Sensors / Command and Control Architecture

Executive Summary

- The Missile Defense Agency (MDA) continued to mature the Ballistic Missile Defense System (BMDS) sensors/ command and control architecture in FY19 during 19 test events.
- The MDA fielded Command and Control, Battle Management, and Communications (C2BMC) Spiral 8.2-3 across the Combatant Commands and completed delivery of all Space-based Kill Assessment (SKA) payloads for on-orbit checkout of the system.
- FY19 sensor/command and control cybersecurity assessments informed the network defense posture in U.S. Northern Command (USNORTHCOM) and provided data on how to reduce mission risk.
- The Long Range Discrimination Radar (LRDR) continued design verification testing and array buildup. The Homeland Defense Radar-Hawaii (HDR-H) passed its System Requirements Review.
- AN/TPY-2 Forward-Based Mode (FBM) radar operator training improved, but interactive electronic technical manuals continue to be deficient.
- The model of the COBRA DANE radar used in ground testing is insufficient for BMDS-level assessments and does not interface adequately or appropriately with the BMDS modeling and simulation framework.

System

- The BMDS sensors provide real-time ballistic missile threat data to the BMDS.
  - The COBRA DANE radar is a fixed site, L-band phased array radar operated by the Air Force.
  - Three Upgraded Early Warning Radars (UEWRs) are fixed site, ultrahigh frequency radars, operated by the Air Force. A fourth radar is operated by the Royal Air Force (RAF) with U.S. Air Force liaisons on site.
  - The Sea-Based X-band (SBX) radar is a mobile, X-band phased array radar operated by the MDA and located aboard a self-propelled, ocean-going platform.
  - 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 operated by the Air Force with external interfaces to the BMDS.
  - The SKA development project is a network of space sensors that will observe BMDS intercepts and determine a kill assessment.

↑ **Sensors**   ↓ **Command and Control**
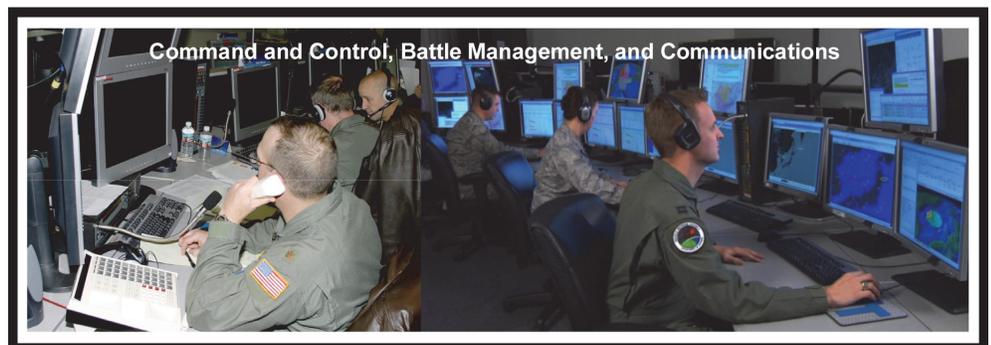
HDR-H – Homeland Defense Radar-Hawaii   **SBX – Sea-Based X-band**
LRDR – Long Range Discrimination Radar   **UEWR – Upgraded Early Warning Radar**

- The LRDR is a fixed site, two-face, S-band phased array radar being constructed.
- The HDR-H is being designed as a fixed site, single-face, S-band phased array radar based on LRDR technology.
- The Aegis Ballistic Missile Defense (BMD) interceptor system includes the Aegis AN/SPY-1 radar, which can also be used as a forward-based sensor. See page 215 for reporting on the AN/SPY-1 radar.
- The C2BMC element is the Combatant Command interface to the BMDS and the integrating element within the BMDS.
  - The C2BMC provides Combatant Commands and other national leaders with situational awareness of BMDS status, system coverage, and ballistic missile track data. It also provides a consolidated upper echelon BMD mission plan at the Combatant Command and component level.
  - The C2BMC suite provides command and control for the AN/TPY-2 (FBM) radar as well as BMD system track reporting. BMDS Overhead Persistent Infrared Architecture (BOA) receives infrared sensor information on boosting ballistic objects and provides that data to C2BMC.
  - Using the BMDS Communications Network, the C2BMC provides sensor data to BMDS interceptor weapon systems, and coalition systems, for sensor cueing and threat missile engagement support.

Mission

- Combatant Commands use the BMDS sensor/command and control architecture with guided missile weapon systems to intercept missile threats that target the United States and U.S. allies.
  - Combatant Commands employ BMDS sensors to detect, track, and classify/discriminate ballistic missile threats.
  - Combatant Commands 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 Company, Intelligence, Information, and Services – Dulles, Virginia
- UEWRs
  - Raytheon Company (Prime), Integrated Defense Systems – Tewksbury, Massachusetts
  - Harris Corporation/Exelis (Sustainment) – Colorado Springs, Colorado

- SBX and AN/TPY-2 (FBM) Radars
  - Raytheon Company, Integrated Defense Systems – Tewksbury, Massachusetts
- SBIRS
  - Lockheed Martin Corporation, Space Systems – Sunnyvale, California
- SKA
  - Johns Hopkins University, Applied Physics Laboratory – Laurel, Maryland
- LRDR and HDR-H
  - Lockheed Martin Corporation, Maritime Systems and Sensors – Moorestown, New Jersey
- C2BMC
  - Lockheed Martin Corporation, Rotary and Mission Systems – Huntsville, Alabama, and Colorado Springs, Colorado
- BOA
  - Northrop Grumman Corporation – Boulder, Colorado; Colorado Springs, Colorado; and Azusa, California

Activity

- The MDA conducted testing in accordance with the DOT&E-approved Integrated Master Test Plan.
- During FY19, the MDA used the sensors/command and control architecture in four intercept flight tests, six ground tests, three cybersecurity tests, and four Air Force intercontinental ballistic missile (ICBM) reliability and sustainment flight tests.

Intercept Flight Tests

- The MDA conducted:
  - Flight Test, Aegis Weapon System-45 (FTM-45) in October 2018. An Aegis BMD ship performed an organic engagement with a Standard Missile-3 (SM-3) Block IIA guided missile against a medium-range ballistic missile target.
  - Flight Test, Integrated-03 (FTI-03) in December 2018. Using a SM-3 Block IIA guided missile, Aegis Ashore performed an engage-on-remote intercept of an intermediate-range ballistic missile target using C2BMC system tracks based on BOA and AN/TPY-2 (FBM) radar data.
  - Flight Test, Ground-based Midcourse Defense (GMD) Weapon System-11 (FTG-11) in March 2019. The GMD weapon system performed a two-interceptor salvo engagement of an ICBM target missile based on data from the SBX radar, the AN/TPY-2 (FBM) radar, C2BMC, BOA, and SBIRS.
  - Flight Test, Terminal High-Altitude Area Defense (THAAD) Weapon System-23 (FTT-23) in August 2019. The THAAD weapon system performed an intercept using a remote launcher. Data were collected by SBIRS,

BOA, and SKA during the test, but they were not connected to THAAD.

Ground Tests

- The MDA conducted:
  - A two ground test series in December 2018 and March 2019 used hardware and software representations of the Homeland Defense BMDS and Theater/Regional BMDS to assess Capability Increment 5 functionality. A follow-on ground test in May 2019 included operational assets and Service operators on console.
  - Ground testing in June and August 2019 assessed the functionality of the U.S. Forces, Korea, Joint Emergent Operational Need Phase 3 architecture.
  - In August 2019, hardware-in-the-loop ground testing assessed sensor performance, GMD fire control engagement planning and execution, and Exo-atmospheric Kill Vehicle performance.
  - A September 2019 ground test assessed sensor architecture changes in Theater/Regional U.S. Central Command (USCENTCOM) scenarios.

Cybersecurity Tests

  - The Army conducted a cybersecurity Adversarial Assessment on C2BMC S8.2-3 in May 2019 at the request of the MDA and in support of fielding this software to USNORTHCOM and U.S. Indo-Pacific Command (USINDOPACOM).
  - In July 2019, the Army conducted a cybersecurity Cooperative Vulnerability and Penetration Assessment and Adversarial Assessment on SBX 4.0.x. Both tests were executed at the request of the MDA.

- The Air Force conducted a cybersecurity event on an UEWR in August 2019, but MDA interfaces were excluded from the event.

Air Force ICBM Reliability and Sustainment Flight Tests

- The Air Force conducted four ICBM flight tests in 2019. C2BMC, SBIRS, and SBX participated in all four events. SKA participated in three of the four events.

• The MDA fielded C2BMC S8.2-3 to U.S. European Command and USCENTCOM in December 2018 and to USNORTHCOM and USINDOPACOM in June 2019. Further, they fielded BOA 6.1 to all four Combatant Commands in December 2018.

• The Air Force fielded SBIRS 18-1 in April 2019.

• The Army approved the AN/TPY-2 Electronics Equipment Unit with x86 processor and software version CX2.1 for conditional materiel release in June 2019. The MDA and Army have scheduled x86 upgrades for the remaining Electronics Equipment Units with the superdome processor at a rate of two per year. The MDA also installed an x86 processor on the SBX in FY19.

• The MDA completed delivery of all SKA payloads, the last of which was commercially launched in November 2018. The MDA conducted on-orbit checkout of the system during FY19.

• The LRDR development contractor continues verification testing at its facility. LRDR array buildup has begun.

• HDR-H passed its System Requirements Review in June 2019.

Assessment

• During FY19 testing, the MDA collected sensor/command and control data supporting development and fielding of new capabilities and architectures associated with BMDS Capability Increment 5 and U.S. Forces, Korea Joint Emergent Operational Need Phase 3 functionalities. New capabilities and architectures examined during testing included:

- Software improvements for SBX and SBIRS

- C2BMC, BOA, and AN/TPY-2 (FBM) support to Aegis BMD engage-on-remote engagements
- Radar coverage of an UEWR
- New BOA-to-Aegis BMD communication links
- AN/TPY-2 (FBM) and C2BMC support to Space Domain Awareness
- Sensor support to GMD under various engagement procedures
- USCENTCOM sensor and command and control architecture changes

• Test data and resulting assessments are classified; see the DOT&E "FY19 Assessment of the BMDS," to be published in February 2020.

• The model of the COBRA DANE radar used in ground testing is insufficient. It cannot accept dynamic input from the BMDS modeling and simulation framework, such as interceptors or debris.

• FY19 cybersecurity assessments informed the network defense posture in USNORTHCOM and provided data on how to reduce mission risk for these elements operating in a cyber-contested environment. Test data and resulting assessments are classified; see the DOT&E "FY19 Assessment of the BMDS," to be published in February 2020.

• AN/TPY-2 (FBM) radar operator training improved, but interactive electronic technical manuals continue to be deficient.

Recommendation

1. The MDA and Air Force should modify the existing COBRA DANE model or develop a new model so it is able to adequately and appropriately interface with the BMDS modeling and simulation framework.