

## Sensors

### Executive Summary

- In January 2010, the Missile Defense Agency (MDA) conducted the Flight Test Ground-based Interceptor-06 (FTG-06) event employing the Sea-Based X-band (SBX) radar as the sole midcourse sensor. No other Ballistic Missile Defense System (BMDS) operational sensor participated in the flight test intercept attempt. The SBX exhibited undesirable performances that contributed to the failure to intercept.
- The MDA has gained significant operational experience with each of the BMDS sensors since the completion of sensor upgrade and development programs. However, the BMDS Operational Test Agency Team has not accredited any high fidelity performance models and simulations for assessing the performance of BMDS sensors.

### System

The BMDS sensors are the following:

- **Aegis Ballistic Missile Defense (BMD) Radars**  
Aegis AN/SPY-1 radars modified to provide surveillance and tracking of long-range ballistic missiles.
- **AN/TPY-2 (Forward Based Mode (FBM)) Radar**  
(formerly called Forward based X-band Transportable (FBX-T))



Aegis BMD

- A Terminal High-Altitude Area Defense (THAAD) high resolution, X-band, phased array radar with modified software to provide acquisition and tracking of ballistic missiles of all ranges in the boost phase and transition to the midcourse phase of flight. There are two radars operationally deployed, one to Shariki, Japan, and the other to Israel.



AN/TPY-2

- **Cobra Dane Upgrade (CDU) Radar**  
An L-band, fixed site, fixed orientation, phased array radar located at Shemya, Alaska.



Cobra Dane

- **Space-Based Infrared System/ Defense Support Program (SBIRS/DSP)**  
An infrared satellite constellation and ground stations (primary and backup) that provide the BMDS with the initial notification of a ballistic missile launch and defended area determination.



SBIRS/DSP

- **SBX Radar** (in development)  
An X-band phased array radar on a movable mount, positioned on a fifth generation, twin hulled, semi-submersible, self-propelled ocean-going platform.



SBX

- **Upgraded Early Warning Radars (UEWRs)**  
Ultra High Frequency fixed site, fixed orientation, phased array radars located at Beale AFB, California (two radar sides or “faces,” 240-degree azimuth field of view); Fylingdales, England (three “faces,” 360-degree azimuth field of view); and Thule Air Base, Greenland (future addition) (two “faces,” 240-degree azimuth field of view).



UEWR

### Mission

U.S. Strategic Command, U.S. Northern Command, U.S. European Command, U.S. Pacific Command, and U.S. Central Command will use the BMDS sensors to:

- Detect, track, and classify ballistic missile threats targeting the United States, its allies, and its friends.
- Provide data for situational awareness and battle management to the BMDS Command, Control, Battle Management, and Communications (C2BMC) element.
- Provide track data to generate weapon task plans for ballistic missile defensive systems such as Aegis BMD and Ground based Midcourse Defense (GMD).

# BALLISTIC MISSILE DEFENSE SYSTEMS

## Major Contractors

- Aegis AN/SPY-1: Lockheed Martin – Moorestown, New Jersey
- AN/TPY-2: Raytheon Integrated Defense Systems – Tewksbury, Massachusetts
- CDU: The Boeing Company, Integrated Defense Systems, Missile Defense Systems – Huntsville, Alabama
- SBIRS: Lockheed Martin Space Systems Company – Sunnyvale, California
- SBX: The Boeing Company, Integrated Defense Systems, Missile Defense Systems – Huntsville, Alabama
- UEWRs:
  - Beale AFB and Fylingdales – The Boeing Company, Integrated Defense Systems, Missile Defense Systems – Huntsville, Alabama;
  - Thule – Raytheon Missile Defense Center – Woburn, Massachusetts

## Activity

- Aegis BMD AN/SPY-1: Aegis BMD AN/SPY-1 participated in multiple live tracking exercises and ground tests during FY10. Japanese Flight Test Mission-3 (JFTM-3) and Flight Test Other-06 (FTX-06) Events 2 through 4 performed live target tracking and simulated engagement support. AN/SPY-1 participated in hardware-in-the-loop and distributed ground tests, including Fast Contingency Analysis and Activation Team (CAAT) East-C (FCE-C), Ground Test Other -04a (GTX-04a), and Ground Test Integrated-04b (GTI-04b).
- AN/TPY-2 (FBM): An AN/TPY-2 (FBM) radar observed a number of targets of opportunity in FY10, such as Booster Verification Test-01 (BVT-01) in June 2010 and Flight Test Airborne Laser-01 in February 2010. The radar collected data on the performance of the software version (CX-1) that is planned for use in the first phase of the Phased Adaptive Approach in Europe. The radar also participated in focused GTX-04a in March 2010 and GTI-04b, using hardware-in-the-loop to demonstrate interoperability with other BMDS components. GTX-04a was a regional focused test using defense scenarios against short-, medium-, and intermediate-range ballistic missile threats, and GTI-04b was a full BMDS exercise using defense scenarios with short-, medium-, and intermediate-range and intercontinental ballistic missile threats. AN/TPY-2 (FBM) also participated in the Juniper Cobra 10 war game and the FCE-C test events in 1QFY10.
- Cobra Dane Upgrade: The Cobra Dane Upgrade viewed a number of targets of opportunity. A Cobra Dane Upgrade laboratory representation using operational software and operationally representative hardware participated in the system-level event, GTI-04b, in August 2010.
- SBIRS/DSP: A SBIRS/DSP laboratory representation using operational software and operationally representative hardware participated in GTI-04b.
- SBX: SBX collected track and discrimination data on the target during the FTG-06 flight test in January 2010. Undesirable SBX performances occurred that contributed to a failed intercept. An SBX laboratory representation using to-be-fielded software and operationally representative hardware participated in GTI-04b.
- UEWR: UEWR-Beale participated in the FTG-06 flight test in a passive role that did not affect the test. The UEWRs

(Beale and Fylingdales) also participated in several MDA system-level ground test events, notably GTI-04b.

## Assessment

- Overall: Since the completion of their respective upgrade or development programs, the MDA has gained significant operational experience with each of these sensors. An area of concern is the development of consistent, validated environmental and post-intercept debris models to assess integrated system performance.
- Aegis BMD AN/SPY-1: Aegis BMD AN/SPY-1 continues to evaluate its interoperability with the BMDS and to support BMDS testing and real-world activities. Aegis BMD has not participated in a BMDS flight test that uses AN/SPY-1 radar data in real-time as the primary data source for developing a GMD weapon task plan, although it has supported intercepts as part of an ensemble of sensors including AN/TPY-2 (FBM), SBX, and UEWR-Beale.
- AN/TPY-2 (FBM): AN/TPY-2 (FBM) had a number of opportunities to collect data on the performance of upcoming software build CX-1, but an opportunity to test it as a contributing sensor in a flight test is not scheduled until FTG-06a in 1QFY11. DOT&E cannot assess the utility of CX-1 until that time.
- Cobra Dane Upgrade: Due to its location and field-of-view, Cobra Dane Upgrade has not participated in BMDS intercept flight test events. Performance estimates for the current configuration of Cobra Dane Upgrade have been limited to the ground test results and targets of opportunity. These estimates rely on models and simulations that are not yet validated and accredited for use in assessing performance. To collect the required data, the MDA will fly another target through the Cobra Dane Upgrade field of view. This flight test event is currently scheduled during FY13.
- SBIRS/DSP: SBIRS/DSP continues to support the BMDS with timely and accurate launch data and with initial predictive impact data.
- SBX: SBX has not successfully supported a live intercept as the sole primary midcourse sensor. During FTG-06, SBX participated as the sole midcourse targeting sensor, but the SBX exhibited undesirable performances that contributed

to the failure to intercept. SBX performance estimates are currently based on unaccredited models and simulations.

Significant work remains to collect the applicable data necessary to validate modeling of SBX performance.

- UEWRs: UEWR-Beale viewed the GMD interceptor flyout in FTG-06, but due to its location, it played no role in targeting. UEWR-Beale and UEWR-Fylingdales laboratory representations using operational software and operationally representative hardware participated in GTI-04b. UEWR-Beale and UEWR-Fylingdales performance estimates are based on unaccredited models and simulations.

## **Recommendations**

- Status of Previous Recommendations. Although the MDA and Combatant Commanders have made progress on developing concepts of operations for the sensors to be used as part of the phased adaptive approach to providing missile defense in Europe, the FY09 recommendation remains open pending completion of those concepts and implementation in operational testing.
- FY10 Recommendations. None.

# BALLISTIC MISSILE DEFENSE SYSTEMS