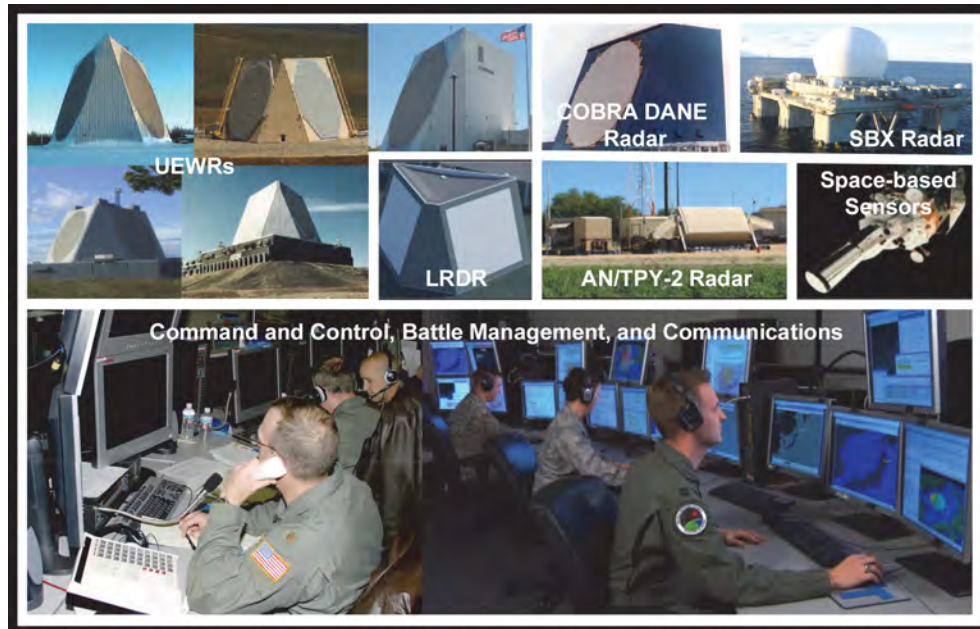


## Sensors / Command and Control Architecture



LRDR – Long Range Discrimination Radar; SBX – Sea-Based X-band; UEWR – Upgraded Early Warning Radar

### Executive Summary

- The Missile Defense Agency (MDA) continued to mature the Ballistic Missile Defense System (BMDS) sensors/command and control architecture in FY20 during seven test events.
- The lack of AN/TPY-2 Forward-Based Mode (FBM) radar test assets hinders efficient test planning and scheduling. The Army typically makes one radar available for testing. This significantly limits the amount of flight testing that can be accomplished in a year.
- Modeling and simulation (M&S) of BMDS sensors continues to be a challenge. The MDA should address BMDS sensor M&S deficiencies to enable credible assessments against operationally relevant threats.
- Electronic attack and threat countermeasure testing for BMDS sensors are needed; developing an accredited M&S capability in these areas should be a high priority.
- The Aegis Ballistic Missile Defense weapon system includes the Aegis AN/SPY-1 radar, which can also be used as a forward-based sensor. See page 217 for reporting on the AN/SPY-1 radar.
- The AN/TPY-2 (FBM) radar is a transportable, single-face, X-band phased array radar.
- The Space-Based Infrared System (SBIRS) is a satellite constellation of infrared sensors.
- The BMDS Overhead Persistent Infrared Architecture (BOA) processes infrared sensor data to provide track information on missile events.
- The Space-based Kill Assessment (SKA) system is a network of space sensors.
- The Long Range Discrimination Radar (LRDR) is a fixed site, two-face, S-band phased array radar; it is under construction.

### System

- An extensive set of sensors provides real-time ballistic missile threat detection, tracking, and classification/discrimination to the BMDS:
  - The COBRA DANE radar is a fixed site, L-band phased array radar.
  - Five Upgraded Early Warning Radars (UEWRs) are fixed site, ultrahigh frequency radars.
  - The Sea-Based X-band (SBX) radar is a mobile, X-band phased array radar located aboard a self-propelled, ocean-going platform.
- The Command and Control, Battle Management, and Communications (C2BMC) element is the integrating element within the BMDS. It provides deliberate and dynamic planning, situational awareness, sensor track management, engagement support and monitoring, data exchange between BMDS elements, and network management. It also directs sensor tasking for the AN/TPY-2 (FBM) radar, LRDR, BOA, and SKA systems.

## Mission

Combatant Commands employ BMDS sensors to detect, track, and classify/discriminate ballistic missile threats and operate the C2BMC for deliberate and dynamic planning, situational awareness, sensor track management, engagement support and monitoring, data exchange between BMDS elements, and network management.

## Major Contractors

- COBRA DANE Radar
  - Raytheon Technologies Corporation – Dulles, Virginia
- UEWRs, SBX, and AN/TPY-2 (FBM) Radars
  - Raytheon Technologies Corporation – Tewksbury, Massachusetts
- SBIRS
  - Lockheed Martin Corporation – Sunnyvale, California
- BOA
  - Northrop Grumman Corporation – Boulder, Colorado; Colorado Springs, Colorado; and Azusa, California
- SKA
  - Johns Hopkins University, Applied Physics Laboratory – Laurel, Maryland
- LRDR
  - Lockheed Martin Corporation – Moorestown, New Jersey
- C2BMC
  - Lockheed Martin Corporation – Huntsville, Alabama, and Colorado Springs, Colorado

## Activity

- The MDA conducted testing in accordance with the DOT&E-approved Integrated Master Test Plan as affected by the coronavirus (COVID-19) pandemic. As a result, the MDA delayed several test events involving the sensors/command and control architecture; for example:
  - Two of the FY20 ground tests were executed prior to the pandemic, one was delayed 1 quarter, and one maintained schedule. Two of the three FY20 Air Force intercontinental ballistic missile (ICBM) reliability and sustainment flight tests, which the MDA participated in, were delayed until the end of this fiscal year.
  - To date, the first half of FY21 flight tests have been delayed 2-4 quarters and the second half of the FY21 flight tests have slipped 1-2 quarters. The initial FY21 ground tests have slipped 1-2 quarters.
- During FY20, the MDA assessed the sensors/command and control architecture in four ground tests and participated in three Air Force ICBM reliability and sustainment flight tests:
  - In November to December 2019, the MDA conducted a ground test of legacy Homeland Defense exo-atmospheric kill vehicle upgrades and of Capability Increment 5C functionality for U.S. Indo-Pacific Command Regional/Theater Defense.
  - In February 2020, the MDA conducted a ground test evaluating European Phased Adaptive Approach Phase 3 capabilities.
  - In June 2020, the MDA assessed the Patriot Missile Segment Enhancement interceptor launch-on-Terminal High-Altitude Area Defense capability in U.S. Indo-Pacific Command scenarios.
  - In July 2020, the MDA conducted an AN/TPY-2 (FBM) radar System Integration and Checkout ground test for future Site 4c deployment.
  - The Air Force conducted three ICBM flight tests in FY20 that included MDA sensors/command and control architecture assets. The SBX radar, SKA network of space sensors, and the C2BMC command and control element participated in all three events.
- The MDA oversaw LRDR requirements verification testing using a subscale array at the contractor’s test facilities. The operational LRDR arrays have been installed and are undergoing initial checkout.
- The MDA fielded two SBX radar software upgrades.
- The MDA incorporated operational use of the Cape Cod UEWR and SBIRS version 19-1 into the fielded BMDS.
- The Air Force fielded UEWR software upgrades at two locations.

## Assessment

- The MDA continued to mature the BMDS sensors/command and control architecture in FY20.
- During FY20 testing, the MDA collected sensor/command and control data supporting development and fielding of new capabilities and architectures associated with BMDS Capability Increments 5B, 5C, and 6B and an urgent materiel release. Test data and resulting assessments are classified; see the DOT&E “FY20 Assessment of the BMDS,” to be published in February 2021.
- The lack of AN/TPY-2 (FBM) radar test assets hinders efficient test planning and scheduling. The Army typically makes one radar available for testing. This significantly limits the amount of flight testing that can be accomplished in a year. The MDA is exploring radar emulation for the AN/TPY-2 (FBM) radar, but use of radar emulation reduces operational realism in testing and limits the use of these data for M&S accreditation.
- Immature M&S of BMDS sensors continues to be a challenge that prevents adequate assessments of BMDS performance. For example, the COBRA DANE radar model cannot accept a dynamic input, such as interceptor debris and the UEWR models have never been accredited. The MDA plans to make a fielding decision for the LRDR based on M&S results, but

prior to data being available to accredit the M&S, which adds risk to the decision. Ground and flight test threat M&S for BMDS sensors cannot adequately represent current threat missiles, electronic attack, countermeasures, debris, or raid sizes.

## **Recommendations**

The MDA should:

1. Pursue acquisition of an additional AN/TPY-2 (FBM) radar to facilitate more efficient BMDS testing.
2. Continue to mature the AN/TPY-2 (FBM) radar emulation concept.
3. Address BMDS sensor M&S deficiencies to enable credible assessment against operationally relevant threats.
4. Include electronic attack and threat countermeasure testing for BMDS sensors and develop an M&S capability in these areas.

