Global Sensors	**SBIRS[d]:** Satellite constellation of infrared sensors. **BOA[a]:** Element that combines OPIR observations to provide missile event and track reports to C2BMC. **HBTSS[a]:** Network of space sensors to detect and track hypersonic and limited ballistic missile threats and provide fire-control quality data to MDS sensors and weapon systems. Prototype satellites participated in FY25 testing. **DSS[a]:** Space sensor that will track and discriminate objects in all phases of flight in support of the MDS. Currently in development. **PWSA[a]:** Network of space sensors and communication satellites to provide global communication and persistent fire control quality data of advanced missile threats, including hypersonic missile systems.		

Table 1. Elements of MDA's Missile Defense System, continued

Type	U.S. Homeland Defense	Global Regional/Theater Defense	Hypersonic Defense
C2	**C2BMC[a]:** Integrating element within the MDS, providing deliberate and dynamic planning, situational awareness, sensor track management, engagement support and monitoring, data exchange between elements, and network management. C2BMC also directs sensor tasking for the LRDR and AN/TPY-2 (FBM) radars, and it provides cueing support to BOA.		

Notes:
[a] Under MDA development/sustainment.
[b] Under Army development/sustainment.
[c] Under Navy development/sustainment.
[d] Under Space Force development/sustainment.

Acronyms: AN/SPY – Army Navy/Surface Ship Radar Surveillance; AN/TPY – Army Navy/Transportable Radar Surveillance; BMD – Ballistic Missile Defense; BMDS – Ballistic Missile Defense System; BOA – BMDS Overhead Persistent Infrared Architecture; C2 – Command and Control; C2BMC – Command and Control, Battle Management, and Communications; DSS – Discriminating Space Sensor; FBM – Forward-Based Mode; GMD – Ground-based Midcourse Defense; GBI – Ground-Based Interceptors; GPI – Glide Phase Intercept; HBTSS – Hypersonic and Ballistic Tracking Space Sensor; IAMD – Integrated Air and Missile Defense; IBCS – IAMD Battle Command System; ICBM – Intercontinental Ballistic Missile; Inc – Increment; IRBM – Intermediate-Range Ballistic Missile; LRBM – Long-Range Ballistic Missile; LRDR – Long Range Discrimination Radar; LTAMDS – Lower Tier Air and Missile Defense Sensor; MDA – Missile Defense Agency; MDS – Missile Defense System (formerly BMDS); MRBM – Medium-Range Ballistic Missile; OPIR – Overhead Persistent Infrared; PAC – Patriot Advanced Capability; PWSA: Proliferated Warfighter Space Architecture; SBIRS – Space-Based Infrared System; SBT – Sea-Based Terminal; SBX – Sea-Based X-band Radar; SM – Standard Missile; SRBM – Short-Range Ballistic Missile; THAAD – Terminal High Altitude Area Defense; UEWR – Upgraded Early Warning Radar

MISSION

The Commanders of U.S. Northern Command (USNORTHCOM), USINDOPACOM, USEUCOM, USCENTCOM, and U.S. Space Command (USSPACECOM) employ the assets of the MDS to defend the United States, deployed forces, allies, and friends against missile threats at all ranges and in all phases of flight.

PROGRAM

The MDS is a single Acquisition Category (ACAT) ID program that encompasses six of its seven weapon elements (all but Patriot), most of its sensor architecture, and its command-and-control element. A subset of the MDS elements will comprise the Guam Defense System architecture. In FY25, the DoW began initial planning and development of the Golden Dome for America architecture, which will also include multiple elements of the MDS. In 2002, the Secretary of Defense granted the MDA nonstandard acquisition authorities for the MDS, which allowed it to use tailored processes and milestones to deploy new capability, as soon as technologically possible, to defend the United States and its allies against limited ballistic missile attacks.

The MDA maintains responsibility for integrating all elements into the MDS whether or not the MDA developed the element. The MDA publishes a test plan update twice a year in an Integrated Master Test Plan (IMTP) that corresponds to the MDA Program Objective Memorandum submission to the Department and the President's Budget release to Congress, which DOT&E reviews. DOT&E disapproved IMTP Version 26.1 in December 2024 because of a lack of flight test resources for future tests. In FY25, the MDA began revising the overall test approach, moving toward a high-cadence test program to address next-generation missile defense needs. This restructuring includes changes to the IMTP development process as well as many test event modifications and additions. DOT&E will review these ongoing changes throughout FY26.

The Army manages the Patriot and Lower Tier Air and Missile Defense Sensor (LTAMDS) programs. Patriot is an ACAT IC program. DOT&E approved the Patriot Post Deployment Build (PDB) 8.1 TEMP in FY20. The LTAMDS program achieved a conditional Milestone C and major capability acquisition program designation in February 2025. DOT&E approved the LTAMDS TEMP in March 2025. LTAMDS-specific test activities and assessments are provided in the LTAMDS article in this Annual Report.

The Navy manages the AN/SPY-1 and AN/SPY-6(V)1 radar programs. The AN/SPY-6(V)1 radar is an ACAT IC program. DOT&E approved its TEMP in September 2022.

The Space Force operates and sustains four sensor systems integrated into the MDS: Cobra Dane Upgrade, five Upgraded Early Warning Radars (UEWRs), LRDR, and the Space-Based Infrared System (SBIRS) constellation. More details on SBIRS testing and assessments are in the SBIRS Survivable Endurable Evolution (S2E2) article in this Annual Report. The Air Force completed development and initial operational testing for the first three sensor systems prior to them becoming Space Force assets. The MDA completed development and initial operational testing for LRDR in FY25, and the Space Force anticipates operationally accepting LRDR in early FY26.

» MAJOR CONTRACTORS

- The Boeing Company
  - GMD Integration, Test and Readiness: Huntsville, Alabama
- Lockheed Martin Corporation
  - Aegis BMD, AAMDS, Aegis SBT, AGS, AN/SPY-1 radar, LRDR, AN/TPY-6, and Glide Phase Intercept (GPI) Weapons System: Moorestown, New Jersey
  - C2BMC: Huntsville, Alabama and Colorado Springs, Colorado
  - Next Generation Interceptor All-Up Round in product development: Huntsville, Alabama
  - SBIRS: Sunnyvale, California
  - THAAD Weapon System, PAC-3 Command and Launch System, and PAC-3 interceptor variants: Dallas, Texas
  - THAAD interceptors: Troy, Alabama
- Northrop Grumman Corporation
  - GMD Weapon Systems Development and GPI missile: Huntsville, Alabama
  - GBI Boost Vehicles: Chandler, Arizona
  - BOA: Boulder, Colorado; Colorado Springs, Colorado; and Azusa, California
  - HBTSS through Prototype Demonstration Phase: Redondo Beach, California and Azusa, California
- RTX
  - GMD EKV, SM-3/6 Interceptors, and LTAMDS: Tucson, Arizona
  - Patriot Ground System and PAC-2 interceptor variants, AN/SPY-6(V)1 radar, AN/TPY-2 radar, SBX radar, and UEWRs: Tewksbury, Massachusetts
  - Cobra Dane Radar: Dulles, Virginia
- L3Harris Technologies
  - HBTSS and DSS through Prototype Demonstration Phases: Fort Wayne, Indiana

TEST ADEQUACY

The MDA IMTP documents planned flight, ground (e.g., hardware-in-the-loop), and cyber survivability testing in support of operational capability declarations, as well as for the verification, validation, and accreditation of associated M&S. In FY25, the MDA conducted testing in accordance with the IMTP, although some events experienced technical and programmatic delays. Table 2 outlines the flight, ground, high-fidelity M&S, and cyber survivability test events that the MDA performed or participated in during FY25. For each test event in Table 2, the footnotes indicate whether DOT&E approved the test plan and whether DOT&E observed the event.

Table 2. FY25 Missile Defense System Testing

Date	Test	Mission Area	Description
October 2024	GTD-08b (USNORTHCOM/ USINDOPACOM)[a,e]	Homeland Defense and Regional/Theater Defense	The MDA and the MDS OTA conducted this DT/OT using operational assets and HWIL test assets supporting MDS-level interoperability assessments in USNORTHCOM/USINDOPACOM geographic regions, with new Aegis BMD and AN/TPY-2 (FBM) functions.

Table 2. FY25 Missile Defense System Testing, continued

Date	Test	Mission Area	Description
October 2024	Cyber Test-08b Part 2 (N/I)[a,d]	Homeland Defense	The MDA conducted a CVPA and AA on the LRDR and C2BMC Spiral 8.2-5.1 as configured for USNORTHCOM defense, to assess cyber survivability via a CVPA and AA events.
December 2024	FEM-02[c,d]	Regional/Theater Defense	The MDA demonstrated an initial AGS capability with an AN/TPY-6 radar to detect and track an MRBM target, and to engage and intercept the target in the midcourse phase of flight using an SM-3 Block IIA guided missile. This was the first BMD event executed from Guam.
December 2024	Joint Flight Campaign Resolve[c,e]	Hypersonic Defense	The MDA participated in this Army/Navy event to collect hypersonic missile phenomenology and tracking data to inform future capability development.
January 2025	Hypersonic Test Bed-2[c,e]	Hypersonic Defense	The MDA and NSWC-PH conducted this experiment to collect data on the hypersonic environment. An HBTSS observed the rocket-launched hypersonic vehicle.
February 2025	GTI-08b Part 2 (USNORTHCOM/USINDOPACOM)[c,e]	Homeland Defense	The MDA conducted this DT/OT using HWIL test assets supporting MDS-level assessments of updates that were implemented to address findings from the FY24 GTI-08b test.
February 2025	Glory Trip 252[c,e]	Homeland Defense	The MDA participated in this Air Force Global Strike Command event to collect data, exercise MDS communication links, and perform future capability assessments.
March 2025	FTX-40[a,d]	Regional/Theater Defense	The MDA and Navy demonstrated an Aegis SBT Inc 3 capability to detect, track, and conduct a simulated SM-6 engagement against a maneuvering hypersonic target.
March 2025	GTI-101 (USEUCOM/USCENTCOM)[a,e]	Regional/Theater Defense	The MDA and the MDS OTA conducted this DT/OT using HWIL test assets supporting MDS-level assessments in USEUCOM/USCENTCOM geographic regions, with new Aegis BMD and AN/TPY-2 (FBM) functions.
April 2025	GTI-108 (THAAD)[a,e]	Regional/Theater Defense	The MDA conducted this DT using HWIL assets supporting MDS-level assessments in USCENTCOM geographic regions, with a focus on interoperability within new THAAD operational laydowns.
April 2025	Joint Flight Campaign-4[c,e]	Hypersonic Defense	The MDA participated in this Army/Navy event to collect hypersonic missile phenomenology and tracking data to inform future capability development.
April — May 2025	UEWR Clear AOC Upgrade[a,e]	Homeland Defense	STARCOM conducted M&S OT on the UEWR at Clear Air Force Base, to evaluate the operational effectiveness, suitability, and survivability, after installation of the AOC upgrade.
May 2025	At-Sea Demonstration/Formidable Shield-25[c,e]	Regional/Theater Defense	NATO forces executed a series of live fire IAMD exercises to build joint interoperability and demonstrate joint command and control in complex integrated air and missile defense scenarios. Two Aegis BMD destroyers detected, tracked, and engaged ballistic missile targets with SM-3 Block IA interceptors during the exercises.
May 2025	Glory Trip 253[c,e]	Homeland Defense	The MDA participated in this Air Force Global Strike Command event to collect data, exercise MDS communication links, and perform future capability assessments.
June 2025	Live Radiate-26a[c,e]	Space Domain Awareness	The MDA conducted this event to assess MDS tasking and LRDR capability in support of the USSPACECOM space domain awareness mission while maintaining missile defense surveillance.

Table 2. FY25 Missile Defense System Testing, continued

Date	Test	Mission Area	Description
June 2025	FTX-26a[a,e]	Homeland Defense	The MDA demonstrated the LRDR's ability to acquire, track, and report missile data of an ICBM-representative target to C2BMC and GMD, which simulated an intercept.
June 2025	PCSB-1.0 DT Flight Test[c,e]	Regional/Theater Defense	The Army demonstrated the capability of the Patriot system, using PCSB-1.0, to search, detect, track, classify, engage, and kill a maneuvering surrogate ABT equipped with electronic attack using a PAC-3 MSE effector.
July 2025	Cyber Test-08b Part 2 (N/I) for AN/TPY-2[e]	Homeland Defense and Regional/Theater Defense	The MDA conducted a CVPA and AA on the AN/TPY-2 CX 5.0 software configuration on an operational radar to assess cyber survivability.
July 2025	UEWR Fylingdales CVPA[a,e]	Homeland Defense	STARCOM conducted a CVPA on the UEWR at RAF Fylingdales in the UK, to assess its cyber survivability from insider and nearsider threat postures.
August 2025	GTI-107 (USNORTHCOM) [a,e]	Homeland Defense	The MDA conducted this DT/OT using HWIL test assets to support MDS-level assessments in USNORTHCOM geographic regions with a focus on new LRDR capabilities.
September 2025	SBT Inc 2 M&S OT Runs for Record, Phase 3A Part 2[a,d]	Regional/Theater Defense	The MDA executed and delivered endgame and lethality results for a set of high-fidelity M&S OT runs for record to assess Aegis SBT Inc 2 organic engagement performance against select ballistic missile threats.
September 2025	SBT Inc 2 M&S OT Runs for Record, Phase 3C Part 1[a,d]	Regional/Theater Defense	The MDA executed and delivered Aegis Weapon System results for a set of high-fidelity M&S OT runs for record to assess Aegis SBT Inc 2 organic engagement performance against select ballistic missile and hypersonic threats.

Notes:
[a] Testing performed per DOT&E-approved test plan.
[b] Test plan not approved by DOT&E.
[c] Test plan not required by DOT&E.
[d] Test observed by DOT&E.
[e] Test not observed by DOT&E.

Acronyms: AA – Adversarial Assessment; ABT – Air-Breathing Threat; AGS – Aegis Guam System; AN/TPY - Army Navy/Transportable Radar Surveillance; AOC – Advanced Object Classification; BMD – Ballistic Missile Defense; C2BMC – Command and Control, Battle Management, and Communications; CVPA – Cooperative Vulnerability and Penetration Assessment; DT – Developmental Test; FBM – Forward-Based Mode; FEM – Flight Test Experiment Aegis Weapon System; FTX – Flight Test Other; FY – Fiscal Year; GMD – Ground-based Midcourse Defense; GTD – Ground Test Distributed; GTI – Ground Test Integrated; HBTSS – Hypersonic and Ballistic Tracking Space Sensor; HWIL – Hardware-in-the-Loop; IAMD – Integrated Air and Missile Defense; IBCS – Integrated Battle Command System; Inc – Increment; LRDR – Long Range Discrimination Radar; M&S – Modeling and Simulation; MDA – Missile Defense Agency; MDS – Missile Defense System; MRBM – Medium-Range Ballistic Missile; MSE – Missile Segment Enhancement; NSWC-PH – Naval Surface Warfare Center, Port Hueneme; OT – Operational Test; OTA – Operational Test Agency; PAC – Patriot Advanced Capability; PCSB – Patriot Component Software Build; RAF – Royal Air Force; SBT – Sea-Based Terminal; SM – Standard Missile; STARCOM – Space Training and Readiness Command; THAAD – Terminal High Altitude Area Defense; UEWR – Upgraded Early Warning Radar; UK – United Kingdom; USCENTCOM – U.S. Central Command; USEUCOM – U.S. European Command; USINDOPACOM – U.S. Indo-Pacific Command; USNORTHCOM – U.S. Northern Command; USSPACECOM – U.S. Space Command

In FY25, the MDA also conducted an extensive analysis on MDS performance in real-world events. The analysis has proven highly valuable in assessing system performance, developing software and concept of operations improvements, and identifying features that should be added to the test program.

As previously reported, the need for additional threat representations, independently accredited M&S, and system survivability data in a cyber-contested environment presents significant challenges for DOT&E in completing a comprehensive assessment of the MDS. Specifically:

- Realistic and up-to-date representations of threat missile scenes are critical to the assessment of MDS performance. As DOT&E has noted since FY21, the rate of adversary threat development is faster than the pace of flight test target and ground test high-fidelity M&S threat model development. The MDA should also continue investigating parametric targets so the extent of potential threat variations can be explored quickly and methodically.
- Independent accreditations of M&S used in ground tests and high-fidelity analyses are needed to ensure M&S can adequately represent current threat missile capabilities, including electronic attack, countermeasures, and realistic raid sizes. DOT&E has emphasized this need in previous annual reports. The rate at which the MDA's models have been independently accredited has increased, but significant gaps remain, such as validation of post-intercept debris models and an accredited model for Patriot. Also, as threat and system model capabilities become more complex, the MDA has sometimes struggled to maintain a real-time test architecture that can handle this complexity. The MDA partially addressed this increase in complexity in FY25 by performing a risk reduction event preceding the current ground test campaign, which allowed the MDA to identify many integration problems before formal testing began. Integration will remain an ongoing concern as more complex capabilities are added to the MDS, such as the Next Generation Interceptor (NGI) and the Glide Phase Intercept (GPI). Finally, as a complement to the real-time testing, the MDA had been developing an End-to-End Digital Integrated System-Level Simulation, which was an MDS-level high-fidelity digital modeling architecture needed to assess effectiveness of the MDS. In FY24, the MDA removed funding from the effort, and no funding was restored in FY25. The effectiveness of the MDS cannot be fully assessed without such a tool.
- The MDS has an extensive cyber-attack surface, which to date has not been rigorously tested in operationally realistic settings at the MDS-level. MDS-level cyber survivability assessments with multiple elements, warfighter participation, and federated M&S accredited for performance are needed to identify the full mission effects of cyber-attacks. To date, the MDA has struggled to maintain the scope of such MDS-level tests as specified in the IMTP, in part because of delays in other non-cyber tests, element unavailability, or elements that the MDA later deems untestable in their current configuration. The MDA, in coordination with the Services and MDS OTA, should continue to work to overcome these test planning challenges. Additionally, MDA and OTAs should continue to aggregate element-level cyber survivability data to support MDS-level cyber survivability assessment.
- Flight and ground test programs and high-fidelity M&S analyses at both the MDS- and element-level have been limited in the variety of realistic threat countermeasures, electronic attack, post-intercept debris scenes, raid sizes, and multi-element engagement scenarios. As reported since the DOT&E FY22 Annual Report, the MDA often designs flight tests to demonstrate a specific new capability rather than for operational realism. Operationally realistic intercept flight tests are necessary to provide: (1) needed referent data to support verification, validation, and accreditation of models used in high-fidelity M&S and ground testing; (2) realistic data on multi-element interactions; and (3) data in multi-domain operations.
- In coordination with DOT&E, the Guam Defense System Joint Program Office (JPO), Army, Navy, and MDA continue efforts to develop a T&E concept for the Guam Defense System, which is intended to provide persistent, 360-degree, layered, and integrated air and missile defense. The proposed architecture is made of both new and existing components in close proximity and with overlapping areas of regard, with all components working together to defend against cruise, ballistic, and hypersonic missile threats. This architecture presents a significant integration and test planning challenge. The JPO has enumerated significant data gaps that need to be filled to adequately inform the warfighter of system capabilities for interoperability and engagement planning. Test data should be collected through ground testing, digital M&S, tracking exercises, and intercept flight testing. Comprehensive suitability and cyber tests are also needed. The JPO is facing significant test resource shortfalls to close these data gaps.

- Flight and ground test infrastructure modernization efforts are needed to increase range capability and throughput to meet the projected increase in the tempo of missile defense testing. Developing and maintaining more long-range flight test corridors and mobile data collection assets will be essential to testing going forward. Progress was made in FY25, when the MDA received funding for the full replacement of a major test resource ship needed for adequate flight testing, and partial funding for a second ship and shipboard radar. The MDA intends to budget the additional required funds in future Program Objective Memorandum submissions. The MDA's current acquisition plan calls for full operational capability of the ships in FY30 and FY31. This funding of the ships resolves one of the major reasons DOT&E disapproved IMTP 26.1.

PERFORMANCE

» U.S. HOMELAND MISSILE DEFENSE

With the support of the full architecture of MDS sensors, the GMD weapon system has demonstrated the capability to defend the U.S. homeland from a small number of ballistic missile threats employing simple countermeasures and with ranges greater than 3,000 kilometers. In FY25, the MDA demonstrated new capabilities of LRDR and C2BMC when the radar successfully acquired, tracked, and reported a missile complex to C2BMC. GMD used the LRDR and C2BMC data to simulate an engagement.

» REGIONAL/THEATER MISSILE DEFENSE

The regional/theater MDS has demonstrated a capability to defend the USINDOPACOM, USEUCOM, and USCENTCOM areas of responsibility from a small number of MRBM or IRBM threats with ranges less than 4,000 kilometers, and from representative raids of SRBM threats.

Fielded Aegis BMD variants continue to demonstrate the capability to intercept non-separating, simple-separating, and complex-separating ballistic missiles in the midcourse phase of flight with SM-3 guided missiles, although flight testing and M&S have not addressed all expected threat types, threat features, and raid sizes. Aegis BMD destroyers engaged Iranian ballistic missile threats targeting Israel in both FY24 and FY25. In December 2024, the MDA demonstrated, for the first time, that the initial build of the AGS has a capability to intercept a ballistic missile using radar data from a single-face AN/TPY-6 radar. However, further development and testing of that system is needed to integrate it with the broader Guam Defense System, which consists of a number of Service components and addresses a complicated threat set with ballistic, hypersonic, and cruise missiles. Aegis BMD also continues to demonstrate a capability to intercept ballistic missile threats in the terminal phase of flight with its SBT capability with SM-6 guided missiles. In FY26, the MDA plans to conduct first-time flight tests with the new Aegis Flight III destroyer, USS *Jack H. Lucas* (DDG 125), to include an intercept attempt.

The Terminal High Altitude Area Defense (THAAD) system has demonstrated the capability to intercept and destroy ballistic missiles of short- to intermediate-range inside or outside the earth's atmosphere during the terminal phase of flight. In FY25, THAAD participated in the defense of Israel, demonstrating capability against Iranian and Houthi missile threats. However, flight testing and M&S still need to address more complex engagement conditions and raid scenarios. The MDA continues to develop and deploy updates to the THAAD software and hardware for the radar and software updates to THAAD Fire Control and Communications in response to real-world events, but these updates should undergo appropriate operational testing. The THAAD 5.0 build, consisting of new hardware and software, started testing in FY25. The MDA and the Army continue to address THAAD training and component reliability shortfalls.

Patriot has demonstrated the capability to provide point defense against missile and aircraft attacks on deployed forces and critical assets and to defeat enemy surveillance air assets. Patriot systems have participated in the defense of Ukraine against Russian threats. However, DOT&E does not have access to the U.S. Army's data to assess Patriot's performance. In the 12-day war between Iran and Israel, Iran launched a salvo of missiles at Al Udeid Air Base, Qatar, where Patriot showed some capability in defending against a raid scenario. The Patriot program is developing the Patriot Component Software Build 1.0 and will begin operational testing in FY26.

AN/TPY-2 Forward-Based Mode (FBM) and AN/SPY-1 radars contribute to regional/theater defense and monitoring. In the future, AN/SPY-6(V)1 radars on Aegis Flight III destroyers will also contribute to those missions, and one or more AN/TPY-6 radars may contribute to the defense of Guam. In FY25, the AN/TPY-2 (FBM) radars continued to participate in the defense of Israel, demonstrating tracking capacity against Iranian and Houthi threats in raid environments. Also in FY25, AN/SPY-1 demonstrated the capability to detect, track, and discriminate a hypersonic vehicle during a live target tracking event. The AN/SPY-6(V)1 radar prototype at the Pacific Missile Range Facility, Hawaii, continues to track all classes of ballistic missiles, as available, during MDA flight tests. However, USS *Jack H. Lucas*, the first Aegis Flight III destroyer with Aegis Baseline 10 and AN/SPY-6(V)1 radar, did not participate in MDA flight tests in FY25. The AN/TPY-6 radar on Guam detected and tracked a ballistic missile for the first time in FY25.

» HYPERSONIC MISSILE DEFENSE

The MDA collected hypersonic test data throughout FY25 to inform future sensor design, sensor detection and tracking algorithms, and M&S validation. The MDA also conducted ground optical, thermal, and aerodynamic testing to support the development of new technologies and the M&S architecture specifically for hypersonic missile defense. In FY25, results from flight testing and high-fidelity M&S demonstrated an Aegis SBT capability to engage select hypersonic missile threats in the terminal phase of flight. During the flight test, the Aegis SBT capability detected, tracked, and conducted a simulated engagement against a hypersonic target as a risk reduction exercise for a planned live SM-6 intercept of a hypersonic target.

» COMMAND AND CONTROL AND SPACE SENSORS

Almost every test the MDA conducted in FY25 included space sensors acquiring, tracking, and reporting on observed objects. A prototype Hypersonic and Ballistic Tracking Space Sensor (HBTSS) continued data collection on hypersonic targets. C2BMC globally and regionally integrates and synchronizes autonomous sensors, weapon systems, and operations. C2BMC is also a part of all system ground and flight tests, which verify and exercise current and future MDS capabilities. In FY25, C2BMC and the BMDS Overhead Persistent Infrared Architecture (BOA) continued to support real-world situational awareness in USEUCOM and USCENTCOM. In a live-radiate event in FY25, C2BMC communicated with Space Command and Control (Space C2) for space domain awareness, tasking LRDR and receiving reports back from the radars on resident space objects. In FY25, the MDA demonstrated new capabilities of LRDR and C2BMC when the radar successfully reported a missile complex to C2BMC, which was then sent to GMD. During real-world events, BOA and OPIR assets contributed to situational awareness, and C2BMC relayed threat information between assets in stressing scenarios.

» SUMMARY

DOT&E will provide additional information and recommendations in the classified FY25 Assessment Report on the MDS to be published in February 2026.

RECOMMENDATIONS

The MDA should:

1. Continue to increase the rate of U.S. homeland defense and regional/theater target and threat model development to keep pace with emerging real-world threats, as recommended in the FY23 and FY24 Annual Reports, and continue to pursue the creation of parametric threats in ground testing that allow for threat variations in testing.
2. Continue to prioritize independent accreditation of M&S used in ground tests and high-fidelity analyses and ensure M&S can adequately represent current threat capabilities, electronic attack, countermeasures, post-intercept debris, and realistic raid sizes, as recommended in the FY24 Annual Report.
3. Continue investments in ground test architecture improvements to accommodate more complex threat and system model features, as recommended in the FY24 Annual Report.
4. Fund and develop an MDS-level digital integrated simulation, to allow quantitative assessments of both current MDS capability as well as more complex future capabilities that will require such

a capability, like NGI, GPI, and the Guam Defense System.

5. Ensure that relevant intercept flight testing with operationally representative targets is conducted prior to any planned M&S operational testing runs for record to provide referent data to support verification, validation, and accreditation of the models representing post-intercept debris, as recommended in the FY24 Annual Report.
6. Conduct high-fidelity M&S runs for record with independently accredited M&S to assess individual weapon system and MDS-level effectiveness against emerging threats, as recommended in the FY24 Annual Report.
7. Prioritize working within the DoW to ensure test resources are available for the higher cadence and more demanding flight and ground tests planned for the future.
8. Ensure comprehensive cyber T&E plans are created and developmental and operational cyber testing is completed prior to capability delivery of MDS element and interceptor builds to the warfighter, as recommended in the FY24 Annual Report.
9. Conduct routine operational cyber survivability assessments with multiple elements, warfighter participation, and federated M&S accredited for performance, as recommended in the FY24 Annual Report.

The Army, in coordination with the MDA, should:

1. Continue to develop Patriot and LTAMDS models that interface properly with the MDS ground test architecture to address current shortfalls in supporting MDS-level performance assessments. Verification, validation, and accreditation efforts for the models should be fully funded.
2. Coordinate with the Navy and other DoW stakeholders to ensure the test strategy for the Guam Defense System is sufficiently funded to incorporate multi-element interoperability into intercept flight testing, tracking exercises, ground testing, and digital M&S, as recommended in the FY23 and FY24 Annual Reports. Additionally, ensure comprehensive MDS-level suitability and cyber testing is planned.