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Report to the Chairman, Subcommittee
on Military Research and Development,
Committee on Armed Services, House of
Representatives

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CRUISE MISSILE DEFENSE

Progress Made but Significant Challenges Remain



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National Security and
International Affairs Division

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March 31, 1999

The Honorable Curt Weldon
Chairman, Military Research and
Development Subcommittee
Committee on Armed Services
House of Representatives

Dear Mr. Chairman:

Because of the Committee's concerns that the Department of Defense (DOD) might not be giving sufficient emphasis to cruise missile defenses, you asked us to review DOD's progress in establishing adequate mechanisms for coordinating cruise missile defense programs.¹ Our objectives were to (1) identify the organizational structure and mechanisms for coordinating cruise missile defense efforts, (2) determine potential measures of the progress of coordination efforts, (3) assess the progress of coordination using these measures, and (4) identify the challenges that DOD officials believe still must be overcome. Because of your interest, this report focuses on defense against land attack cruise missiles.

You also asked us to identify the systems that have or will have cruise missile defense capabilities and the amount of funding being requested or planned for these programs. We agreed to provide the system and funding information in a separate briefing.

Results in Brief

The organizational structure for coordinating cruise missile defense efforts across all services consists of the Joint Theater Air and Missile Defense Organization and the Ballistic Missile Defense Organization supported by a three-tiered set of integrated product teams. The Joint Theater Air and Missile Defense Organization is to focus on operational requirements issues, while the Ballistic Missile Defense Organization is to focus on acquisition issues. These organizations are to work closely together, using

¹A cruise missile is an unmanned, armed aircraft that can be launched from another aircraft, ship, submarine, or ground-based launcher to attack ships (antiship cruise missiles) or ground-based targets (land attack cruise missiles).

a three-tiered set of teams² comprised of personnel from all organizations involved in theater air and missile defense development, acquisition, and operations. These teams are to develop and refine the overall mechanism for coordinating cruise missile defense efforts—the Theater Air and Missile Defense Master Plan. The individual military services are primarily responsible for funding and developing systems and modifications for cruise missile defense.

DOD officials told us the ultimate measure of the effectiveness of the coordination process would be the fielding of a cost-effective, interoperable³ cruise missile defense capability. However, full accomplishment of this goal is several years away, and DOD has not specified interim measures of progress toward the goal. Progress can be measured in terms of both the process and the outputs or results of the process. We identified some process measures, for example, whether affected organizations were involved. We also identified, through discussions with senior-level officials, some outputs and results that would indicate progress toward coordinating these efforts. These measures are (1) developing and refining an overall defense strategy and options for implementing the strategy (the Theater Air and Missile Defense Master Plan), (2) gaining acceptance of the master plan by affected organizations, (3) developing and approving overall requirements for a family of theater missile defense systems, (4) planning and conducting joint demonstrations of the systems, (5) achieving agreement between the master plan and the services' proposed budgets, and (6) establishing investment priorities.

DOD has made initial progress toward coordinating its cruise missile defense efforts based on both the process and output measures. The three-tiered team approach is improving coordination through joint efforts to define and reach consensus on the issues. Through December 1998, the teams had prepared four iterations of the master plan, each revising and expanding on prior versions. Future iterations are planned on an annual basis. One of the teams also significantly contributed to the development of the Theater Missile Defense Capstone Requirements Document, which was approved in July 1998. The Capstone Requirements Document

²The three-tiers—working level, integration, and overarching—are staffed by progressively higher levels of DOD management. Each team includes representatives from DOD, the Joint Staff, each of the military services, the theater combatant commands, and other organizations involved with the air and missile defense mission.

³The ability of two or more systems to exchange information and use that information to work together toward accomplishing the mission.

contains the overall requirements for the family of theater missile defense systems. In addition, although the master plans and the services' budgets are not yet in full agreement, the new coordination process has affected budgets and acquisition programs to a limited extent, and other budget issues have been identified for future resolution.

Even though progress has been made, DOD officials recognize they still face coordination challenges in acquiring a cost-effective cruise missile defense. These include getting the services to work together to resolve issues in a joint fashion; identifying, defining, and obtaining service agreement on the threat; and funding the technologies most vital to an effective cruise missile defense.

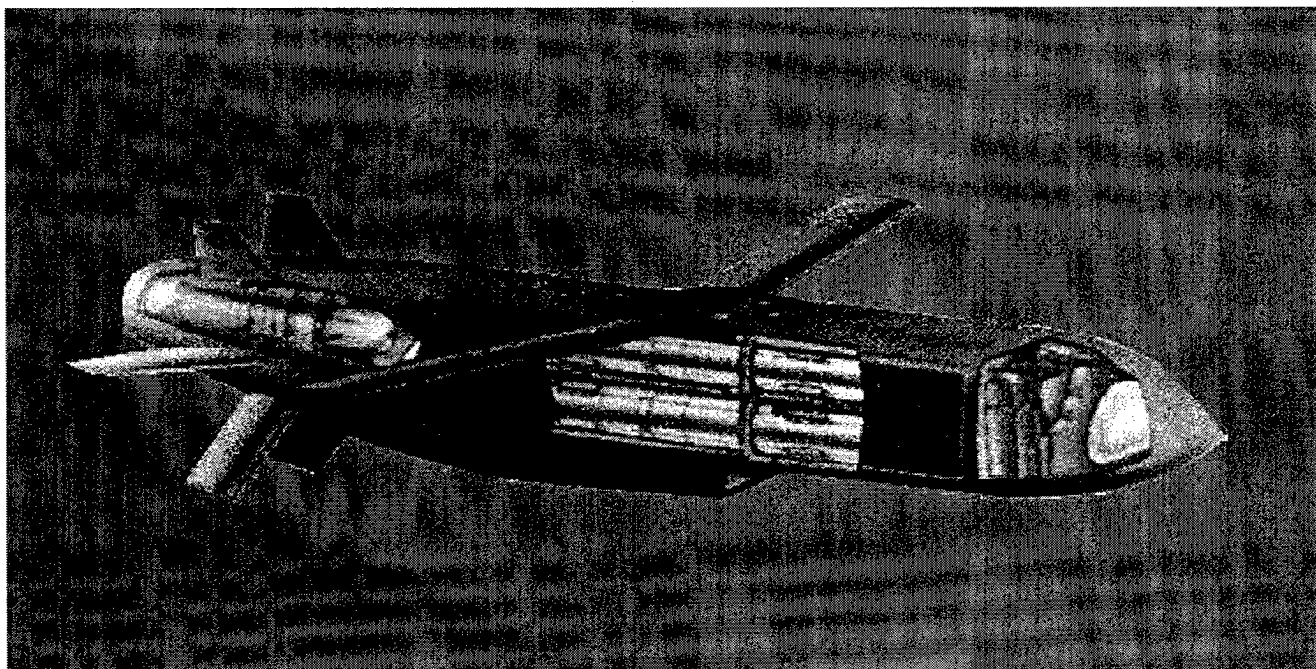
In addition, there are technical challenges to be overcome. The technical challenges identified by the senior level officials include developing mechanisms to enhance warfighters' ability to fight jointly and a capability to intercept cruise missiles outside the view of weapon system operators, improving sensors' abilities to detect and track low observable (stealthy) cruise missiles, fielding interoperable systems, and developing low-cost defense systems to counter attacks by large numbers of unsophisticated cruise missiles.

We recommend in this report that DOD develop a time-phased set of interim measures to assess progress toward DOD's goal of a cost-effective, interoperable family of cruise missile defense systems and that DOD report such progress to the Congress in a timely manner for annual budget deliberations.

Background

Land attack cruise missiles, most of whose ranges vary from about 90 to 190 miles, may be sufficiently accurate to impact within a few feet of their intended targets. Defending against these cruise missiles will stress air defense systems because these missiles are very difficult to detect, track, and intercept under the best conditions. Cruise missiles are smaller, and therefore much less visible to radar than aircraft or ballistic missiles, and can fly at low altitudes to stay below radar coverage. For example, due to the earth's curvature, a ground based radar can detect a low flying cruise missile that is about 20 miles away. In comparison, an aircraft flying at 10,000 feet can be detected when it is about 150 miles away. Newer missiles are incorporating stealth features to make them even less visible to radars and infrared detectors. A picture of a cruise missile is shown in figure 1.

Figure 1: Cruise Missile



Source: National Air Intelligence Center.

DOD officials believe that a credible land attack cruise missile threat does not yet exist but that the threat could emerge rapidly. Threat planners believe that, because of the Tomahawk's apparent success during the Persian Gulf War, development of cruise missiles will greatly increase. According to a 1998 report by the National Air Intelligence Center, only three countries currently have operational land attack cruise missiles, but the threat will increase after the year 2000 when several countries will start production, and probably export a new generation of land attack cruise missiles.

Countries interested in acquiring cruise missiles can do so by developing new systems, modifying antiship cruise missiles or unmanned aerial vehicles, or purchasing them directly. A 1994 Defense Science Board Summer Study⁴ concluded that, while land attack cruise missiles are not

⁴Report of the 1994 Defense Science Board Summer Study Task Force on Cruise Missile Defense.

widely available, potential adversaries have the motives and means to acquire them. The study group also concluded that coping with the threat would require a comprehensive strategy to prevent or delay possession and to deter and defend against their use. According to the group's report, cruise missile defense should be pursued within the concept of overall theater air defense. The report identified an overall acquisition strategy based on (1) improving the capabilities of existing air defense systems to share data and work together, (2) upgrading selected sensors and missiles to deal with stealthy cruise missiles, and (3) fielding new airborne surveillance and fire control systems. The report noted that effective joint air defense required two centers of expertise—one for joint doctrine, requirements, and concepts of operations and the other for systems engineering and battle management command, control, and communications.

The Fiscal Year 1996 Authorization Act directed the Secretary of Defense to undertake an initiative to coordinate and strengthen the cruise missile defense programs to ensure that the United States develops and deploys affordable and effective defenses. The act directed the Secretary to ensure, to the extent practicable, that cruise missile programs and ballistic missile defense programs are coordinated and mutually supporting. The act required DOD to prepare a plan to carry out the initiative, including organization and management changes that would strengthen and further coordinate cruise missile defense programs. The act also directed the Secretary to ensure that the appropriate existing and planned air defense systems be upgraded to provide an affordable and operationally effective defense against existing and near-term cruise missile threats. The Fiscal Year 1997 report of the House Committee on Appropriations, issued in June 1996, expressed concern that each of the services and the Defense Advanced Research Projects Agency were developing unique cruise missile defense systems rather than building systems optimized to meet the needs of the theater combatant command Commanders in Chief in joint service operations.

In July 1996, the Under Secretary of Defense for Acquisition and Technology advised the Chairman, House Committee on National Security, that the key elements of a land attack cruise missile defense program had been identified. The key elements are

- an advanced mix of airborne sensors (aerostats and fixed-wing aircraft systems);

Organizational Structure and Coordination Mechanisms Established

In late 1996, DOD created an organizational structure for coordinating theater air and missile defense activities, including cruise missile defenses. The structure consists of a partnership between a new organization—the Joint Theater Air and Missile Defense Organization (JTAMDO)—and an existing one—the Ballistic Missile Defense Organization (BMDO)—supported by a three-tiered set of integrated product teams. The teams consist of representatives of those organizations and activities responsible for planning, acquiring, and using theater air and missile defense systems. Together, these organizations are to develop and refine a theater air and missile defense master plan. The individual military services' continue to be responsible for funding and developing systems and modifying existing systems for cruise missile defense.

New Management Arrangement Created

DOD established JTAMDO as the warfighters' (theater commanders, Joint Staff, and the services) focal point for developing joint operational architectures,⁶ overall requirements, and operational concepts.⁷ JTAMDO is also responsible for validating the capabilities through simulations and demonstrations. It reports to the Joint Staff's Director for Force Structure, Resources, and Assessment.

DOD also directed BMDO to assume the role of integration systems architect. Working jointly with JTAMDO, BMDO is to translate the operational architectures into system architectures,⁸ perform systems engineering at the architecture level, plan and ensure integrated testing of defense architectures, and lead program acquisition activities. For example, BMDO is to work with the services and the joint program offices to develop an overall plan for acquiring systems with integrated capabilities.

DOD directed that the two organizations work closely together and with others involved in air and missile defense requirements, acquisitions, and operations, using a three-tiered integrated product team approach—

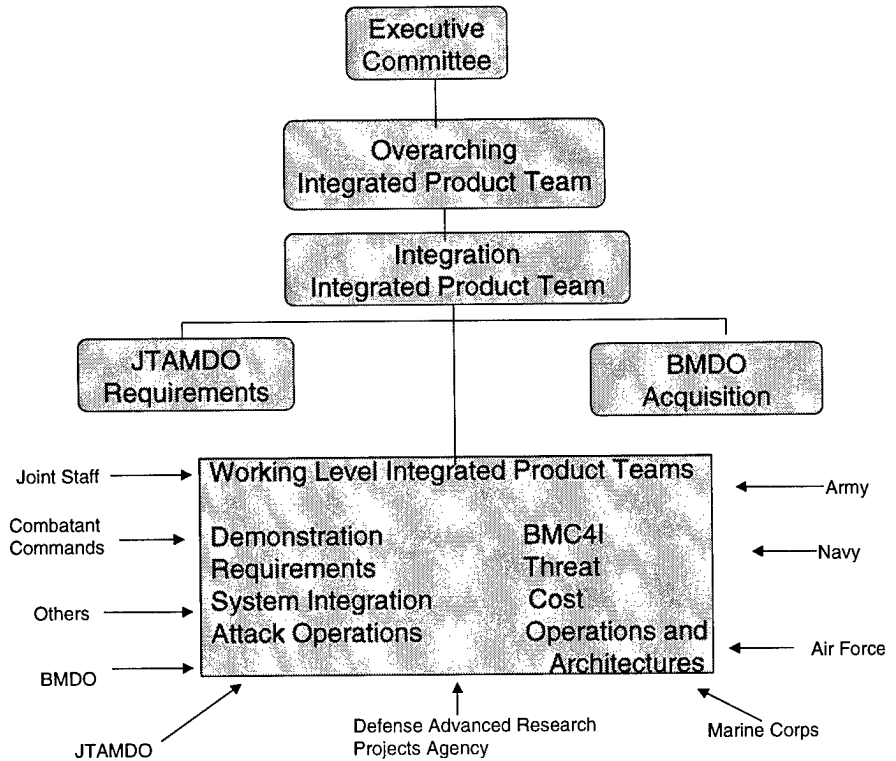
⁶An operational architecture describes the basic framework and structure of what is to be built and defines the field deployment of system components to the force. It describes who needs to exchange information, what information needs to be exchanged, and how that information will be used.

⁷An operational concept is a description of how to fight and how to use the equipment.

⁸A systems architecture is a description of the specific systems (hardware and software) and interconnections necessary to fight a battle.

working level, integration, and overarching teams. The teams are composed of representatives from JTAMDO, BMDO, the Joint Staff, the Office of the Secretary of Defense, each of the services, the Defense Advanced Research Projects Agency, the Defense Intelligence Agency, and theater combatant commands. Their goal is to achieve coordination through collaboration and consensus building. The structure of the coordination process is shown in figure 2.

Figure 2: Coordination Process Structure



Source: JTAMDO.

There are eight working level integrated product teams: threat; requirements; operations and architecture; battle management command, control, communications, computers, and intelligence (BMC4I); systems integration; demonstration; cost; and attack operations. The responsibilities of each team are shown in table 1.

Table 1: Working Integrated Product Team Responsibilities

Team	Responsibilities
Operations and architecture	Develop operational and battle management concepts and associated architectures.
Cost	Develop cost estimates and perform trade-off analyses.
Threat	Obtain comprehensive threat intelligence.
Systems integration	Coordinate, establish, and maintain system-level architectures for an interoperable family of systems.
Requirements	Document theater air and missile defense-related requirements and assist in developing the Theater Missile Defense Capstone Requirements Document.
BMC4I	Produce a BMC4I architecture to describe the interfaces to achieve a joint integrated air and missile defense system.
Attack operations	Integrate attack operations data into joint theater air and missile defense plans.
Demonstration	Develop approaches and a plan for validating the family of system capabilities.

Each team was chartered to develop and refine its assigned part of the overall master plan for theater air and missile defense, identify and investigate the issues related to its area, and resolve those issues in a collaborative manner. Their goal is to reach a consensus at the lowest possible level. To more expeditiously accomplish the tasks, most teams are broken into subgroups, but their products or issues are addressed and approved by the full team. Personnel from JTAMDO and BMDO lead most of the teams, but, in some cases, teams are led by personnel from the Defense Intelligence Agency, the Joint Staff, and the Atlantic Command⁹ when the subject matter warrants. For example, the threat working-level team is co-chaired by representatives from the Defense Intelligence Agency and JTAMDO, and the requirements team is co-chaired by representatives from JTAMDO and the Atlantic Command, a combatant command.

The integration integrated product team, co-chaired by the Deputy Director, JTAMDO, and the Deputy for Theater Air and Missile Defense, BMDO, provides management guidance and focus; directs the coordination of the requirements and acquisition activities; builds consensus among the services and other participants; and approves the master plan before it

⁹The Atlantic Command has been assigned responsibility to help enhance joint force capabilities through a blending of technology, systems, and doctrine. See U.S. Atlantic Command: Challenging Role in the Evolution of Joint Military Capabilities (GAO/NSIAD-99-39, Feb. 17, 1999).

goes to the next level. The overarching integrated product team—co-chaired by the Director for Strategic and Tactical Systems, Office of the Under Secretary of Defense for Acquisition and Technology, and the Director for Force Structure, Resources, and Assessment, Joint Staff—provides policy and financial guidance, receives and refines the recommendations from the integration integrated product team, examines any germane issues, and suggests a review of appropriate cruise missile defense issues by the Executive Committee. The Theater Air and Missile Defense Executive Committee, co-chaired by the Under Secretary of Defense for Acquisition and Technology and the Vice-Chairman, Joint Chiefs of Staff, provides DOD level guidance.

Master Plan Is to Be Overall Coordination Mechanism

The Theater Air and Missile Defense Master Plan is to be the overall mechanism for achieving coordination. The plan, which is to be updated annually in the future, is designed to develop and articulate the rationale for improving the defense capabilities and to focus attention upon the decisions necessary to implement the improvements. It outlines a concept for joint theater air and missile defense operations (including cruise missile defense), describes a family of systems to accomplish the mission, identifies current and future shortcomings, defines the demonstrations needed to validate the family of system capabilities, and makes specific recommendations for implementing future capabilities. The plan is intended to (1) better focus service and BMDO proposed budgets and procurement of new systems and (2) influence service priorities for upgrades to existing systems.

According to the former Under Secretary of Defense (Acquisition and Technology) and the Vice-Chairman of the Joint Chiefs of Staff, the coordination process is not intended to alter the services' traditional responsibilities for program execution and resource management. Unlike the case for ballistic missile defense programs, neither JTAMDO nor BMDO controls most cruise missile defense funding; rather it is included in the services' budgets. Therefore, obtaining funding for specific cruise missile defense programs often requires influencing the services to include funding in their budget proposals.

Potential Interim Indicators to Assess Progress

Many senior-level officials told us the ultimate measure of coordination would be to field a cost-effective, interoperable cruise missile defense, but that goal is not scheduled to be accomplished until 2010. In the interim, DOD has not specified time-phased measures that can be used to gauge whether the coordination process is on track to accomplish its goal. Coordination progress can be measured both in terms of extent to which the process has been implemented (process measures) and the outcomes and results of the progress (output measures). We identified two process measures—whether issues were being discussed in a collaborative manner and whether the affected organizations are involved in the process. To identify some potential output measures, we solicited opinions regarding interim measures of coordination progress from 22 current and former senior-level officials. These officials currently are or have been involved in development, acquisition, or operation of air and missile defenses. The primary indicators follow:

- **Maturation of the master plan.** Many officials, including co-chairs of the integration and overarching integrated product teams, believed that obtaining a coordinated master plan and maturation of the master plan over time would be a progress indicator. For example, successive iterations of the master plan should better define the family of systems needed, the joint demonstrations needed to validate the capabilities, the priority of acquiring these systems, and the estimated cost.
- **Acceptance of the master plan by the services.** The Director, BMDO, the Director for Theater Air and Missile Defense, BMDO, and one service representative told us that cruise missile defense coordination progress will occur as the services increasingly "buy into" the master plan, approaching cruise missile defense with complete agreement regarding establishing priorities and making trade-off decisions.
- **Development and approval of a Theater Missile Defense Capstone Requirements Document.** This document identifies overall requirements for a family of theater missile defense systems and is to guide the services in developing (1) system operational requirements documents and (2) systems that will work together. Several officials stated that development and approval of this document indicates progress is being made in coordinating cruise missile defense efforts.
- **Joint demonstrations of systems.** Several officials said that, since fielding the joint cruise missile defense is several years away, an interim measure of progress would be to plan and successfully conduct joint, cross-service demonstrations of systems that work together.

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- Agreement between the master plan and the services' budgets. Several DOD and service officials said that, if progress is occurring, the master plan and the services' budgets for cruise missile defense activities should agree. The Director, JTAMDO, told us that the December 1998 version of the master plan should provide sufficient information for the services to make decisions regarding their proposed budgets.
 - Development of investment priorities. The Director of Strategic and Tactical Systems told us that an agreement on investment priorities and the ability to cancel some programs and accelerate others would indicate progress. According to this official, priorities cannot be established in a few years, but if cruise missile defense priorities are not established, the process will not be effective.

The need for output measures is consistent with the provisions of the Government Performance and Results Act of 1993 (P. L. 103-62). The Results Act requires federal agencies and activities to clearly define their missions, set goals, link activities and resources to goals, prepare annual performance plans, measure performance, and report on their accomplishments. The Senate and House reports on the Results Act legislation anticipated that the act's principles would be institutionalized and practiced at all organizational levels.

Initial Progress Has Been Made

DOD is making progress toward coordinating cruise missile defense efforts both in terms of implementing the process and outcomes resulting from the process. In terms of process, the three-tiered integrated team approach is improving coordination by more intensive examination of air and missile defense issues, collaboration on these issues, and attempts to reach consensus. And, although still limited, JTAMDO has obtained more involvement by theater combatant command representatives responsible for wartime operations. In terms of outcomes, joint planning documents to enhance coordination have been prepared or assisted by the coordination process. Although the services' budgets do not yet fully support the master plan, budgets and programs have been affected to a limited extent, and other budget issues have been identified.

Issues Are Being Identified and Discussed

Most working level team members we spoke with believe that coordination has been enhanced. They cited the following examples: (1) issues are addressed jointly, (2) the varying team members obtain information regarding the other organizations' positions and rationale on the issues, (3) each team member is responsible for coordinating with his/her

respective organization, and (4) they attempt to resolve the issues at the lowest possible level. They said this process requires collaboration and builds consensus.

Each working level integrated product team is responsible for drafting a specific section of the Theater Air and Missile Defense Master Plan. As a part of this process, the working level teams and subgroups identify issues related to their part of the master plan, examine the issues, and attempt to resolve them to all members' satisfaction. For example, during a meeting, the requirements team discussed a set of effectiveness values, but one service representative expressed concern about the values. As a result, JTAMDO and BMDO provided funds for the service to perform a further analysis; the service presented its results during the next team meeting. New values were subsequently adopted. The team member, who raised the issue, informed us that had the issue not been resolved, the dissenting view would have been raised to the next tier—the integration integrated product team.

In addition, the master plan and other products developed are examined and approved by the integration integrated product team and the overarching integrated product team. This process provides oversight on product development and guidance regarding the products and permits consensus building at levels higher than the working-level teams. The higher tier teams are composed of higher level representatives from each of the services and the other organizations associated with theater air and missile defense.

Affected Organizations Are Involved

The three-tiered integrated product teams include representatives from the organizations responsible for determining requirements and developing, acquiring, and operating theater air and missile defense systems. Also, the theater combatant commanders—responsible for operational control of military forces in a specific theater or region of the world¹⁰—are becoming more involved in the theater air and missile defense coordination process. According to the commanders' representatives, their involvement in the coordination process has been limited because of the high cost of travel and the lack of staff to fully participate. However, JTAMDO and BMDO have obtained combatant command comments on the iterations of the

¹⁰A combatant command is comprised of forces from two or more services.

master plan, and the combatant commands provided input to the Capstone Requirements Document.

In addition, JTAMDO and BMDO have begun a program to obtain more involvement in the coordination process by the combatant commands' representatives. Under this program, JTAMDO and BMDO visited each theater command to increase awareness of the coordination process and invited all representatives to a week-long meeting to (1) inform the representatives about the air and missile defense initiatives and future direction and (2) provide opportunities for the representatives to express their opinions concerning direction and focus. JTAMDO also has initiated a newsletter to keep theater commands better informed about the key issues addressed at working-level team meetings, and it has placed a representative in each theater. The representative is to assist the theater command with and provide expertise on emerging issues and facilitate the exchange of information among JTAMDO, BMDO, and the combatant commands.

Joint Planning Documents Have Been Started

The integrated product teams have produced or assisted in producing several joint planning documents to enhance coordination. These documents include the Theater Air and Missile Defense Master Plan, the Joint Theater Air and Missile Demonstration Plan, and the Theater Missile Defense Capstone Requirements Document.

Through December 1998, the master plan had been published in four iterations, each revising and expanding on prior versions. The initial master plan was published in May 1997. The April 1998 version provides better-defined and updated information about requirements and systems as well as an acquisition roadmap not included in previous versions. The December 1998 version makes additional improvements, including revised and more refined analyses of the system architecture and additional information about the single integrated air picture. As of January 1999, the Joint Theater Air and Missile Defense Executive Committee had not approved this plan. The master plan is to be updated annually in the future. Future iterations, for example, are to include a refined cruise missile defense architecture to support the current strategy that accommodates emerging threats in the near term.

Another document is the Joint Theater Air and Missile Defense Demonstration Plan, which is incorporated into the master plan, and identifies the joint demonstrations necessary to validate the family of

systems capabilities, using cross-service capabilities. Several joint demonstrations are scheduled annually between 1998 and 2004, including eight specifically related to cruise missile defense. These demonstrations are to be conducted at already planned exercises and test events by adding features to demonstrate joint cruise missile defense capabilities.

The requirements working level team assisted the Atlantic Command in producing the Theater Missile Defense Capstone Requirements Document. The document not only identifies the overall requirements for a family of theater missile defense systems (including cruise missile defense) to protect forces and critical assets in a theater or region from missile attacks but also establishes joint warfighting standards for defense capabilities to be provided to the theater commanders. It is intended to (1) guide the services in developing operational requirements for future systems and (2) facilitate development of interoperable systems. The requirements apply to any service or other acquisition authority. It was approved by the Joint Requirements Oversight Council in July 1998. Now the services must modify their formal requirements for new defense systems and improvements to existing defense systems to achieve the requirements in the capstone document. In some cases, incorporation of the capstone requirements will necessitate modifications to existing systems such as changes needed to achieve required levels of interoperability. In addition, the Atlantic Command has drafted a Mission Need Statement for Theater Air and Missile Defense, and the draft is currently being coordinated.¹¹

Budgets and Programs Have Been Affected to a Limited Extent

According to JTAMDO and BMDO officials, the services' budgets do not yet fully support the master plan. For example, the budgets do not include the amounts these officials believe are required for the single integrated air picture—a mechanism to enhance the services' ability to fight jointly. However, the coordination process has affected budgets and programs to a limited extent. For example, in the fiscal year 1998 budget process, JTAMDO identified disconnects between the master plan and one service's proposed budget for funding key technology upgrades. JTAMDO officials briefed DOD leadership on the disconnects and proposed funding

¹¹A mission need statement is a statement of operational capability required to perform an assigned mission.

alternatives to correct the problem. As a result, DOD issued a program budget decision that realigned the funding for the upgrades.¹²

In addition, JTAMDO officials conducted a cruise missile defense study that identified disconnects between the services' fiscal year 1999 budgets and the demonstration plan; many of the disconnects were resolved. We were informed that one service was asked to provide funding to eliminate the remaining disconnect, but the matter has not yet been fully resolved.

Challenges Remain

While there has been progress toward coordinating cruise missile defense efforts, the senior level officials with whom we spoke and documents we reviewed recognize that challenges remain—both managerial and technical—which must be overcome before achieving a cost-effective, coordinated cruise missile defense. Managerial challenges must be met to ensure continued coordination progress. Technical improvements are required because (1) more countries are expected to obtain cruise missiles and (2) the newer cruise missiles are expected to be more difficult to detect and track than current cruise missiles.

Managerial Challenges

One of the challenges for continued coordination progress identified by the senior level officials is getting services to work together. Many of the officials told us that one of the more formidable challenges is obtaining a genuine commitment from the services to develop a joint, interoperable cruise missile defense. One official said getting the services to work together on the joint mission, rather than being advocates for a specific system or plan, is the challenge; however, he acknowledged that, as the process has matured, the services are working together better than at the beginning. Another official believed that the greatest challenge is overcoming the interservice rivalry for funds in a tight budget environment. Another official said that the challenge is obtaining agreement on joint tactics, procedures, and rules of engagement that may require changing some service procedures. We reported on the conflicts of service-oriented priorities in the context of the Atlantic Command's mission in our February 1999 report.

¹²Further details are not included because of the classified nature of these upgrades.

Another challenge is correctly defining the threat. According to the co-chair of the overarching integrated product team, identifying and characterizing the threat and timing the acquisition of defense capabilities to that threat is a major challenge. The Director, BMDO, and the co-chairs of the integration integrated product team also identified determining the correct threat as a major challenge. The land attack cruise missile threat has been limited, but it could emerge rapidly through development of new systems, conversion of antiship cruise missiles, or purchase of advanced systems from other countries. Although the threat is expected to increase, changes could be difficult to detect. The threat information could be vital to timing the development of cruise missile defense capabilities.

A third challenge is adequately funding the most vital programs. According to the 1997 Defense Science Board report, funding for all of the promising concepts being pursued by the services is insufficient. The report further stated that if priorities are not set and choices are not made, none of the concepts are likely to move forward rapidly enough to be in place when needed. However, the Director, Strategic and Tactical Systems, told us that canceling programs would be a difficult task. Neither JTAMDO nor BMDO can ensure that funding is requested for the items considered most vital to cruise missile defense because most funding requests are included in the services' proposed budgets, not in JTAMDO's or BMDO's budget request. Therefore, the funding for the priority items must be obtained by influencing the services to include the funding requests in their proposed budgets. According to the Director, JTAMDO, the goal is to provide sufficient rationale and support to convince the services to adequately fund recommendations in the master plan.

Technical Challenges

A number of technical challenges must be overcome before the effective defense envisioned for 2010 is possible. Some were identified as key elements of a land attack cruise missile defense by the Under Secretary of Defense (Acquisition and Technology) in 1996 (see p. 5).

Senior level officials identified acquiring the capability to develop and share a single integrated air picture as a technical challenge. Future employment concepts will view individual weapon systems (whether air, sea, or land based) as just contributing elements to an overall defense capability. The real time execution of an integrated defense plan will require a level of coordination and communication far beyond that currently available. At its core is an air picture that will allow each member of the force to make decisions based on the same information. This is the

single integrated air picture. The single integrated air picture will merge data from multiple sensors and provide all system operators and decisionmakers with one common set of information about each airborne target in the battle area.

Another identified challenge is to improve sensor technologies to meet future threats. To counter the future threat, sensor technology will need to be improved to detect stealthy cruise missiles at longer ranges, distinguish them from friendly aircraft, and intercept them over enemy territory. Defense Science Board reports and current and former theater air and missile defense officials stated that this capability would require significant upgrades to surveillance sensors, tracking sensors, and interceptor missile sensors as well as the acquisition of additional improved elevated (airborne) sensors. The upgrades and new systems are to ensure the early detection and engagement that is needed to (1) provide the maximum number of potential engagements and (2) destroy cruise missiles carrying weapons of mass destruction while they are still over enemy territory.

A third challenge is to achieve over the horizon intercepts. To intercept cruise missiles at longer ranges, the sensors will need to be connected to enable an over the horizon intercept. Elevated sensors (such as the Airborne Warning and Control System, the E-2C, and the Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System) would detect the target; the sensors would notify a sea-based or ground-based system (such as the Patriot) where to fire the interceptor; the system would fire the interceptor; and the interceptor would be guided to a target not visible to its ground-based radar. This concept is referred to as air-directed, surface-to-air missile operations.

A fourth challenge is to develop interoperable weapon systems. Most existing air and missile defense systems were developed with the premise that each service would direct the use of its own weapons; however, the systems must now operate jointly with other services' systems under the direction of the Commanders in Chief of the combatant commands and with allied forces. Some theater combatant command representatives said that the Commanders in Chief have systems that do not interoperate with U.S. forces or with allies and that they have been forced to develop tactics, techniques, and procedures to compensate for the lack of interoperability. In a July 1998 meeting to discuss joint theater air and missile defense issues, most of the theater combatant command representatives stated that interoperability of current and future air and missile defense systems is their highest priority.

The final challenge identified by the senior level officials was developing a defense against massive attacks. A Defense Advanced Research Projects Agency official told us that one challenge is to develop low-cost cruise missile defense systems capable of engaging massive attacks by unsophisticated cruise missiles. The Director of that agency said that the proliferation of inexpensive cruise missiles with improved accuracy and range gives adversaries the option of trying to overwhelm U. S. defenses with large numbers. However, he believes that one manner of addressing the threat is to build low-cost interceptors that would not have the capabilities against high-performance cruise missiles but could contribute where an enemy attack includes large numbers of inexpensive missiles. The agency is studying this issue, and it will continue its efforts until 2001.

Conclusions

DOD has established the mechanisms for coordinating cruise missile defense efforts by creating a new arrangement for managing theater air and missile defense. Senior level officials generally agreed that the ultimate measure of coordination effectiveness would be to field a cost-effective, interoperable cruise missile defense, and they suggested some interim measures of progress toward that goal. While DOD is making progress toward coordinating its cruise missile defense efforts, it has not yet specified time-phased interim measures of coordination progress. In addition, there are still challenges—both technical and managerial—to be overcome before a coordinated, cost-effective cruise missile defense can be achieved.

We believe that the development of time-phased interim measures of coordination progress is warranted. Such measures would be consistent with the Government Performance and Results Act of 1993, which call for performance planning to include measures to help assess whether goals and missions are being accomplished. We also believe that the interim measures of outputs and results identified in this report are a sound building block for the establishment of such measures of coordination progress.

Recommendations

Because the final results of the coordination process will not be known for several years, we recommend that the Secretary of Defense develop a time-phased set of interim measures that can be used to assess progress toward a cost-effective, interoperable family of cruise missile defense systems. These measures should include, as a minimum, metrics that will

show progress toward developing the operational and system architectures required, resolution of the technical and managerial challenges, demonstration of needed technology, and investment priorities.

To enable congressional committees responsible for funding and oversight of theater and missile defense activities to have information with which to assess DOD's progress and make appropriate policy and funding decisions, we recommend that the Secretary (1) incorporate these time-phased measures into the Theater Air and Missile Defense Master Plan and (2) provide the most recently approved master plan to the Congress in a timely manner for annual budget deliberations.

Agency Comments and Our Evaluation

In its comments responding to a draft of this report, DOD partially agreed with our recommendation to develop a set of interim measures to assess progress toward achieving cost-effective and interoperable theater air and missile defense systems. DOD stated, however, that the measures should be broad in nature because air and missile defense are complex mission areas supported by multimission systems. DOD said that allocating a system cost for each mission supported by multimission systems, such as Patriot, F-22, and Aegis, would be difficult and counterproductive. We agree and have modified our recommendation to delete cost as a measure. We also agree that the measures may have to be somewhat broad; however, we believe that they should be sufficiently specific to permit an objective assessment of progress.

DOD did not agree with our recommendation to use the measures in conjunction with the annual budget requests to provide the Congress with reports of progress being made. DOD said that its progress toward achieving a cost-effective and interoperable family of systems for air and missile defense will be documented each year in the Theater Air and Missile Defense Master Plan. DOD also said that the master plan includes the measures we recommended. Our understanding is that the master plan has not, until now, been provided to the Congress, nor has it included time-phased measures of progress. DOD's future use of the master plan as a vehicle to communicate progress to the Congress could meet the intent of our recommendation. However, DOD would need to ensure that (1) time-phased measures of progress are incorporated in the master plan and (2) the master plan is submitted in a timely manner for consideration during budget deliberations. We have modified our recommendation to reflect such clarification.

DOD also provided additional technical comments, which have been incorporated as appropriate. DOD's comments are included in appendix II.

Scope and Methodology

To identify the coordination mechanisms, assess the progress of coordination efforts, and identify challenges, we reviewed theater air and missile defense plans, held discussions with appropriate officials, and attended team meetings. To identify results oriented progress measures and to obtain additional information regarding the progress to date and the challenges, we identified and interviewed 22 current and former senior-level DOD, service, and theater combatant command officials who are or have been involved in the development, acquisition, or operation of air and missile defenses. See appendix I for additional information about our scope and methodology.

As agreed with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from its issue date. At that time, we will send copies of this report to other interested congressional committees; the Honorable William Cohen, Secretary of Defense; the Honorable Louis Caldera, Secretary of the Army; the Honorable Richard Danzig, Secretary of the Navy; the Honorable F. Whitten Peters, Acting Secretary of the Air Force; Rear Admiral Herbert Kaler, Director, JTAMDO; Lt. Gen. Lester Lyles, Director, BMDO, and the Honorable Jacob Lew, Director, Office of Management and Budget. Copies will also be made available to others on request.

Please contact me at (202) 512-4841 if you or your staff have any questions concerning this report. Major contributors to this report were Lee Edwards, Wayne Gilliam, Mark Lambert, and Reginia Grider.

Sincerely yours,



Allen Li
Associate Director
Defense Acquisitions Issues

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Abbreviations

DOD	Department of Defense
BMC4I	Battle Management Command, Control, Communications, Computers and Intelligence
BMDO	Ballistic Missile Defense Organization
JTAMDO	Joint Theater Air and Missile Defense Organization

Scope and Methodology

We obtained information regarding the process and mechanisms for coordinating cruise missile defense efforts by (1) reviewing the directives establishing the theater air and missile defense management process and the charters for the Joint Theater Air and Missile Defense Organization (JTAMDO) and the Ballistic Missile Defense Organization (BMDO); (2) reviewing various iterations of the Theater Air and Missile Defense Master Plan; and (3) discussing the process and mechanisms with officials from the Office of the Secretary of Defense, the Joint Staff, JTAMDO, BMDO, each of the services, the Defense Intelligence Agency, the Defense Advanced Research Projects Agency, and the Atlantic, Central, European, and Pacific Commands.

We obtained information regarding the organizational progress by (1) reviewing various iterations of the master plan and other joint planning documents; (2) discussing the process progress with officials from the Office of the Secretary of Defense, the Joint Staff, JTAMDO, BMDO, and integrated product team members from each of the services, the Defense Intelligence Agency, and the Defense Advanced Research Projects Agency; and (3) observing selected integrated product team meetings. To identify interim output measures of coordination progress, we interviewed 22 current and former senior level officials who are or have been involved with the development, acquisition, or operation of air and missile defense programs. These officials are listed below.

- Director, Strategic and Tactical Systems, Office of the Under Secretary of Defense for Acquisition and Technology (Co-chair of the Overarching Integrated Product Team).
- Director for Force Structure, Resources and Assessments, Office of the Joint Chiefs of Staff (Co-chair of Overarching Integrated Product Team).
- Director, JTAMDO (former co-chair of the Integration Integrated Product Team).
- Director, BMDO (member of the Executive Committee).
- Deputy Director, BMDO (member of the Overarching Integrated Product Team).
- Deputy for Theater Air and Missile Defense, BMDO (Co-chair of the Integration Integrated Product Team).
- Director, Joint Advanced Warfighting Programs, Institute for Defense Analysis (Co-chair of the 1994 Defense Science Board Task Force on Cruise Missile Defense and Chair of the 1996 Task Force).
- Former Assistant Deputy Chief of Staff for Operations and Plans, Department of the Army (former member of the Integration Integrated Product Team).

- Program Manager, Advanced Technology and Overland Cruise Missile Defense, Program Executive Office for Theater Surface Combatants, Office of the Under Secretary of the Navy for Research, Development, and Acquisition (member of the Integration Integrated Product Team).
- Deputy Chief, Theater Air Defense Division, Director of Global Power Programs, Office of the Assistant Secretary of the Air Force (Acquisition).
- Program Manager for Ground-based Air Defense Systems, U.S. Marine Corps Systems Command.
- Chief, Theater Missile Defense Branch, U.S. Central Command.
- Deputy Director, Plans and Policy Directorate, U.S. European Command.
- Director for Operations, U.S. Pacific Command.
- Chief, Theater Air and Missile Defense Operations Division, U.S. Atlantic Command.
- Director, Directorate of Combat Developments, U.S. Army Air Defense Artillery School.
- Director, Sensor Technology Office, Defense Advanced Research Projects Office (member of the Overarching Integrated Product Team).
- Director, Strategic Defense and Space Programs, Program Analysis and Evaluation, Office of the Secretary of Defense (member of the Integration Integrated Product Team).
- Former Commander (August 1992–August 1994), U.S. Army Space and Strategic Defense Command.
- Former Commander (August 1994–August 1996), U.S. Army Space and Strategic Defense Command.
- Former Director, Defense Advanced Research Projects Agency (former member of the Executive Committee).
- Former Director, Sensor Technology Office, Defense Advanced Research Projects Agency (former member of the Overarching Integrated Product Team and member of the 1996 Defense Science Board Task Force on Cruise Missile Defense).

We obtained information regarding the progress of coordination efforts through (1) reviewing various versions of the master plan, the Theater Missile Defense Capstone Requirements Documents and other documents such as minutes of integrated product team meetings; (2) attending an integration integrated product team meeting and a working level team meeting; and (3) discussing progress with the co-chairs and selected members of each of the working level teams as well as the 22 officials listed above.

Appendix I
Scope and Methodology

We obtained information concerning the technical and managerial challenges by reviewing the master plan and other documents such as minutes of the integrated product team meetings and discussions with JTAMDO and BMDO officials and the 22 officials listed above.

We conducted our work from October 1997 through January 1999 in accordance with generally accepted government auditing standards.

Comments From the Department of Defense



ACQUISITION AND
TECHNOLOGY

OFFICE OF THE UNDER SECRETARY OF DEFENSE

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WASHINGTON, DC 20301-3000

12 MAR 1999

Mr. Allen Li
Associate Director, Defense Acquisition Issues
National Security and International Affairs Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Li:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "CRUISE MISSILE DEFENSE: Progress Made But Significant Challenges Remain," dated February 12, 1999 (GAO Code 707297/OSD Case 1752).

The Department partially concurs with the draft report Recommendation 1. The Department concurs with developing a set of interim measures to assess progress toward achieving cost-effective and interoperable theater air and missile defense systems. However, the measures should be broad in nature, because air and missile defense is a complex mission area and is supported by multi-mission systems. For example, allocating system cost for each mission supported by multi-mission systems, such as PATRIOT, Airborne Warning and Control System (AWACS), F-22, F-15, F/A-18, and AEGIS, would be difficult and counterproductive.

The Department does not concur with the draft report Recommendation 2. The Department's progress toward achieving a cost-effective and interoperable family of systems for air and missile defense will be documented each year in the Theater Air and Missile Defense Master Plan. The Theater Air and Missile Defense Master Plan sets the direction for future efforts toward improving air and missile defense capability and includes the measures cited in Recommendation 1.

Technical comments for accuracy and clarification were provided separately. The Department appreciates the opportunity to comment on the draft report.

Sincerely,

George R. Schneider
Director
Strategic and Tactical Systems

