Supporting Ballistic Missile Defense Warfighters with a Training Capability

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ABSTRACT

At the Missile Defense Agency's (MDA) Missile Defense Integration and Operations Center in Colorado Springs, an integrated architecture is being used that enables missile defense training to occur for warfighters from the element to above element level. As a relatively new warfighting capability, the Ballistic Missile Defense System requires a new Concept of Operations (CONOPS), training regimen, and an integrated, distributed training system to assure that warfighter training needs are met. Previously, missile defense elements working independently were able to train and develop processes that enable them to successfully perform their mission. As the world's knowledge of Ballistic Missile Defense increases and the possibility of potential threats increases, the ability to train in coordination with other elements is essential. Coordination issues such as preventing conflict, verification of sensor indications, and responsive actions cannot be fully practiced in a stand-alone environment.

This paper describes MDA's support to Combatant Commander training using exercises, wargames, and the distributed multi-echelon training system for sustainment. This paper provides an overview of various training systems employed in the distributed architecture; and discusses the methodology for determining the appropriate tactical hardware, virtual simulations and constructive simulations connected for training. Additionally this paper describes issues and lessons learned related to the integration of distributed systems and simulations in the missile defense domain.

ABOUT THE AUTHORS

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INTRODUCTION

A Ballistic Missile Defense System (BMDS) is limited in its functionality if operators have not been trained on its use. A BMDS is an integrated and layered defense system that can track and engage threat missiles through all phases of flight. The flight of a ballistic missile is divided into three phases. During the initial phase or boost phase, a threat missile's engine ignites and launches the missile into space. During the second phase or midcourse, the missile may deploy a Reentry Vehicle (RV) and countermeasures. In the final or terminal phase, the missile reenters the atmosphere and proceeds to the intended target. The defense system may be capable of engaging the threat missile during any of the three phases of flight (Figure 1). A breakdown at any level of the defense system can provide undesired results.

MISSILE DEFENSE INTEGRATION AND OPERATIONS CENTER (MDIOC)

The United States Missile Defense Agency (MDA) has a mission to develop and field an integrated, layered BMDS to defend the United States, its deployed forces, allies, and friends against all ranges of missiles in all phases of flight. This mission is more relevant now than ever before. As part of MDA, the Missile Defense Integration and Operations Center (MDIOC) has been tasked with a mission to provide missile defense related analysis, system level engineering, integration, test, and evaluation support for the development, acquisition and deployment of missile defense systems and architectures; basically every portion of the fielding continuum. The MDIOC has an additional mission to support combatant commands by integrating missile defense concepts, space asset exploitation, battle management/command, control, communications,

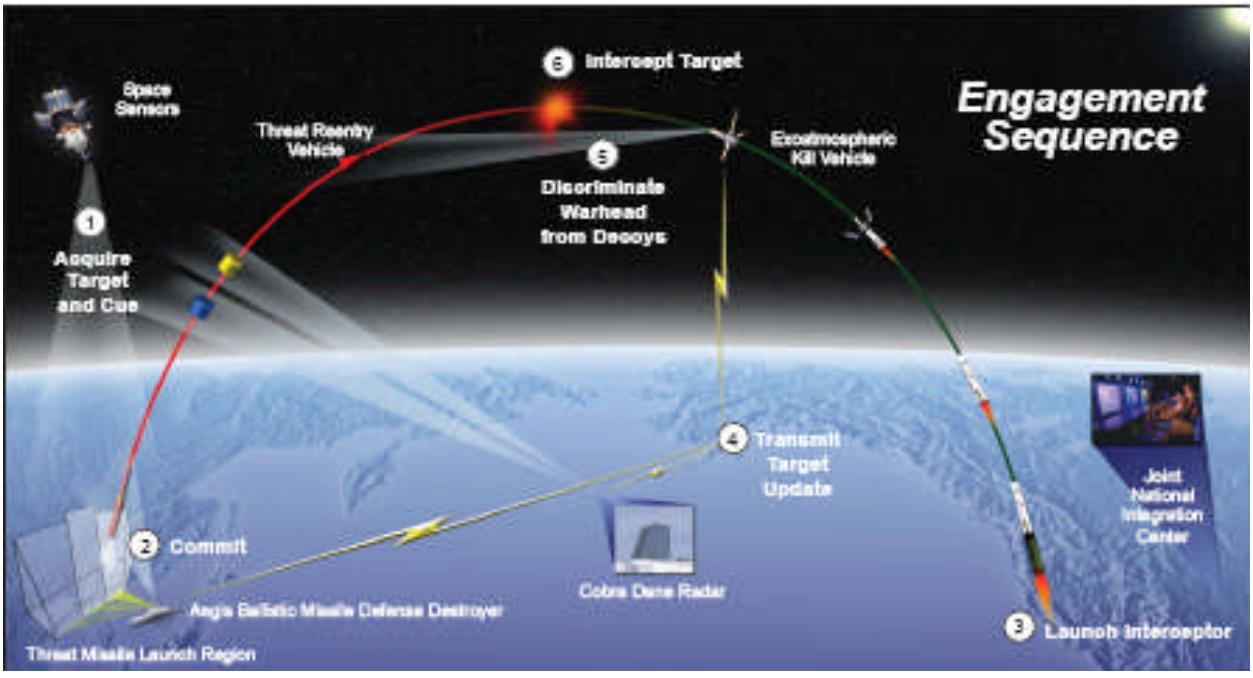

Figure 1. Phases of Threat Missile Flight

computers, and intelligence (BM/C4I) and by conducting joint and combined simulations, wargames and integrating participants in exercises as directed.

Warfighter training is supported by three separate and distinct events. The first type of events are Exercises, which are distributed hardware-in-the-loop (HWIL) and operator-in-the-loop (OITL) events. This type of event has warfighter participation on fielded systems and equipment as well as simulations to provide stimulation for unavailable systems. Exercises provide for cross Combatant Command (COCOM), cross-mission, cross-services, and cross-country coordinated training. The second type of event is Wargames, those events designed to examine future capabilities and to assist the developer and warfighters in identifying issues early in the developmental process. This type of event provides participants opportunities to address the "what if" questions and is primarily executed using simulations.

The last type of event is Sustainment Training, which provides Combatant Commands an opportunity to continue working with various elements using a combination of simulations and HWIL after an exercise has completed. In all aspects of the BMDS capability-based acquisition schema, there is no final architecture but a continual emphasis on improving the effectiveness of capabilities. To support the Warfighters in providing input into the acquisition process, the MDIOC provides an engineering, design, integration and test, and data collection and analysis capability. This capability facilitates an effective collaborative effort between the BMD system developers, Warfighters, and the test, exercise and training community. This collaboration is required to ensure operational expectations are being met, a common understanding exists, and good information channels are open in all directions, which in turn increase the Warfighter's confidence in the current and future fielded system (Figure 2).

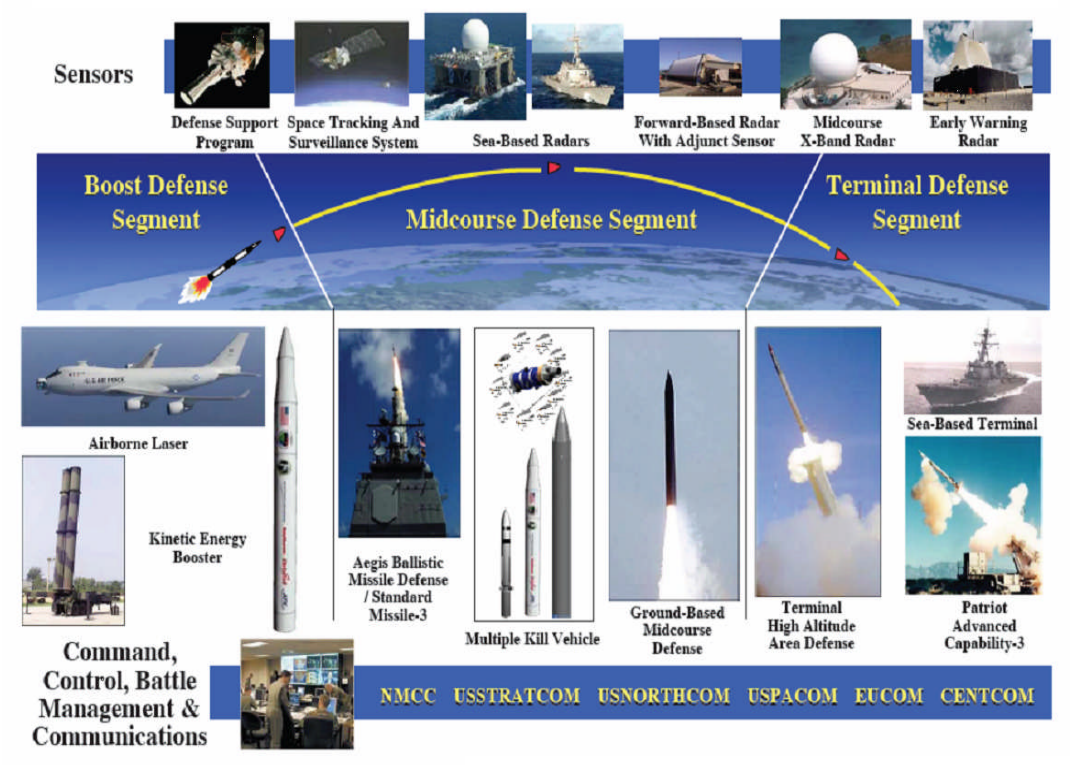

Figure 2. Elements of the US Ballistic Missile Defense System (BMDS)

OVERVIEW OF MISSILE DEFENSE TRAINING SYSTEMS

An effective BMDS involves participation at various levels from the console operator in the field to the top level military Commander. As a system is developed, training is conducted to verify operational capability as well as develop Concept of Operations (CONOPS) and Tactics, Techniques, and Procedures (TTPs) for the use of the system. This stand-alone training provides the operators an opportunity to develop inputs to human factors modifications for the developers. This training however, does not completely provide the necessary operator or system stimulus to completely examine integrated functionality. The MDIOC, in accordance with its mission statement, has developed a joint training environment that provides the warfighters with the stimulus missing from stand-alone system training. This training environment is a Joint Live, Virtual Constructive (JLVC) network consisting of tactical HWIL, system laboratories containing actual system software, and simulations.

Each branch of service and every BMD program has independently developed a simulation or simulations that provide stimulation to other systems and to train the operators who use their systems. Currently the exercise architectures include lower tier, sea based mid-course, and land based mid-course hardware and simulations. The MDIOC has established several network hubs at various distributed locations to connect these systems together. It is not feasible or cost effective to develop a closed network to connect every current and potential JLVC participant location. The MDIOC has taken the lead in the design and engineering for interfacing to training and exercise networks used by various organizations.

JOINT TRAINING AND EXPERIMENTATION NETWORK (JTEN)

The Joint Forces Command (JFCOM) has established the Joint Training and Experimentation Network (JTEN). This network has connection nodes throughout the world to provide network access for various warfighter events. Along with the network, JFCOM provides additional simulations, some of which MDA currently does not own, that can augment the training provided to the warfighters. These simulations include aircraft, air launched cruise missiles, sea and land based missile defense systems, and logistics.

NAVY CONTINUOUS TRAINING ENVIRONMENT (NCTE)

The NCTE consists of a variety of LVC systems to generate synthetic wargames. The NCTE primarily focuses on training required by Navy personnel. This environment provides communication networks and interfaces to the various Naval systems.

Linking MDA's communications network to the NCTE network and other training and experimentation networks, such as the JTEN and the Air Force Distributed Mission Operations Network, increases connectivity exponentially, to more than 200 sites worldwide.

COMMON DATA

To provide a level of fidelity to the exercise and training architectures, tactical hardware along with models and simulations are interfaced using two primary types of data. The truth data is the information provided to stimulate the HWIL and the simulations. This data is transmitted in a DIS protocol data unit (PDU) format or in a High Level Architecture (HLA) format. The second type of data is perceived data which is the output of the HWIL or simulation after processing. This data, during exercises, is transmitted in a tactical message format.

For the MDIOC to integrate several distributed standalone systems, it is required that each conform to a recognized standard. In each exercise that includes tactical hardware, threat data is injected primarily using the distributed interactive simulation (DIS) protocol. Because DIS is a widely used standard, the difficulties of interfacing simulations developed by different organizations are reduced. Each entity used by the simulation is defined using DIS enumerations, which identifies to each system the simulated entity's site, type of application being represented, and the type of entity being simulated. One of the most common issues found when working with the various systems that receive and transmit DIS protocol data was the lack of implementation of specific enumerations. The simple correction for this was to have the entity added to the system's enumeration file. Alternatively, if the DIS

enumeration did not previously exist, one was developed and agreed upon by all participants for the event.

High Level Architecture (HLA) is the successor of the DIS protocol. HLA was created based on the idea that individual simulations developed for one purpose can be used as part of other applications. In general, the intent of the HLA is to provide a structure which will support different simulations, ultimately reducing the cost and time required to integrate a training environment.

To provide communication between simulations using HLA and simulations using DIS, a DIS/HLA converter is employed. This system performs the translation between the two formats allowing each simulation to provide their stimulation to the architecture.

To provide warfighters the ability to train on their tactical equipment, participating simulations need to receive and transmit tactical messages. These tactical messages are the standard for communicating between tactical HWIL.

The MDIOC uses a Threat Injection Unit (TIU) that runs on a Solaris platform and is portable to provide a common threat source for participating systems. The TIU receives a DIS start PDU from a master system. This start begins the stimulation of the various systems based on GPS time sync. The threats are resident on the TIU, reducing the network traffic needed. This system is able to inject ballistic missile entities and air platform entities. A TIU system can also provide stimulation over long-haul networks, eliminating the requirement for a local TIU. These simulated real-world threat scenarios are simultaneously injected into geographically distributed tactical sensors and weapon systems. Tactical systems respond in real-time via their respective tactical communications links, allowing each individual BMDS system to operate in a tactically realistic environment.

MDA performs verification and validation of their models and simulations. This process helps to ensure accuracy of input provided to the warfighter based on the exercise requirements. There is no single architecture, simulation or model for every BMD training requirement, however by utilizing the best resource from the available sources (JTEN, NCTE, MDA, etc.), the MDIOC can provide the combatant Commanders with an adaptable architecture to refine their TTPs and CONOPS.

CHALLENGES AND SOLUTIONS

Interfacing with different systems, located in different states and in many instances, a different country is at times challenging. As with any joint or combined exercise or event, challenges arise and become the immediate priority. Some of the most notable challenges we encounter include:

- Distributed Interactive Simulation data standard not implemented to the latest version
- DIS enumeration mismatches between systems
- Tactical message data standard not implemented to the latest version
- Tactical messages not fully implemented
- Cross network accreditation and connectivity approval
- Ease of use and scalability of simulations
- Real-time and near real-time capability

SIMULATION AND SYSTEM DECISIONS

The planning for events is started at Concept Development Conferences (CDC). This is the discussion point for determining the Commander's intent and their training objectives for an exercise. Combatant Commanders provide the MDA Event Lead with their objectives and expectations for a training event. The MDA Event Lead and the MDIOC event staff, in conjunction with event stakeholders, determine the combination of LVC systems to accomplish the training mission.

A prioritization is applied when considering which BMD system to use for an exercise. The first priority is given to the tactical hardware. Although the use of tactical hardware is preferred, availability of equipment and support personnel are usually a determining factor. The second priority is given to the use of development laboratories. These labs provide the Warfighter with the same operator interfaces, but are usually located inside a building.

A lab is an operationally realistic alternative for warfighters, but the labs are usually scheduled to support other events such as developmental testing, and are often cost prohibitive. The third option is to use simulations. As with other decisions, the availability of network connectivity is the primary driver. Current connections and potential implementation constraints are considered. Accuracy of the simulation is then considered. Having connectivity to a simulation that does not accurately reflect a tactical system can result in negative or limited-use training. The availability of simulations is considered last.

WAY AHEAD

The Ballistic Missile Defense System will be enhanced by continued improvements to implement fully integrated, multiple system architectures. The MDIOC will continue to work with various tactical systems as well as the various simulations and models to produce a flexible training architecture that provides realistic training to the warfighter. By continuing to expand the nodes to include other military, joint, and coalition simulation systems, more challenging objectives will be achieved. As technology grows and new systems and simulations are developed, we will continue to leverage these systems to provide the warfighters with an opportunity to examine these future capabilities and execute sustained training on fielded system in a practical and cost effective manner.

The three levels of training events are an essential part of being prepared for BMD activities throughout the world. Each software and hardware developer will continue to focus on making their product the best that it can be. MDA will continue to look for and work with these developers to ensure that the warfighters and our Allies/Coalition Partners are receiving the best possible training. Exercises are the venue to bring together the different BMD devices and systems to examine their interoperability and to give the Warfighters opportunities to provide feedback on the current and near-term system functionality. Real-time warfighter actions, combined with actual voice reporting, affect the outcome of scripted scenario events, enabling training staffs to assess crew member performance and proficiency based on established training objectives.

Warfighters, understanding the opportunities gained through cross level testing and training, have requested daily sustainment training, to support their BMD proficiency and readiness. To fulfill this request, MDA has developed a system-of-systems that enables a widely distributed audience (both US and allied) to participate collectively in real-time BMD training scenarios. The Distributed, Multi-echelon Training System, or DMETS, consists of tactical hardware, models and simulations, and threat generation tools to provide a near operational environment that is interactive based on actions taken by participating warfighters. This system of systems provides continued, repeatable training to warfighters using scenarios and threats that allow them to focus on particular objectives. During sustainment training, warfighters can continue to work on their Joint Mission Essential Tasks (JMETs). These tasks are defined by the individual COCOMs for their troops to exercise and understand implications based on their actions or reactions to a scenario event.

Both the Exercise and the DMETS environments are scalable, which enables them to support training for any number of participants. When units are unable to participate, but would logically have an operational decision-making or execution role in a given training session, MDA personnel replicate the functions of the missing elements by manning a White Cell.

MDA's vision did not stop at current, near term, or sustainment training. Instead, MDA uses Wargames to look towards the future of the BMDS. MDA elements have developed simulations to represent what is known today about future BMD capabilities such as the Airborne Laser (ABL), the Kinetic Energy Interceptor (KEI), and the Space Based Tracking and Surveillance System (STSS). Wargames request that program offices and simulation developers think into the future and develop a system that provides the warfighter with the additional capabilities that they would need to be successful in the BMD arena. These types of events allow stakeholders from all levels (Tier 1-5) to re-examine their requirements for executing their mission. This is also an opportunity to further the interaction and the often under-exercised cross-COCOM coordination.

CONCLUSION

Creation of a successful ballistic missile defense will be enhanced by the firm establishment of integration standards. A warfighter's ability to perform their mission is enhanced through an integrated and complete training architecture, developed on these minimum standards. The ability to provide training, reduce the duplication of efforts for simulation developers who require stimulation for their systems, and reduced cost can be gained by effectively using the limited available resources. Simulation developers also gain valuable insight into modifications required for their systems to better replicate expected behaviors and functionality when operated in an integrated environment.

The MDIOC is currently taking the lead for Modeling and Simulating all facets of missile defense, whether through simple and unclassified modeling of a few parameters to answer simple objectives, or world wide federation with allies and combat platforms, to explore the hard C2, CONOPS or TTP issues. Looking toward the future should bring exciting opportunities to enable warfighters to execute their mission successfully in a Global Missile Defense architecture. We will continue to work with the Warfighter to understand their training needs, and provide outstanding solutions.

Being successful in providing training to warfighters with many different systems and devices requires that program offices and developers have an understanding of the benefit to the warfighter. Integrating BMD systems and providing training on them are not simple tasks nor should they be ignored. MDA has focused its efforts to ensure the program offices and developers understand that the ultimate goal is to deter missile attacks and be ready to defend against them. Failing to deter, we as a collective, have to have the best system ready to effectively react to a threat, and the best trained warfighters to execute the mission.

CAVEATS

The opinions expressed here are those of the authors and do not necessarily reflect the official position of Northrop Grumman Corporation, the U. S. Department of Defense, or the U. S. Missile Defense Agency.

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