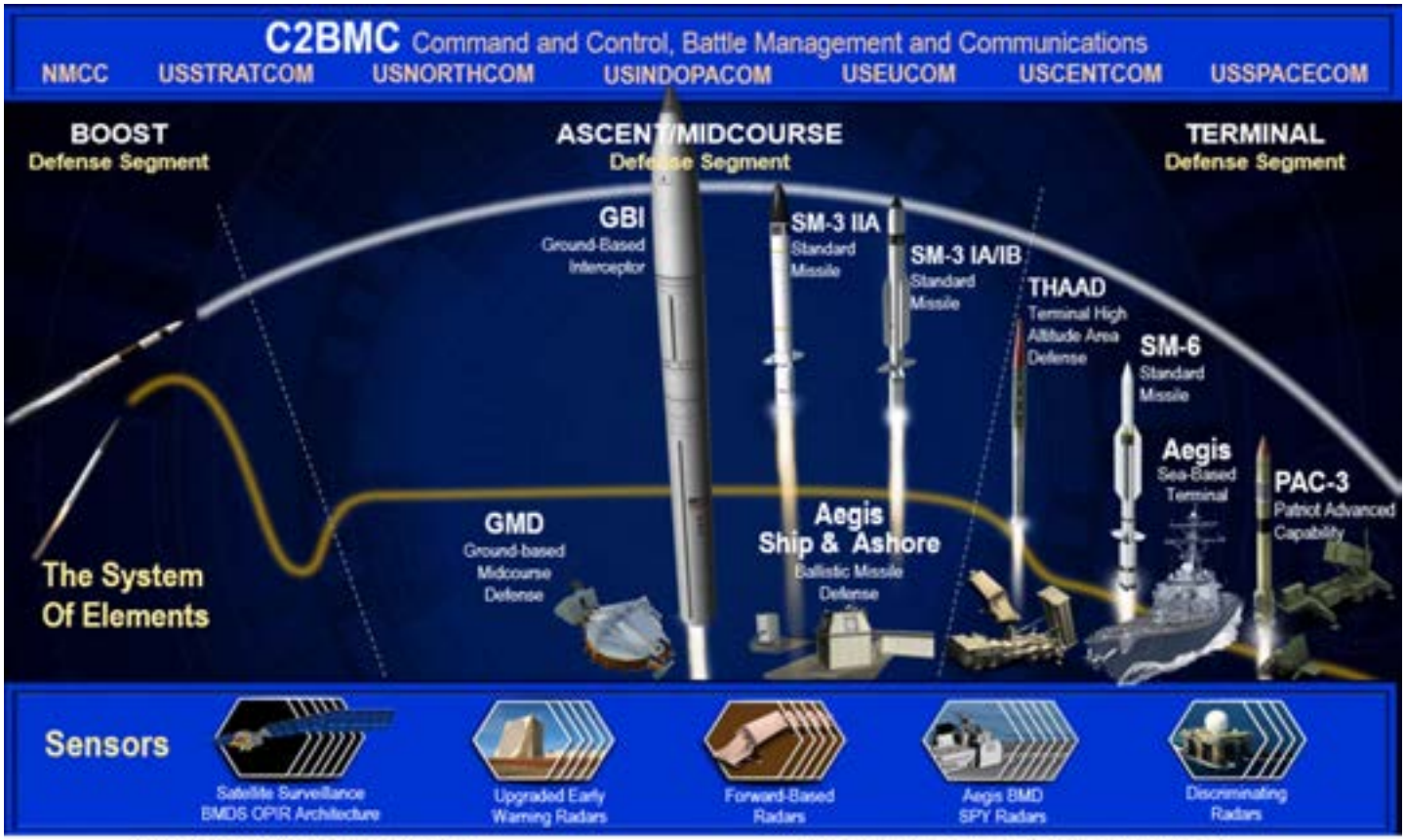
MISSILE DEFENSE SYSTEM



BMD - Ballistic Missile Defense
BMDS - Ballistic Missile Defense System
NMCC - National Military Comand Center
OPIR - Overhead Persistent Infrared
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
USSTRATCOM - U.S. Strategic Command

> The MDS has demonstrated a measured capability to defend the United States, deployed forces, and allies from a rogue nation's missile attack.

Missile Defense System (MDS)

The Ground-based Midcourse Defense (GMD) weapon system has demonstrated the capability to defend the United States Homeland from a small number of ballistic missile threats with ranges greater than 3,000 kilometers and employing simple countermeasures, when supported by the full architecture of Missile Defense System (MDS) sensors. Similarly, 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 threats with ranges less than 4,000 kilometers, and from representative raids against short-range ballistic missile (SRBM) threats. DOT&E assesses that the top five challenges for the MDS are: 1) the need for realistic and emerging threat representations in flight and ground testing; 2) the need for accredited modeling and simulation (M&S) to assess MDS effectiveness; 3) susceptibility of the MDS to cyberattack; 4) system reliability and sustainment; and 5) interoperability and maturation of engagement coordination.

In FY22, the Missile Defense Agency (MDA) tested three significant new MDS capabilities:

- Terminal High Altitude Area Defense (THAAD) integration with Patriot Missile Segment Enhancement (MSE) interceptors and launchers, designed to improve THAAD self-defense without requiring a dedicated Patriot battery.
- Initial Long Range Discrimination Radar (LRDR) performance in support of U.S. Homeland Defense.
- An Aegis Ballistic Missile Defense (BMD) capability to detect, track, and report on resident space objects based on Space Domain Awareness (SDA) when tasked by Command and Control, Battle Management, and Communications (C2BMC).

DOT&E will provide additional information and recommendations in the classified DOT&E FY22 Assessment of the MDS report to be published in February 2023.

SYSTEM DESCRIPTION

The MDA's 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 six weapon systems, a sensor architecture (i.e., terrestrial, maritime, and global sensors), and a command and control element.

MISSION

The Commanders of U.S. Northern Command (USNORTHCOM), USINDOPACOM, USEUCOM, and USCENTCOM employ the assets of the BMDS to defend the United States, deployed forces, and allies against ballistic missile threats at all ranges.

Table 1. Elements of MDA's Missile Defense System

Type	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. MDA is developing a Next Generation Interceptor to supplement the current GBI fleet.	**Aegis BMD[a]:** Both sea- and land-based variants defend U.S. deployed forces and allies from SRBM, MRBM, and IRBM threats. Aegis BMD uses the SM-3 family of guided missiles against exoatmospheric ballistic missile threats alongside SM-6 guided missiles that Aegis SBT (Inc 2) uses for endo-atmospheric engagements. **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 from Aegis BMD or other sensors via C2BMC. THAAD complements the upper-tier Aegis BMD and the lower-tier PAC-3 weapon systems. **PAC-3[b]:** Defends U.S. deployed forces and critical assets 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.	**Aegis SBT (Inc 3)[a]:** Aegis SBT provides critical asset protection at sea and for joint forces ashore against ballistic, maneuverable, and hypersonic glide threats in the terminal phase. **GPI[a]:** Provides an additional layer of Hypersonic Defense augmenting Aegis SBT (Inc 3) to increase depth of fire against hypersonic threats. The program is currently in development of prototype interceptors.
Terrestrial and Maritime Sensors	**Cobra Dane Upgrade[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]:** 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]:** Being developed for installation on new construction Aegis DDG 51 Flight III destroyers, this S-band four-face radar will extend Aegis threat detection ranges and provide simultaneous ballistic missile and air defense support. **AN/TPY-2 FBM Radar[a]:** X-band single-face transportable phased array radar. **LTAMDS[b]:** C-band three-face multi-function, multi-mission radar interfacing with IBCS and supporting interoperability with PAC-3.	Leverages Homeland Defense, 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. **SKA[a]:** Network of space sensors providing interceptor hit assessments. **HBTSS[a]:** Network of space sensors to detect and track both ballistic and hypersonic threats, and provide fire-control quality data to MDS sensors and weapon systems.		
Command and Control	**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 AN/TPY-2 FBM radars and BOA systems.		

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

Acronyms: BMD – Ballistic Missile Defense; BMDS – Ballistic Missile Defense System; BOA – BMDS Overhead Persistent Infrared Architecture; C2BMC – Command and Control, Battle Management, and Communications; FBM – Forward-Based Mode; GMD – Ground-based Midcourse Defense; GBI – Ground Based Interceptors; GPI – Glide Phase Interceptor; 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; 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; SBIRS – Space-Based Infrared System; SBT – Sea-Based Terminal; SBX – Sea-Based X-band; SKA – Space-Based Kill Assessment; SM – Standard Missile; SRBM – Short-Range Ballistic Missile; THAAD – Terminal High Altitude Area Defense; UEWR – Upgraded Early Warning Radar

PROGRAM

The MDS is a single Acquisition Category (ACAT) ID program that encompasses five of its six weapon systems, most of its sensor architecture, and its command and control element. In 2002, the Secretary of Defense granted the MDA special 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 attack. The MDA manages the MDS through a series of six program baselines – Schedule, Test, Technical, Resource, Contract, and Operational Capability and maintains responsibility for integrating all elements into the MDS whether or not the MDA developed the element. The MDA publishes the Test Baseline 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. DOT&E approves each version of the IMTP, the latest of which was dated March 2022 (version 23.1).

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 Test and Evaluation Master Plan (TEMP) in FY20. LTAMDS is a Middle Tier of Acquisition program, for rapid prototyping, and is expected to be designated as an ACAT IC program at its Materiel Development Decision scheduled for December 2023. DOT&E approved its initial TEMP in 2019. A Test and Evaluation Strategy is under development to replace the TEMP, with DOT&E approval expected in FY23.

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

The Space Force operates and sustains three sensor types integrated into the MDS: Cobra Dane Upgrade, five Upgraded Early Warning Radars (UEWRs), LRDR, and the Space-Based Infrared System (SBIRS) constellation. The Air Force completed development and initial operational testing for these sensors prior to them becoming Space Force assets.

» MAJOR CONTRACTORS

- The Boeing Company
  - GMD Integration: Huntsville, Alabama
- Lockheed Martin Corporation
  - Aegis BMD, AAMDS, Aegis SBT, AN/SPY-1 radar, LRDR, and GPI: Moorestown, New Jersey
  - C2BMC: Huntsville, Alabama, and Colorado Springs, Colorado
  - NGI AUR through Critical Design Review: 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; Chandler, Arizona
  - GBI Booster Vehicles: Chandler, Arizona
  - GCN, LMS, and GFC: Huntsville, Alabama
  - NGI AUR and GPI through Critical Design Review: Chandler, Arizona
  - BOA: Boulder, Colorado; Colorado Springs, Colorado; and Azusa, California
  - HBTSS through Prototype Demonstration Phase: Redondo Beach, California, and Azusa, California
- Raytheon Technologies Corporation
  - GMD EKV, SM-3/6 Interceptors, LTAMDS, and GPI: 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
- L3 Harris Technologies
  - GMD IDT: Melbourne, Florida

  - HBTSS through Prototype Demonstration Phase: Fort Wayne, Indiana
- Johns Hopkins University, Applied Physics Laboratory
  - SKA: Laurel, Maryland

TEST ADEQUACY

The MDA IMTP focuses on collecting the flight, ground, and cybersecurity test data needed for contract compliance and operational capability declarations, as well as for the verification, validation, and accreditation of associated M&S. The MDA conducted testing in accordance with the DOT&E-approved IMTP although there were technical and programmatic delays to some events. Table 2 outlines the 24 flight, ground, high-fidelity M&S, and cybersecurity test events that the MDA performed or participated in during FY22. Testing was conducted in accordance with a DOT&E approved the test plan and DOT&E observed the testing as shown in Table 2 below.

Table 2. FY22 Body of Testing

Date	Test	Mission Area	Description
October 2021	At Sea Demonstration-2[b,c]	Regional/Theater Defense	The MDA conducted an Aegis AN/SPY 1 radar SDA mission providing sensor tracking of resident space objects. This test informed radar performance and C2BMC/Space C2 interfaces for mission tasking.
October 2021	Flight Test Other-43[b,d]	Regional/Theater Defense	The MDA conducted a developmental test of the MDS to assess its ability to detect, track, and report on an advanced vehicle.
October 2021	THAAD 4.0 CVPA-08a[a,c]	Regional/Theater Defense	The MDA, MDS OTA, and the Army's DEVCOM conducted a CVPA to characterize cybersecurity elements of THAAD and unit operators, and provide reconnaissance in support of the adversarial assessment.
November 2021	Patriot PDB 8.1 DT-1a[b,d]	Regional/Theater Defense	The Army demonstrated the capability of the Patriot PDB-8.1 system to detect, track, engage, intercept, and kill a low radar cross section cruise missile target at low altitude with a GEM-T Ballistic Missile interceptor.
December 2021	THAAD 4.0 AA-08a[a,c]	Regional/Theater Defense	The MDA, MDS OTA, and the Army's TSMO conducted an AA to determine an adversary's ability to achieve mission effects and assess THAAD's operational resilience to insider, nearsider, and outsider cyber threats.
February 2022	THAAD Controlled Test Vehicle-01a[b,c]	Regional/Theater Defense	The MDA conducted this non-intercept flight test to demonstrate the capability of THAAD to fire and direct a PAC-3 MSE interceptor against a simulated SRBM target. The successful outcome of the test verified that THAAD could compute a firing solution, communicate with the M903 launcher, and control the MSE interceptor in flight to the target.
March 2022	Flight Test THAAD Weapon System-21[b,c]	Regional/Theater Defense	The MDA and the MDS OTA conducted this test to support the THAAD/PAC-3 MSE integration capability. The AN/TPY-2 Terminal Mode radar tracked the SRBM target. Per the test design, there were no THAAD interceptors available, thus ensuring an MSE engagement. A salvo of 2 MSE interceptors were launched using THAAD fire control data and successfully intercepted the target.

Table 2. FY22 Body of Testing

Date	Test	Mission Area	Description
April 2022	Flight Test Experiment Aegis Weapon System-01[b,c]	Regional/Theater Defense	The MDA conducted a developmental test of Aegis BMD, firing a Standard Missile-3 Block IIA guided missile against an MRBM target. Operational assets included overhead sensors, BOA, C2BMC, and the Enterprise Sensor Processing Network at Buckley Space Force Base, Colorado.
March 2022	Hypersonic Air-breathing Weapon Concept-7[b,d]	Hypersonic Defense	The MDA participated in this DARPA event to collect hypersonic missile phenomenology and tracking data to inform future capability development.
April 2022	Ground Test Integrated-08a (USNORTHCOM/ USINDOPACOM)[b,c]	Homeland Defense and Regional/Theater Defense	The MDA and the MDS OTA conducted this developmental/operational HWIL laboratory test to support assessment of MDS capabilities in the USNORTHCOM/USINDOPACOM geographic regions, examining new functions of LRDR, C2BMC, GMD, SBX, BOA, Aegis BMD, and AN/TPY-2 FBM.
May to July 2022	SM-3 Block IIA M&S Runs for Record, Phase 1C[a,c]	Regional/Theater Defense	The MDA executed and delivered a set of high-fidelity M&S runs to assess Aegis BMD performance against raids of threats in scenarios relevant to European Phased Adaptive Approach Phase 3.
June 2022	C2BMC/BOA Cyber Event[b,c]	Homeland Defense	The MDA, MDS OTA, and the Army's DEVCOM performed a DT cyber event on the C2BMC and BOA using a HWIL laboratory representation to assess insider and nearsider threat postures.
June 2022	UEWR CVPA[b,c]	Homeland Defense	The Space Force performed a CVPA on the UEWR at Beale AFB that explored insider and nearsider threat postures.
June 2022	LRDR Cyber Event[b,c]	Homeland Defense	The MDA, MDS OTA, and the Army's DEVCOM performed a DT cyber event on LRDR using a HWIL laboratory representation to assess insider and nearsider threat postures.
June 2022	Joint Flight Campaign-1[b,d]	Hypersonic Defense	The MDA participated in this Army/Navy event to collect hypersonic missile phenomenology and tracking data to inform future capability development. However, an anomaly occurred during the flight, and data collection was sub-optimal.
July 2022	HAWC-9[b,d]	Hypersonic Defense	The MDA participated in this DARPA event to collect hypersonic missile phenomenology and tracking data to inform future capability development. HAWC-9 provided a unique opportunity to support MDA's need for realistic and emerging threat representations in flight and ground tests.
June 2022 to August 2023	Patriot PDB-8.1 Limited User Test[a,c]	Regional/Theater Defense	During this operational test, the Army is assessing the effectiveness, suitability, and survivability of the Patriot PDB-8.1 system through flight tests, accredited HWIL scenarios, interoperability testing in an MDA ground test, and cybersecurity testing (a CVPA and an AA).
July 2022	Ground Test Integrated-09 Sprint 1[b,d]	Regional/Theater Defense	The MDA conducted this developmental HWIL laboratory test to support assessment of MDS capabilities in the USEUCOM/USCENTCOM geographic regions, examining new functions of C2BMC, BOA, Aegis BMD, THAAD, and AN/TPY-2 FBM.

Table 2. FY22 Body of Testing

Date	Test	Mission Area	Description
July 2022	Air Force National Nuclear Security Agency Demonstrator Initiative[b,d]	Homeland Defense	The MDA participated in this NNSA event as a target of opportunity to exercise sensors, communication links, and emerging technologies to help assess the system-level capabilities and performance of the integrated MDS.
August 2022	Glory Trip-243[b,d]	Homeland Defense	The MDA participated in this Air Force Global Strike Command event to collect data, exercise MDS communication links, perform future capability assessments, and provide confidence to participating MDS elements and component.
August 2022	Pacific Dragon-22[b,c]	Regional/Theater Defense	The MDA participated in this multilateral warfighter exercise. During three events, U.S. and allied naval vessels conducted a live intercept of a ballistic missile target with an SM-3 Block IA, simulated engagements against ballistic missile targets, and tracked two ballistic targets simultaneously. The test supported the 2017 and 2019 NDAA requirement for international interoperability.
August 2022	Patriot PDB 8.1 DT-1b,c[b,d]	Regional/Theater Defense	The Army demonstrated the capability of the Patriot PDB-8.1 system to detect, track, engage, intercept, and kill a subscale aircraft target employing electronic attack with a GEM-T interceptor.
September 2022	Glory Trip-244[b,d]	Homeland Defense	The MDA participated in this Air Force Global Strike Command event to collect data, exercise MDS communication links, perform future capability assessments, and provide confidence to participating MDS elements and component.

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

Acronyms: AA – Adversarial Assessment; 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; CVPA – Cooperative Vulnerability and Penetration Assessment; DARPA – Defense Advanced Research Project Agency; DEVCOM – U.S. Army Combat Capabilities Development Command; DT – Developmental Testing; FBM – Forward-Based Mode; FY – Fiscal Year; GEM-T – Guidance Enhanced Missile – Tactical; GMD – Ground-based Midcourse Defense; HAWC – Hypersonic Air-breathing Weapon Concept; HWIL – Hardware-in-the-Loop; 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; NATO – North Atlantic Treaty Organization; NDAA – National Defense Authorization Act; NNSA – National Nuclear Security Agency; OTA – Operational Test Agency; PAC – Patriot Advanced Capability; PDB – Post Deployment Build; SBT – Sea-Based Terminal; SBX – Sea-Based X-Band; SDA – Space Domain Awareness; SM – Standard Missile; SRBM – Short-Range Ballistic Missile; THAAD – Terminal High Altitude Area Defense; TSMO – Threat Systems Management Office; UEWR – Upgraded Early Warning Radar; USCENTCOM – U.S. Central Command; USEUCOM – U.S. European Command; USINDOPACOM – U.S. Indo-Pacific Command; USNORTHCOM – U.S. Northern Command; VV&A – Verification, Validation, and Accreditation

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

- Realistic and up-to-date representations of threat scenes are critical to the assessment of MDS performance. The rate of adversary threat development is currently faster than the pace of flight test target and ground test as well as high-fidelity M&S threat model development.

- The MDA and the MDS Operational Test Agency (OTA) continued to make progress in FY22 by increasing the number of OTA-accredited models and mitigating model limitations, but gaps remain. The MDA and MDS OTA are also now considering how to accredit the new MDS-level digital modeling architecture, the Enterprise Digital Integrated System Simulation, which presents a different set of challenges.
- The MDS is a large system of systems with an extensive cyberattack surface. Although the MDA and the MDS OTA made progress in cybersecurity T&E efforts, more realistic testing in accredited hardware-in-the-loop environments is needed, along with greater test planning collaboration with DOT&E. Frequent cyber Red Team events, emulating advanced adversaries, is needed to ensure MDS cyber defenses are adequate to protect MDS missions. Persistent Cyber Operations is the best way to emulate advanced cyber threats and find and fix mission-critical vulnerabilities.

Flight and ground test programs have been limited in the variety of realistic threat countermeasures, electronic attack, post-intercept debris scenes, raid sizes, and multi-element engagement scenarios tested. The MDA often designs flight tests to demonstrate a specific new capability, but relevant intercept flight tests could provide needed referent data to support verification, validation, and accreditation models used in high-fidelity M&S ground testing, provide realistic data on multi-element interactions, and provide data in multi-domain operations. Furthermore, M&S limitations in ground tests are sometimes minor when assessing an element alone, but combine to create substantial impediments at the MDS-level.

The MDA is currently developing a concept for a persistent, 360-degree, layered integrated air and missile defense capability for the defense of Guam. This concept involves interoperability and coordination between multiple assets defending against cruise, ballistic, and hypersonic threats. The proposed architecture is made of both new and existing components in close proximity and with overlapping areas of regard. This presents a significant test planning challenge. DOT&E currently assesses that the proposed test strategy needs further development to be adequate. An agile test program that fully explores interoperability and engagement planning through ground testing, tracking exercises, and intercept flight testing is warranted.

PERFORMANCE

» BALLISTIC MISSILE DEFENSE FOR THE HOMELAND

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.

» BALLISTIC MISSILE DEFENSE FOR THE REGIONAL/THEATER

The Regional/Theater MDS has demonstrated a capability to defend the USINDOPACOM, USEUCOM, and USCENTCOM areas of responsibility from a small number of medium- or intermediate-range ballistic missile threats with ranges less than 4,000 kilometers, and from representative raids against SRBM threats.

Aegis BMD has demonstrated that it can intercept non-separating, simple-separating, and complex-separating ballistic missiles in the midcourse phase of flight with Standard Missile-3 (SM-3) guided missiles, although flight testing and M&S have not addressed all expected threat types, ground ranges, and raid sizes. Aegis BMD has also demonstrated a capability to intercept select ballistic missiles in the terminal phase of flight with SM-6 guided missiles. However, corrective actions are needed to address failure review board findings from the two Sea-Based Terminal Increment 2 flight tests in FY21. All fielded Aegis BMD variants have demonstrated sufficient reliability, with operational availabilities that exceed the specification. However, SM-3 Block IIA missile reliability is not known with a high degree of certainty, due to the relatively small number of live firings and ground test data

collection events to date. The MDA is implementing a process to monitor the health and status of deployed SM-3 Block IIA missiles, which will provide additional reliability data for future assessments.

THAAD has proven capability to intercept and destroy, by ballistic missiles of varying types (short- to intermediate-range) inside or outside the earth's atmosphere during the terminal phase of flight, although the test program still needs to address more complex engagement conditions and more realistic raid scenarios. In FY22, MDA demonstrated THAAD launch and control of MSE interceptors. This new function expands options for theater defense, though more testing of full THAAD/Patriot integration is needed to assess overall MDS capability. The United Arab Emirates THAAD weapon system successfully intercepted ballistic missiles operationally for the first time in FY22. The MDA and 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 has long-standing shortfalls in reliability, training, and survivability. The ongoing Patriot PDB-8.1 Limited User Test will assess how Patriot effectiveness, suitability, and survivability have changed since the last Patriot operational test in 2016 – 2019. The Patriot M&S representations for ground tests used the new Battalion Simulation in development by the Army, but the Army has not yet provided sufficient verification and validation evidence to accredit Battalion Simulation for performance assessments.

AN/SPY-1 and AN/TPY-2 Forward-Based Mode (FBM) radars contribute to regional/theater defense and monitoring. In the future, AN/SPY-6(V)1 will also contribute to those missions. In FY22, Aegis BMD, with AN/SPY-1, demonstrated the capability to detect, track, and report on resident space objects based on SDA tasking received by C2BMC during an at-sea demonstration. The AN/SPY-6(V)1 radar prototype at the Pacific Missile Range Facility continues to track all classes of ballistic missiles, as available, during MDS flight tests. In FY22, MDA and the Army completed processor upgrades in all deployed AN/TPY-2 FBM radar electronic equipment units.

» HYPERSONIC MISSILE DEFENSE

The MDA collected data throughout FY22 to inform future sensors, sensor detection and tracking algorithms, and M&S validation. The MDA also conducted ground impact and wind-tunnel testing to support the development of the M&S architecture specifically for hypersonic missile defense.

» COMMAND AND CONTROL AND SPACE SENSORS

Almost every FY22 test conducted by the MDA included space sensors, as well as sensors unique to Homeland and Regional/Theater Defense to acquire, track, and report on observed objects. C2BMC globally and regionally integrates and synchronizes autonomous sensors, weapon systems, and operations. C2BMC is a part of all system ground and flight tests, which verify and exercise current and future MDS capabilities. C2BMC and BOA also supported real-world situational awareness in USEUCOM in FY22, and the MDA added an additional C2BMC management node to the MDS this year to improve resiliency. The C2BMC tasked an Aegis BMD with a SDA tasking and Aegis BMD detected and tracked a resident space object and reported back to C2BMC.

RECOMMENDATIONS

The MDA should:

1. Increase the rate of target and threat model development to keep pace with emerging real-world threats.
2. Continue to prioritize independent accreditation of M&S used in ground tests and ensure M&S can adequately represent current threat missile capabilities, electronic attack, countermeasures, debris, and realistic raid sizes.
3. Ensure that relevant intercept flight testing is conducted prior to any planned high-fidelity M&S operational testing runs for record to support verification, validation, and accreditation of the models.

4. Ensure comprehensive cyber test and evaluation plans are created and included in the IMTP, and developmental and operational cyber testing is completed prior to capability delivery to the warfighter.
5. Work with DOT&E and Combatant Commands to conduct Persistent Cyber Operations – Red Teams emulating advance adversaries – across MDS systems and networks.
6. Ensure the test strategy for the defense of Guam incorporates multi-element interoperability and coordination into intercept flight testing.

The Army should:

1. Continue to develop the Patriot Battalion Simulation to address current shortfalls in supporting performance assessments.