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Ballistic Missile Defense Study Findings on NAVY THEATER WIDE TBMD (1994 - 1998)

EXECUTIVE SUMMARY

Since just after Desert Storm in 1991, the Navy has been actively engaged with the Ballistic Missile Defense Organization (BMDO) in the development of two Theater Ballistic Missile Defense (TBMD) efforts: Navy AREA TBMD and Navy Theater Wide (NTW). Navy AREA TBMD is in full scale development. Navy Theater Wide (NTW) TBMD, currently in system flight demonstrations, is an evolved capability from the AREA system and BMDO developed technologies that offers to provide defense against TBMs and Weapons of Mass Destruction (WMD) over cities and vast geographic regions. Analysis indicates that when NTW is fully developed, the combination of ship mobility and the NTW capability will provide for a two ship defense for all of Japan and the Republic of Korea against the North Korean No-Dong ballistic missile.

Between 1994 and 1998, nine key Department of Defense and Navy studies assessed various aspects of NTW. The military operational necessity for this system, system effectiveness, cost effectiveness, development and technology risks were repeatedly evaluated. Every study endorsed progress to date and strongly supported development of NTW. Several urged an acceleration of NTW development.

Alternative system NTW designs were suggested several times. These alternative designs were analyzed in efforts to find the most capable system, with the best balance between technical risk and development cost. Every study supported the Navy approach and system design.

A close examination of the nine most detailed analytic efforts which evaluated NTW yields the following striking findings:

- Navy Theater Wide (NTW) Ballistic Missile Defense provides the unique capability to detect, track, engage and destroy mid to long range Theater Ballistic Missiles (TBMs) in their ascent, midcourse and descent phases of flight.

- By attacking and destroying TBMs from ships operating anywhere along the TBM flight path, vast geographic regions will be defended against TBM attack.

- NTW will be effective in defeating Weapons of Mass Destruction (WMD) by destroying them in the exoatmosphere at long range from the intended WMD target. NTW will provide a highly significant advantage to operational Commanders-in-Chief who currently lack any TBM-WMD defense, except for limited numbers of terminal defense missiles. Faced with an enemy capable of delivering WMD with TBMs, such as Iraq, Iran or North Korea, NTW will provide significant defense.

- NTW, combined with Navy AREA TBMD, provides "defense in depth" which increases overall system effectiveness by improving the probability of TBM negation.

- Ship mobility provides opportunities to detect, track, engage and kill TBMs from large naval operating areas.

- In many warfare scenarios, the operational flexibility and mobility of AEGIS ships armed with the NTW capability provides a unique war winning capability. In scenarios requiring the build-up of U. S. defense systems and forces, AEGIS ships with TBMD will defend the ports and airfields critical to support U. S. force build-up. In situations requiring forcible entry by amphibious forces or any other means, Navy TBMD provides the only defense in depth required to defeat TBMs prior to the arrival of land-based TBMD systems by airlift and sealift.

- Because NTW is an evolutionary development based upon existing proven systems, including the AEGIS Weapon System, Vertical Launching System (VLS) and the STANDARD Missile, NTW system development is on a lower risk, more cost effective path than comparable TBMD systems.

- The NTW evolutionary deployment approach will provide NTW capability to the CINCs sooner than other candidate defense systems and in time to respond to the urgency of need repeatedly expressed by the intelligence community.

- In scenarios requiring TBMD in locations where U. S. land-based TBMD systems are not in place, Navy TBMD provides a mobile,

flexible defense capability. When host nation support precludes the introduction of land forces, Navy TBMD can be available irrespective of host nation permission or support. For the defense of islands or remote locations such as Guam, Okinawa or Taiwan, Navy TBMD provides a readily available defense capability.

- The first step in NTW development, a flight test series called AEGIS-LEAP Intercept (ALI), is a low cost, risk mitigating demonstration repeatedly evaluated and endorsed by analysis teams.

- Navy Battle Management / Command, Control, Communications, Computer and Intelligence (BMC4I) systems in existence or in development will greatly enhance the CINCs ability to fight and win a conflict including TBM attacks. Sensor netting systems, such as the Cooperative Engagement Capability (CEC), greatly increase battle space and overall allied and joint system effectiveness. The addition of the Area Air Defense Commander (AADC) capability to AEGIS ships greatly enhances the CINCs ability to manage and control air defense, including TBMD.

The nine most detailed analytic studies relevant to Navy Theater Wide (NTW) TBMD development are summarized in this document. These studies represent thousands of man-years of analytic effort spread over the last four years. Each study supported continued development of NTW. Several studies recommended program acceleration in view of the existing and emerging TBM threat to U. S. forces overseas and our allies. Every study that recommended accelerated NTW deployment evaluated NTW in detail and found no technical challenges preventing more rapid deployment. In the aggregate, these nine studies emphasize that the difficult task of defeating TBMs and their associated WMD is understood by the Navy and has not been minimized. The Navy has developed an evolutionary plan for TBMD deployment that is a cost effective, low risk, prudent approach to TBMD that is on a path to deliver substantial capability in 2006, with current funding.

NTW development, testing and acquisition needs to commence in earnest now in order to assure our ability to respond to the critical need for this Theater Wide defense capability.

Memorandum on Theater Ballistic Missile Defense Signed by the Secretary of the Navy and Chief of Naval Operations on April 1, 1998

" The Navy recognizes the pressing operational requirement to deploy TBM defenses at sea. "

" The Navy is committed to executing the AEGIS Area TBMD Program. "

" And we are committed to the earliest deployment achievable for the AEGIS Theater Wide TBMD Program. "

J. M. JOHNSON
Admiral, U.S. Navy
Chief of Naval Operations

JOHN H. DALTON
Secretary of the Navy

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INTRODUCTION TO NAVY THEATER WIDE BALLISTIC MISSILE DEFENSE

Since the end of the Cold War, the United States has shifted emphasis away from preparations for a global conflict towards readiness for regional conflicts. The rapid proliferation of TBMs among potential regional adversaries requires dramatically increased U.S. capability for Theater Ballistic Missile Defense. National objectives for TBMD include protection of forward deployed and expeditionary elements of our own Armed Forces, and the ability to defend friendly forces and allies, including population centers. The goal is not only actual defense against TBMs, but also the strengthening of U.S. security relationships and reassurance for our allies.

TBM defense supports broader political goals because it can help to discourage the proliferation of ballistic missile technology and weapons of mass destruction (WMD). Effective TBMD can reduce incentives to develop, acquire, or use these weapons. The ability to extend reliable protection to allies and friends can have a significant mitigating effect on their desire to produce or acquire their own offensive systems as a deterrent against other nations in a region. At the same time it can encourage the willingness of potential allies to act in concert with the United States during a conflict.

The 1996 launch of M-9 missiles by China into the sea off Taiwan underscored the ease of use, degree of surprise, and political impact inherent in the use of TBMs for power projection. Neither Taiwan nor the United States had an effective counter to this coercive use of ballistic missiles. The AEGIS cruiser, USS BUNKER HILL (CG 52), was able to rapidly reposition to track these Chinese TBMs emphasizing the importance naval forces play in influencing situations and supporting our allies in times of peace and war.

While overall United States' strategic objectives include deterring conflict in the first place, or rapidly stopping a war once it begins, specific naval TBMD objectives include:

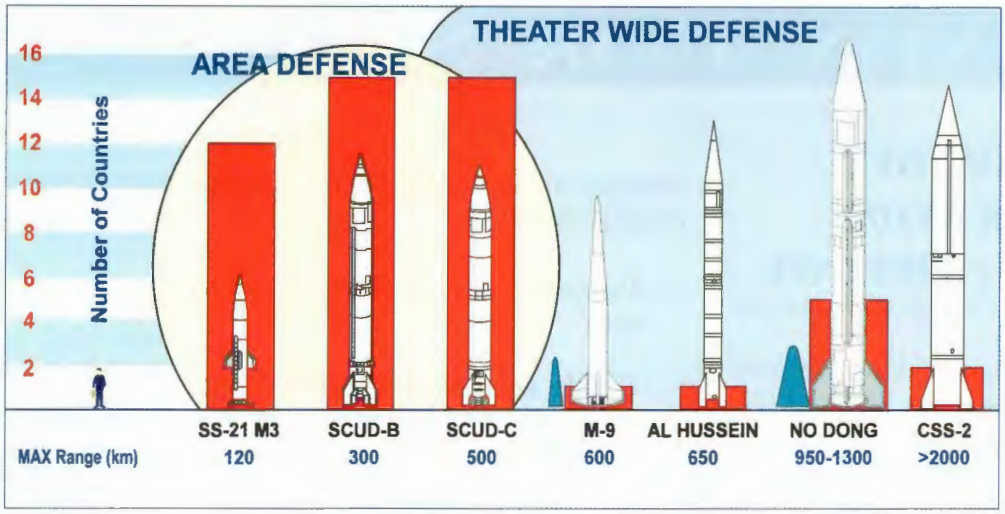
- Protection of U.S. forces deployed to a crisis area.
- Highly effective defense in depth to reassure threatened coalition allies.
- Reinforcement of deployed forces through protected debarkation ports, airfields and staging areas.
- The ability to provide TBMD during forcible entry by Marines or other expeditionary forces.
- Reduction in early demand for airlift and sealift to deploy land based TBMD forces.

THE THREAT IS REAL

More than 25 nations have, or are developing, nuclear, chemical and biological weapons as weapons of mass destruction. More than 30 nations have ballistic missiles in their arsenals with hundreds of launchers. In the immediate future we may face terrorist or rogue regimes armed with ballistic missiles tipped with WMD. These regimes may not buy into the deterrence theory that assured strategic stability during the Cold War era.

Ballistic missiles have become a battlefield weapon. The 1988 Iran-Iraq "War of the Cities," the 1990 civil war in Yemen, and Operation Desert Storm demonstrated the readiness of warring factions to use ballistic missiles to both target military forces and terrorize civilian populations.

Recent intelligence reports on Iran's Shahab-3 and Shahab-4 TBM development efforts now estimate that these longer range TBMs may become available to potential adversaries at an accelerated pace. In North Korea, the 1,000 km No-Dong TBM



Today's TBMD Threat

has been tested, and according to some intelligence estimates, it is now deployed in small numbers. The No-Dong can reach targets in virtually all of South Korea and Japan. Pakistan recently tested its 1,500 km Ghauri TBM, a missile capable of delivering weapons to India's capital city, New Delhi. India's Prithvi is capable of hitting targets throughout Pakistan.

Navy TBMD

Navy Area TBMD, a system capable of defending debarkation ports, airfields and critical assets near shore from short to medium range TBMs, is in the Engineering and Manufacturing Development (EMD) phase of the acquisition process. The system is based upon modifications to the existing AEGIS Weapon System and STANDARD Missile.

The STANDARD Missile to be employed for TBMD is based on thirty years of continued missile design evolution. The SM-2 Block IV missile, now entering fleet service, provides the basis for the TBMD variant being developed. Guidance and warhead enhancements to the SM-2 Block IV are being made to produce the SM-2 Block IVA, a common missile for use against sea-skimming cruise missiles, medium altitude aircraft and TBMs at the upper limits of the atmosphere. A prototype of this missile intercepted a TBM target in 1997.

The existing SPY radars aboard our AEGIS ships provide thorough surveillance, detection and tracking of TBMs. This integrated combat system has repeatedly proven it's capability during real-world tracking of TBMs such as China's M-9 missiles near Taiwan in 1996, and in numerous other real world test events and exercises. Computer program modifications to further improve the demonstrated AEGIS TBMD capability are currently being developed and tested.

Nearly fifty AEGIS ships are in the fleet today with proven SPY radars, vertical launching systems, integrated battle management and well trained and experienced officers and crews. More AEGIS destroyers are being built. AEGIS ships are armed with a mix of STANDARD Missiles, anti-submarine rocket thrown torpedoes and TOMAHAWK land attack cruise missiles in more than 6,000 launch cells. This AEGIS force of cruisers and destroyers represents a national investment of over $40 billion and provides a strong foundation for TBMD development.

The Navy has already developed much of the command and control needed to conduct TBMD and has extensive experience in coordinating widely disbursed forces in integrated air defense. Several battle management and communications enhancements are entering fleet service including

Chinese M-9 Missile

Joint Tactical Information Distribution System (JTIDS), the Cooperative Engagement Capability (CEC), and the developmental Area Air Defense Commander (AADC) capability. Navy ships equipped with TBMD and modern, robust and joint BMC4I systems, can arrive early in a conflict, establishing the joint air defense architecture, and integrating additional air defense assets such as PATRIOT and THAAD as they arrive in theater.

Navy Theater Wide TBMD Development

Navy Theater Wide TBMD is a program based upon an evolution of the AREA TBMD effort, to achieve vast geographic defense of entire regions. NTW continues the evolution of the AEGIS Weapon System by integrating the Ballistic Missile Defense Organization's (BMDO) developed Lightweight Exoatmospheric Projectile (LEAP) and a derivative of BMDO's Advanced Solid Axial Stage (ASAS) rocket motor into the SM-2 Block IV propulsion system.

Navy Theater Wide (NTW) offers a unique warfighting asset to Theater CINCs. By taking advantage of the mobility of AEGIS ships at sea, NTW will provide the ability to destroy medium to long range TBMs in their ascent, midcourse and terminal stages of flight. No other TBMD missile system in development provides this capability. Other TBMD missile systems being developed provide TBM kill opportunities in the terminal phase, or immediately prior to when the TBM impacts at its intended target. The requirement to protect critical land assets using terminal defense systems results in an assembly of defenses as close to the asset to be defended as possible. Because we can position ships closer to anticipated TBM launch points, the same radar capability and TBM interceptor performance that provides tens of thousands of square kilometers of terminal defense ashore, provides hundreds of thousands of square kilometers of defended area from forward positioned ships at sea. NTW, therefore, defends not just singular critical assets ashore, but also defends cities, widely disbursed civilian and military targets, and disbursed TBM targets throughout an entire region which an enemy may choose to attack for their expected terror impact.

Forward deploying long range TBM defense at sea provides a dramatic deterrent and war winning capability. The world's oceans permit this forward positioning at sea, enabling the Navy to achieve early ascent phase TBM intercepts in just the areas we anticipate needing TBMD the most, such as the Sea of Japan, the Arabian Gulf and the Mediterranean Sea. Forward deployed NTW will alleviate the need to provide terminal defenses around every potential point target we wish to protect.

The Current NTW Program

As a result of strong Congressional support, including the addition of over $600M above the President's Budget submit for Fiscal Years 1995, 1996, 1997 and 1998, the current Navy Theater Wide (NTW) TBMD (PE 0603868C) program is planned to provide an initial capability (Block I) in 2006 and could evolve to full capability (Block II) in 2010. The current Department of Defense funding profile for NTW TBMD is:

FY	98	99	00	01	02	03
$M	410	190	180	183	139	144

Funding supports the nine shot AEGIS LEAP Intercept (ALI) flight test program, together with Risk Reduction Activities (RRAs) necessary to support system engineering leading to a Block I in 2006. ALI and RRAs leading to Block I are fully funded in the Future Years Defense Program (FYDP), and the Block I systems engineering and flight testing against threat representative targets to prove system effectiveness are under consideration to be funded between FY03 and FY06.

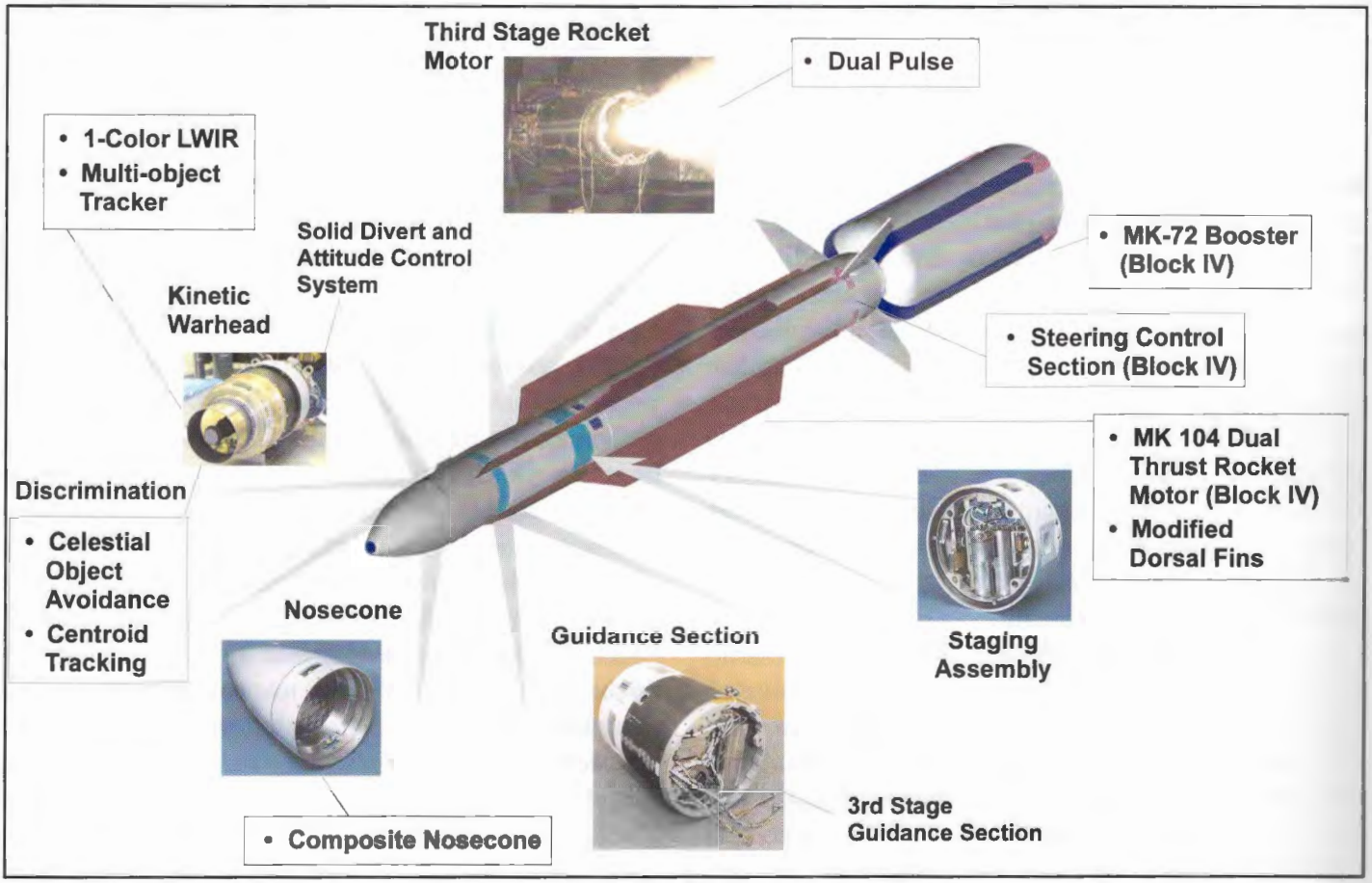
AEGIS-LEAP Intercept Program

The ALI program consists of a series of near-term flight tests to demonstrate the integration of the LEAP and the Third Stage Rocket Motor (TSRM) into a modified SM-2 Block IV STANDARD Missile to achieve a hit on a ballistic missile target using the AEGIS Weapon System. Nine increasingly difficult flight tests culminating in a target hit are programmed. The basis for the ALI weapon system is the Navy Area TBMD User Operational Evaluation System (UOES) computer programs, just beginning land based testing. The missile is based on the SM-2 Block IV propulsion (fleet deployed MK 72 booster and MK 104 rocket motor), the existing steering control section, and the integration of a new Third Stage Rocket Motor (TSRM) and Kinetic Warhead (KW). Technical risk in the ALI program has been minimized by using the proven AEGIS Weapon System, STANDARD Missile, the TSRM derived from the BMDO developed Advanced Solid Axial Stage (ASAS) rocket motor, and BMDO developed LEAP technology. Missile integration for ALI builds from the TERRIER-LEAP integration and flight testing conducted between 1992 and 1995. The ALI program will demonstrate the ability of the LEAP derived KW technology to guide to target intercept using fire control solutions generated by the AEGIS Weapon System and the KW guidance processor. The NTW Block I and Block II deployed capability will evolve from this program.

Risk Reduction Activities

Several moderate technical risk areas have been identified for the Navy Theater Wide Program. A program of activities has been identified to address these risk areas and to develop technical solutions for implementation in the NTW Block I system.

AEGIS LEAP Intercept (ALI) Missile Components



SPY-1 Radar

AEGIS SPY-1 radar signal processor (SIGPRO) upgrades are planned for TBMD to allow the radar to generate and process wideband waveforms. Synthetic wideband waveforms applicable to the SPY-1 radar are also being explored to implement target length measurement capability into the radar. Testing to date has progressed along parallel paths, one focusing on the generation of wideband waveforms, and one focusing on the parallel processor architectures required to process the wideband radar return. The High Range Resolution (HRR) Testbed is a set of synthetic wideband waveforms and a processor, which will be used to evaluate these new waveforms using the S-band TRADEX radar at the Kwajalein Missile Range and in the SPY-1 radar at the AEGIS Combat Systems Center (ACSC) at Wallops, Island, VA. The HRR data collected will be used to modify waveforms and equipment for installation in AEGIS ships for further testing and analysis.

Kinetic Warhead Seeker

This risk reduction activity is focused on developing and demonstrating sensor technology necessary for KW target acquisition, track, and discrimination. KW sensor areas of testing and analyses include a full evaluation of the planned ALI one-color seeker, development of a two-color seeker with a mechanical filter wheel to assess the benefits of multi-color seeker technology, and development and testing of an electronically switched two-color seeker. Kinetic Warhead (KW) sensor development proceeds from acceptance testing through laboratory testing, computer-in-the-loop (CIL) testing and ultimately to testbed testing and testing aboard Captive Carry aircraft prior to full weapon system integration.

Multi-Spectral Discrimination

The process of discriminating the threat payload from associated debris is one of the key tasks in successfully defeating TBMs. Leveraging off past and ongoing BMDO and joint efforts, the NTW discrimination risk reduction program includes simulation, testbed development and field testing to bring together solutions for radio frequency (RF) and infra-red (IR) discrimination and data fusion. Algorithm development to correlate information between the radar and the IR seeker on the KW is included in this risk reduction effort. It builds from ongoing efforts in the Theater High Altitude Area Defense (THAAD) program, Israeli ARROW development, Navy Area TBMD and technology supporting Enhanced Kill Vehicle (EKV) developments. Analysis and high fidelity simulations running in real-time have identified promising techniques for both IR and RF discrimination. Efforts are underway to conduct captive carry testing of the IR seeker to permit integration of simultaneously developed improvements to the SPY-1 radar signal processor. Airborne test beds will allow for real world demonstration of discrimination algorithms prior to the development of the Block I system.

Solid Divert and Attitude Control System

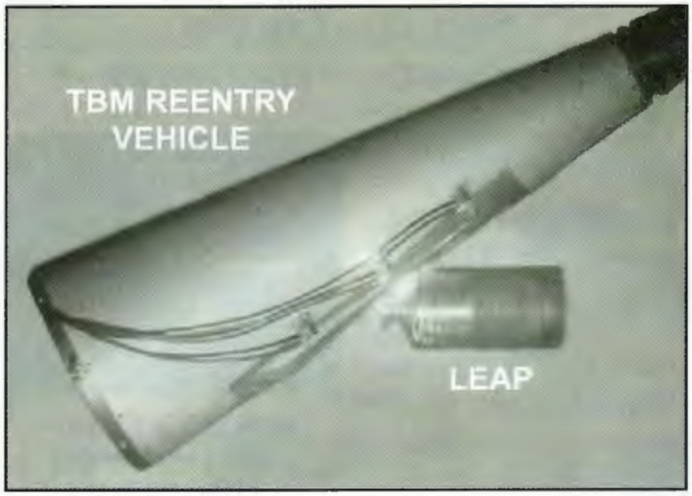
A risk reduction activity to develop a Solid Divert and Attitude Control System (SDACS) for the ALI and follow-on Block I NTW Kinetic Warhead (KW) is in progress. The solid propellant system in development improves packaging, provides additional performance and provides a safe system for shipboard deployment. The SDACS being built for use in the ALI flight test program is a variant of solid propellant systems first hover tested during the TERRIER-LEAP flight test series. The ALI developed SDACS has improved performance features including the ability to accelerate twice as fast as previously tested systems. Hover testing of the ALI KW, including the improved SDACS, is scheduled to commence late in 1998.

NTW Divert System Testing in Hovering LEAP Vehicle

Lethality Sub and Full Scale Tests

The lethality risk reduction activity consists of a comprehensive series of sub-scale, near-full scale and full scale tests and analyses to fully understand the capability of the KW to kill the TBM payload, including weapons of mass destruction (WMD). Tests include modeling and simulation as well as sub-scale light-gas gun and full scale sled tests that replicate KW impacts on threat representative TBM targets. Twelve light-gas gun tests of one-quarter scale LEAP KWs have been completed to assess the lethality effectiveness of the weapon at the U. S. Air Force Arnold Engineering Development Center (AEDC), Tullahoma, TN. An additional twelve sub-scale KW tests are scheduled for completion in 1998. Two full scale direct-hit sled tests are scheduled in 1998 at Holloman Air Force Base, Alamogordo, NM. The NTW program will use these tests, together with hydrocode studies, to assess the amount of inflicted damage against a series of representative threats, while defining refinements to the KW design. Final Block I KW lethality testing is planned to include six near-full scale light-gas gun tests in 1999 and two full scale direct hit sled tests in 2000.

NTW 1/4 Scale Lethality Test



Battle Management/Command, Control, Communications, Computers and Intelligence

Battle Management / Command, Control, Communications, Computers and Intelligence (BMC4I) has been identified as a critical focus area for NTW risk reduction efforts. To take full advantage of national sensors, cueing, and sensor-to-sensor netting while controlling the battle space, coordinating intercepts, alerting population centers and military assets, and assessing TBMD weapon effectiveness, comprehensive BMC4I system development is planned. The NTW-equipped AEGIS ship, because of its ability to protect large geographic regions in the theater, will be a major participant in the joint and coalition BMC4I architecture. A series of experiments and development efforts to enhance, coordinate and demonstrate BMC4I systems for TBMD is structured in the NTW risk reduction program. Efforts have focused on joint interoperability and the integration of national assets into Navy TBMD systems.

STUDY 1

Concept Evaluation and Integration Study (CEIS)

In March of 1994, the Navy Program Executive Officer for Theater Air Defense (PEO (TAD)) convened the Concept Evaluation and Integration Study (CEIS) for Navy Theater Ballistic Missile Defense (TBMD). The charter directed the establishment of a technical and operational team to "define the technical approach and address the developments required to support near, mid, and far term sea based TBMD capability" and to "define the associated ship, missile, and command and control technology and

- Defense Against Short / Medium Range TBMs
- Maximizes TBMD and Cruise Missile Defense Role
- Most Effective Port, Airfield, Critical Asset Defense

- Defense Against Medium / Long Range TBMs
- Enables Ascent Phase Engagement
- Paces Threat
- Hit to Kill
- Theater Wide Protection

engineering trades" required for Navy TBMD.

Although several operational and technical teams had evaluated Navy TBMD prior to the CEIS, the CEIS represented the first full assessment of all operational and technical issues for both Navy Area TBMD ("lower tier") and Navy Theater Wide (NTW) ("upper tier") in one study effort. Consequently the scope, the number of technical experts involved, the depth of technical analyses, and the significant technical findings of the CEIS provided the most comprehensive analyses of the challenges, the development path and the near-term warfighting advantages of Navy TBMD.

Technical and operational teams for the CEIS were drawn from a wide spectrum of experts. To fully understand and evaluate engineering opportunities, past TBMD development efforts and ongoing TBMD technology, the CEIS drew heavily upon the expertise of the Ballistic Missile Defense Organization (BMDO), the U. S. Army, and major industrial centers and teams well versed and experienced in TBMD. Raytheon, the Army developer for Patriot and the Ground Based Radar (GBR), as well as Lockheed (Sunnyvale), the Theater High Altitude Area Defense (THAAD) developer, and Martin Marietta Government Electronic Systems (Moorestown, NJ) participated in the study. Navy operational expertise was drawn from the Navy Staff (OPNAV) and experienced air defense professionals from the fleet. A team of active duty and retired General and Flag officers with a wealth of operational, missile and combat system development experience served as advisors to the study. Navy technical labs and university labs for the CEIS included Johns Hopkins University, Applied Physics Laboratory (JHU/APL); the Naval Surface Warfare Center, Dahlgren; and the Naval Air Warfare Centers (China Lake and Orlando). Kinetic Kill Vehicle (KKV) developers represented in the CEIS included Hughes (Raytheon) and Rockwell (Boeing). Other participants and contributors included the Massachusetts Institute of Technology, Lincoln Labs; the Defense Nuclear Agency, the Defense Intelligence Agency (DIA) and other government and university centers of expertise.

Discussion

The CEIS established the analytic methodology and constraints to support the study effort as follows:

a. Time "eras" were established as near (1999), mid (2004) and far (2009).

b. The current and projected threat for the identified time eras was established and evaluated using approved U. S. Government threat data and analyses.

c. Possible Navy solutions, and technologies, including their performance capabilities and cost effectiveness were established and allayed from a systems engineering and individual component stand point. Radar, combat system, missile, kill vehicle and command and control systems and components were assessed.

d. The potential for integration of Army TBMD solutions to the Navy operational context was evaluated. Technical experts from the Army and industry provided the technical baselines for the Army Extended Range Interceptor (ERINT)/Patriot Advanced Capability-3 (PAC-3) and the Theater High Altitude Area Defense (THAAD) solutions. Technologies, operational pay-off for the Navy mission, and cost and integration issues were assessed.

e. Various Battle Management and Command, Control, and Communication (BMC3) systems and their applications to Navy TBMD were evaluated. These systems included Cooperative Engagement Capability (CEC), Joint Tactical Information Distribution System (JTIDS), and the Joint Maritime Command Information System (JMCIS). Concepts including the integration of off-board space, air, land and sea sensors, and other solution sets were assessed in depth.

FINDINGS

After more than one year of intense analytic effort, wargaming, analyses and data sharing, the CEIS made a number of highly significant findings.

The Navy Area TBMD system being developed during the CEIS was assessed as highly effective with significant warfighting advantages. The requirement for the Navy Area TBMD system was validated along with the system technical approach. Evolving the Area missile from the existing SM-2 Block IV missile was assessed as a low risk development path with great warfighting effectiveness. This new missile, the SM-2 Block IVA, would be effective in defeating short to mid-range TBMs as well as high performance cruise missiles. Development risks were identified, including lethality, discrimination and kill assessment. A road map to mitigate these risks was developed for inclusion in the Area TBMD program. The CEIS also verified that the AEGIS weapon system, including the SPY-1A radar, with slight modifications, had the requisite performance capability to provide the needed detection, tracking and guidance for the TBMD mission. Results of previous AEGIS TBM tracking events, including Red Tigress, yielded valuable phenomenology data and a conclusion that AEGIS, with modifications, would fully support the AREA and NTW mission.

An evaluation of ERINT/PAC-3 suitability for the Navy area defense mission resulted in a conclusion that the missile would not meet the performance specifications of the Navy Operational Requirement Document (ORD).

A major recommendation of the CEIS was to develop Navy TBMD by using the Area TBMD system as the first "stepping stone" in a series of progressively more complex and effective TBMD development. The CEIS team envisioned the Area TBMD missile, SM-2 Block VIA, as the first in a series of TBMD capable missiles, followed in a few years by a pre-planned product improvement (P3I) Area missile, and by the first in a series of Theater Wide Navy TBMD missiles/weapons systems. The CEIS estimated that the SM-2 Block IVA could be available to the fleet by 1999.

For the Navy Theater Wide (NTW) development effort, the CEIS verified the ongoing TERRIER-LEAP flight test series as a prudent risk mitigation and data collection effort as a necessary first step toward integration of LEAP, the STANDARD Missile Block IV propulsion system, and the AEGIS Weapon System. Analyses of projected NTW capability led to a conclusion that the NTW defended area "footprint" had "an entirely different character" from any previously evaluated Army or Navy TBMD system. Because of NTW's ability to attack TBMs in ascent, midcourse and descent, NTW could defend along the entire flight path of the TBM. "Footprints" resulting from NTW intercepts of TBMs before they reached their terminal stage of flight yielded "large geographic areas of coverage behind the ship."

NTW development risks were identified in the areas of systems integration, new rocket motor development, solid divert and attitude control system (SDACS) development, discrimination, target selection, and lethality. As with the Area program, risk mitigation paths were developed for each of these areas for inclusion in the NTW program risk mitigation effort. In the area of discrimination, for example, the CEIS recommended SPY radar signal processor developments and an evaluation of wider bandwidth techniques for target length measurement. The CEIS estimated that, with sufficient funding, the first AEGIS-LEAP NTW system could be available to the fleet as early as 1999.

The CEIS evaluated the integration of THAAD for the NTW mission. Because other study groups, including the BMDO sponsored THAAD-AEGIS Compatibility Study, were evaluating THAAD for the Navy mission, the CEIS did not issue a conclusive finding on THAAD. However, initial CEIS analyses indicated that THAAD would have less flexibility and a smaller "footprint" than the AEGIS-LEAP design. Additionally, the CEIS pointed out significant integration issues for THAAD inclusion in the AEGIS Weapon System and Vertical Launching System (VLS).

The CEIS evaluated the Navy TBMD systems with regard to the technical limits and prohibitions of the Anti-Ballistic Missile (ABM) Treaty and found no obstacles to compliance. This review was not meant to replace formal compliance review by the Treaty Compliance Review Group, but to identify any potential technical factors that might bar treaty compliance. No such technical factors were identified.

Finally, in the BMC4I analysis, the CEIS recognized significant advantages from the integration of sensors and weapons using sensor netting techniques like that found in the Cooperative Engagement Capability (CEC). Cueing from space, land and other sea sensors would also significantly enhance NTW capability, provided the cues contained sufficient accuracy with a minimum of time delays.

STUDY 2

BLUE RIBBON PANEL

In August, 1995, the Director, Ballistic Missile Defense Organization (BMDO) and the Assistant Secretary of the Navy (Research, Development and Acquisition) established a "Blue Ribbon Panel" (BRP) of missile system and acquisition experts to review alternatives for Navy Theater Wide TBMD. Chaired by former Air Force Chief of Staff General Larry D. Welch, the Blue Ribbon Panel membership represented expertise in Army, Navy and Air Force missile systems, guidance and control systems, kinetic kill vehicles, weapons systems, test and evaluation, software and simulations, major defense program acquisition and military operations.

At the inception of the BRP, the Navy had just completed a series of TERRIER-LEAP flight demonstrations, which demonstrated the ability to integrate the BMDO developed Lightweight Exoatmospheric

TERRIER LEAP

Projectile (LEAP) into a Navy STANDARD Missile variant. Although TERRIER-LEAP did not achieve an intercept of a TBM target in the two experimental attempts, 42 of 43 test objectives were successfully met.

The BRP met to answer the question: "Do we need to do more LEAP testing (such as the TERRIER-LEAP effort) to complete an experimental intercept, or have we done enough to be confident we can proceed to a fully engineered AEGIS-LEAP system?" The panel was also charged to recommend a development path for an earlier User Operational Evaluation System (UOES) and a later tactical NTW capability. The group focused on the costs, schedules and risks associated with various alternatives to achieve an intercept and subsequently develop UOES and tactical capability.

The Navy had focused subsequent efforts on the SM-2 Block IV missile, since additional TERRIER LEAP testing would not contribute to the systems engineering that would eventually be required for tactical system integration into the AEGIS ships. The TERRIER Weapon System had been assessed as incapable of being modified for the tactical TBMD mission, and all ships with this weapon system faced imminent decommissioning. The Navy presented three technical options for the Blue Ribbon Panel's consideration:

Option 1: "Hybrid LEAP". This option proposed to proceed directly to mount a TERRIER LEAP front end to the STANDARD Missile 2 Block IV propulsion stack. In order to demonstrate a successful intercept without large schedule delays, this option minimized engineering integration between the missile and the LEAP and kept system engineering (the integration of the AEGIS Weapon System and the LEAP) at a minimum. The option met BMDO's goal of a demonstrated intercept as soon as possible but, if selected, would have required significant schedule delays and additional costs after the intercept demonstration to complete the systems engineering required for a User Operational Evaluation System (UOES) or a tactical system.

Option 2: "AEGIS LEAP". This option proposed a system engineered integration of LEAP, the SM-2 Block IV propulsion, and the AEGIS Weapon System. The system engineering for AEGIS LEAP would lessen risk and provide the potential for an early UOES system after the intercept demonstration. AEGIS LEAP provided the lowest cost option and the option with the earliest deployable system engineered capability.

Option 3: "Combination LEAP". A combination of Option 1 and 2, this option proposed a "Hybrid LEAP" flight demonstration path in parallel with the systems engineering required by "AEGIS LEAP." In the end, this option was the most expensive in terms of time and money and had greater development risk than either of the other two options.

Discussion

The Blue Ribbon Panel unanimously recommended a focused effort to demonstrate the intercept of a TBM target by a LEAP launched from an AEGIS ship as proposed in Option 2, "AEGIS LEAP." The panel found that the lack of complete success with TERRIER-LEAP was not due to technology shortcomings. The BRP assessed that the TERRIER-LEAP effort, while resolving several technical goals, lacked the system engineering required to achieve all mission objectives. The following factors contributed to selection of the "AEGIS LEAP" option:

Nosecone Ejection **LEAP Deployment**

a. All options eventually developed "AEGIS LEAP."

b. An intercept demonstration was required for any path chosen.

c. Risk to achieving an intercept was essentially the same in "AEGIS LEAP" as in "Hybrid LEAP."

d. Engineering and operational payoff for "AEGIS LEAP" greatly exceeded that for "Hybrid LEAP."

e. Although "Hybrid LEAP" would allow for the earliest intercept demonstration, the cost and schedule required to system engineer even a UOES capability to counter the threat provided a significant penalty to the system deployment schedule.

f. The "Combination LEAP" option was rejected as the option with the highest risk on the path to developing a UOES or tactical capability.

Summary of BRP Findings

The BRP recommended that the Navy and BMDO proceed directly to an AEGIS LEAP Intercept (ALI) test program. To support such a test effort, the Panel recommended commencement of systems engineering both to accomplish ALI in the rigorous, low risk manner of previous AEGIS testing and to develop engineering to support the intended system (including the AEGIS Weapon System, STANDARD Missile, Vertical Launcher, and LEAP). This approach had the added benefit of addressing and retiring technical risks in the intended tactical system over time, starting during ALI engineering.

To achieve program goals, the BPR recommended sequential program objectives and focus, starting with the LEAP intercept demonstration (ALI), proceeding to a UOES AEGIS-LEAP NTW capability, and finally the tactical NTW system.

BRP members reached consensus on several other significant areas. First, the members agreed that test success and risk reduction needed to drive schedule. Proceeding along a hard and fast schedule with too little regard for technical progress had little merit. Second, BRP members expressed a belief that technical progress to date warranted a shift in program focus from a technology demonstration toward "a program with disciplined engineering and integration using proven procedures."

The Navy and BMDO concurred with the findings and recommendations of the Blue Ribbon Panel and subsequently established the AEGIS LEAP Intercept (ALI) Program as the initial, critical phase of the NTW program. ALI included the requisite systems engineering on the path to a follow-on UOES (Block I) and tactical (Block II) capability.

STUDY 3

TMD Capstone COEA

In 1995 the Department of Defense identified the need to evaluate the operational effectiveness of existing and planned TMD systems in a force-on-force analysis, using Defense Planning Guidance warfare scenarios. Consequently, the Secretary of Defense chartered the "TMD Capstone Cost and Operational Effectiveness Analysis (COEA)." A year and a half study of unprecedented scope and magnitude, the Capstone COEA evaluated the effectiveness of TMD systems in a variety of scenarios requiring TMD, including:

- Overseas crisis (land-based TMD unavailable).
- Developing theater (land-based TMD inserted into theater under the threat of missile attack).

AEGIS Cruiser AEGIS Display System

- Joint operations (all services participating in an established, joint TMD architecture).

The COEA was charged to show the sensitivity of several factors, including missile inventories, sensor fusion and BMC4I, sustainability, the presence or absence of hostile cruise missiles, attack operations and passive defense, and time phased force arrival in theater using airlift and sealift war plan scenarios. Warfighting models and simulations approved for use by the Department of Defense supported the analysis.

The force-on-force analyses primarily focused on comparing architectural alternatives for TBMD systems. Two time frames (2002 and 2010), and three geographic scenarios (North East Asia (NEA), South West Asia-North (SWA-N), and South West Asia-South (SWA-S)) were used in the assessment. The three operational situations (Crisis Response, Developing Theater, Joint Operations) were evaluated for each case. Special Studies focused on Deployability (lift), Attack Operations, Advanced Submunitions, Sensor Fusion, Conventional and WMD Threat Weapon Effects, Costs and BMC4I.

In order to represent Navy Theater Defense systems and capabilities, the COEA used the performance parameters for the Navy Area and Navy Theater Wide (NTW) systems. BMC4I simulation included the use of the Cooperative Engagement Capability (CEC).

Discussion

As a result of the modeling and simulation conducted to compare system effectiveness in the various theaters and operational situations, an extensive listing of findings and conclusions emerged. In order to simplify these, findings relevant to Navy TBMD systems are listed by the three operational situations.

Crisis Response. The results of the overseas crisis scenarios revealed that:

- Navy systems (Area and NTW together) defended critical assets ashore with attrition of 75-85% of the overall threat. Protection of Sea Ports of Debarkation (SPODs) and Air Ports of Debarkation (APODs) was achieved at an attrition rate of 90%.
- Naval forces provided "defense in depth" which resulted in increased shot opportunities and higher probabilities of kill.
- Only Naval TMD forces could provide defense during forcible entry and amphibious operations.
- Naval forces with NTW provided the most attractive method of defending distant critical assets, such as Guam, Okinawa, and Japan from the threat of TBMs. In some overseas crisis scenarios, such as the defense of Taiwan, NTW provided the only viable defense option.
- Navy TBMD was effective against the entire threat range. Navy Area TBMD is optimized for the short to medium TBMD; while NTW is optimized for the longer range TBM threat.
- NTW is very effective in defending inland defended assets due to ascent phase intercept capability and inland reach.

- BMC4I improvements resulted in more efficient interceptor use and inventory management, but BMC4I failed to "replace" any defense system elements.
- Composite tracking networks like Cooperative Engagement Capability (CEC) expanded critical asset coverage and protection, especially in the early stages of conflict.

Developing Theater. Naval TMD "made the difference in keeping the door open" to allow the insertion of follow-on forces using airlift and sealift. In addition, in the developing theater scenarios Navy systems:

- Provided defended asset coverage comparable to that of a fully deployed ground TBMD architecture.
- Provided defense in depth with consequent increase in enemy missile attrition.
- Area and NTW contributed in virtually all scenarios by improving the probability of successful asset defense, reducing the overall number of joint interceptors used, and providing flexible, mobile defenses without the need for additional airlift and sealift.
- Navy systems could be positioned without regard to the Forward Line of Troop (FLOT) movement, thereby continuing to provide vital asset protection regardless of land battle progress.
- Because of their operational flexibility, tactical mobility and logistics independence, Navy TBMD systems can be on station on short notice and without reliance on airlift; this removes a critical land-based TBMD system deficiency of reliance upon airlift or sealift to move forces to the theater when not previously pre-positioned.
- BMC4I improvements resulted in more efficient interceptor use and inventory management, but BMC4I failed to "replace" any defense system elements.
- Composite tracking networks like Cooperative Engagement Capability (CEC) expanded critical asset coverage and protection, especially in the early stages of conflict.
- Joint deconfliction between ground and sea systems reduced missile inventory usage.

MIDDLE EAST: 1991
Patriot Deployment by Air and Sea

- 1st Patriot Battalion Airlifted to Saudi Arabia by Day 34
- 2nd Patriot Battalion by Day 82 (Airlift / Sealift)
- 2 Patriot Fire Units From Germany to Israel in 48 Hours via 50 C-5A's
- Diverted 120 Airlift Sorties per Day

KOREA: 1994
Patriot Deployment by Sealift

- Four Months to Approve General Luck's Request to Move Patriots to South Korea
- More Than 40 Days From Fort Bliss to Set Up in South Korea

"They [Patriot] Really Take Up an Enormous Amount of Airlift at a Time When We Would Want to be Using it for Other Purposes."

"They Would Consume 80-90 C-5As"

SECDEF Perry, Referring to 1994 Deployment to Korea by Sealift

Joint Operations. Many of the attributes of Navy TBMD systems brought out in the Crisis Response and Developing Theater scenarios remain valid during Joint Operations. The addition of Navy ships (with TBMD and their existing cruise missile defense capability) to each scenario provided:

- Increased defense in depth, high probabilities of kill, and less interceptor usage.
- More flexibility to rapidly relocate defense systems.
- A high degree of cruise missile defense superimposed on the TBMD protection.
- Increased system performance, larger defended areas and more effective defense due to Cooperative Engagement and the combined effects of joint sensors and weapons.

Special Studies

Airlift and Sealift. Airlift and sealift constraints proved to be a significant factor in the rapid deployment of land based TBMD systems. Navy TBMD significantly lessened risks, to an acceptable level, to protect ports and airfield from TBMs while follow-on land based forces were inserted in the theater.

Cost Analyses. In the cost analysis of systems, the Capstone COEA estimated the cost of the Navy architecture (Area and NTW) at one-third to one-half less than a comparable land-based systems architecture. Program Office costs were scrubbed against independent estimates by the Cost Analyses Improvement Group (CAIG), BMDO cost estimates, and contractor inputs. In every case, Navy TBMD systems were cost effective and affordable.

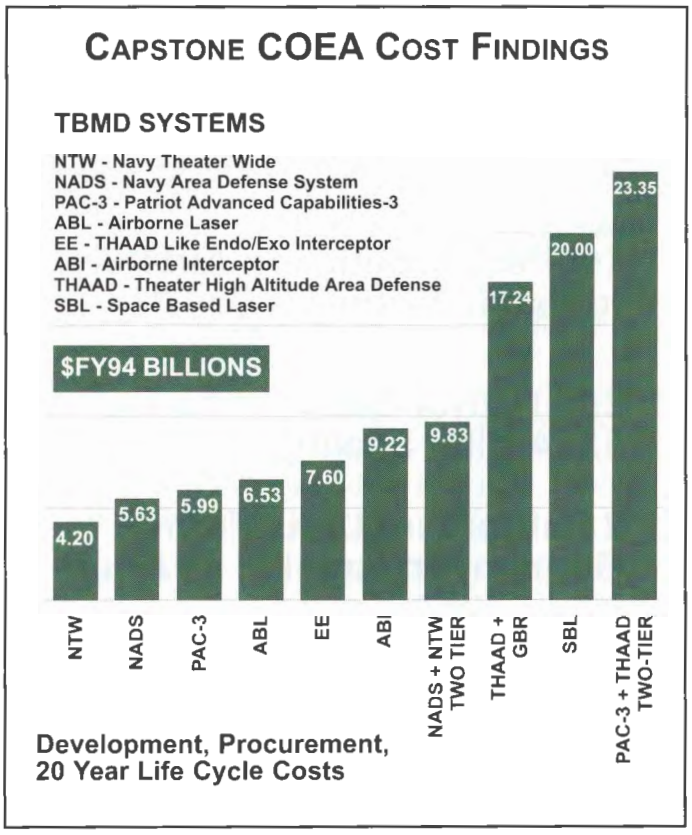
BMC4I. In the BMC4I analysis, the value-added of Cooperative Engagement became a recurring theme. The Capstone COEA emphasized the importance of sensor netting to all TBMD system participants. The COEA specifically recommended that the THAAD Ground Based Radar (GBR) become a participant in the CEC network. GBR contributed additional battle space, strong exo-atmospheric discrimination capability, and resistance to jamming that enhanced the effectiveness of all CEC participants.

Summary of TMD Capstone COEA Findings on Navy Systems

The TMD Capstone COEA made profound findings with regard to Navy Area and Navy Theater Wide TBMD. Analysis indicated that Navy TBMD systems were as effective as ground-based TBMD systems in defeating the current and emerging threat. Flexibility, mobility, and independence from host nation permission or support provided additional Navy TBMD attributes. The ability to deploy Navy TBMD irrespective of airlift and sealift constraints during a crisis greatly enhanced the ability of U. S. forces to provide TBMD in many scenarios. Navy systems offered the only credible defense of beaches, airfields, ports, and critical support facilities necessary to conduct an amphibious operation, forcible entry, or respond to a crisis area lacking pre-positioned ground-based systems.

Navy Theater Wide TBMD proved the only system with the ability to defend cities or vast geographic regions at an affordable cost. NTW also provided the only quickly deployable defense for islands such as Okinawa, Guam, and Taiwan without a large

Capstone COEA Cost Findings



introduction of U. S. troops and ground-based defense systems.

Navy TBMD provided defense in depth and greater overall weapon effectiveness when combined with any mix of alternative systems. Finally, Navy TBMD acquisition and life cycle costs were assessed as between one third to half the cost of land based systems.

STUDY 4

THE JOINT STAFF TBMD REVIEW

In the autumn of 1995, the Joint Staff conducted a Theater Missile Defense (TMD) Review to thoroughly assess current and future TBM systems and to prioritize candidate systems into effective and affordable architectures. A team of retired four-star General and Flag Officers representing each of the military services assisted the TMD Review as advisors to the Joint Requirements Oversight Council (JROC). Factors such as cost, area of coverage, availability, lethality, technical risks, compatibility with other systems, and lift requirements to a crisis area were used to assess the various systems.

The panel prioritized the TMD Core Systems (PATRIOT PAC-3, THAAD and AEGIS Area) and the advanced capability systems (Navy Theater Wide, Corps SAM/MEADS, the Airborne Laser (ABL), and Space Based Laser) into an overall acquisition strategy limited to an annual budget ceiling of $1.5 to $2.0 Billion.

Although the TBM Review assessed all current and future TBM systems, the Four Star Review Panel made several key findings concerning Navy TMD systems, including:

- Navy systems were effective and less costly than other alternatives.
- Navy Area Defense was urgently required to meet warfighting requirements, even when PATRIOT was available in theater.
- Consideration of a "Marinized THAAD" should be discontinued. THAAD, modified for the shipboard environment, would not be as effective as the STANDARD Missile-LEAP for the NTW mission.
- If costs were a driver, NTW was assessed as the best Upper Tier alternative.
- NTW was a system significantly different from THAAD. Because THAAD served as an "upper tier" to PATRIOT in the Army operational context, the two systems together defended the same chosen critical assets by destroying TBMs in their terminal stage of flight. Because NTW can be positioned closer to enemy TBM launch points, the opportunity to attack TBMs all along their trajectory, including in the ascent, midcourse and terminal stages of flight resulted in the defense of large geographic regions.

DISCUSSION

The panel of retired four star advisors reported to the JROC on 26 October 1995. Among the principal outcomes, the Four Star Review Panel recommended:

- Deployment of Area TBMD systems (AEGIS Area and PATRIOT PAC-3) as soon as possible. The current threat of short to medium range TBMs was widely acknowledged. The review also stressed the importance of building upon existing systems to counter the threat in a timely, low risk manner.
- Slowing the acquisition of Upper Tier systems. The TMD Review determined that threat development to date did not support the current schedule of Upper Tier Systems development.
- Ending the "Marinized THAAD" effort. The

study found that the capability provided by THAAD launched from a ship failed to meet or exceed the performance of the AEGIS-LEAP design. Because the "Marinized THAAD" design could not support ascent or midcourse engagements, the interceptor could not exploit the full potential of forward positioning of the AEGIS ships.

- Accelerating BMC4I systems supporting TMD. Specifically, the TMD Review stressed the near-term value added of the Cooperative Engagement Capability (CEC) and JTIDS. The Review recommended an accelerated buy for CEC with installation in the THAAD Ground Based Radar (GBR) as particularly important. By combining the advantages of CEC, the Navy AEGIS systems, and THAAD, a much more robust joint TBMD and Air Defense architecture could be created.

- Attack operations and future systems such as BPI/ABL had merit but did not reduce the need for defensive systems.

The Four Star Review Panel again reiterated the importance of the TBM threat and the world-wide Air Defense threat in general. By stating a belief that short to medium range TBMs posed the most urgent threat, the review concluded that THAAD and NTW development could be slowed with minimum risk.

In discussions at the JROC, the TMD Review added new emphasis to the effort to build upon existing systems to create more effective TMD. For example, the review favored a migration of PAC-3 capability to a future "PAC-4" as a more cost effective and lower risk approach to fielding new Army capability. The Review also supported the Navy's logic of developing the Area capability in AEGIS ships with the STANDARD Missile, followed by the NTW system building from AEGIS ships, the basic SM-2 Block IVA STANDARD Missile and LEAP. The Panel also stated a belief that future missile acquisition programs would buy smaller missile inventories than those planned at the time of the review. Finally, the Panel recommended using the terms "Area Defense" and "Theater Wide" as more descriptive and appropriate than the terms "Upper Tier" and "Lower Tier."

The JROC carried the retired Four Star Panel's recommendations to the four Service Chiefs, who approved a December 1995 memorandum on TMD which stated an intent to:

- Focus dollars first on PATRIOT PAC-3 and the Navy AREA program.

- Buy the right mix of land and sea based systems and only the numbers of interceptor missiles required.

- Continue the development, as much as possible, of multi-role systems capable of cruise missile and TBM defense (like Navy AREA).

- Delay THAAD and NTW to mature the programs at a relatively even pace. Conduct a fly-off in the 2002/2003 time frame. Limit the investment in THAAD to no more than $400M and NTW to about $200M per year.

- Refocus TMD BMC4I. A vigorous approach to deploying netted distribution CEC-like systems was advocated. The JCS, as executive agent for BMC4I development, was tasked with providing a joint service architecture.

- Continue work toward demonstration of Boost Phase Intercept (BPI) and the Airborne Laser (ABL). The service chiefs believed that these programs, though immature, showed promise. Demonstration and validation (Dem/Val) in the 2002/2003 time frame was recommended, along with exploration of other candidate ABL systems such as Unmanned Arial Vehicles (UAVs).

Strike operations were recommended as the most preferred method of eliminating the threat, yet the leadership acknowledged the difficulties posed by

SCUD Missile

this mission. Even when effectively employed, strike operations did not eliminate the need to develop and deploy defensive systems. Continued emphasis was needed to reduce time delays and increase the accuracy in BMC4I systems supporting the strike mission execution in order to improve upon the record of strike elimination of all TMD threat systems.

Summary of Joint Staff TMD Review Findings on Navy Systems

The Joint Staff TMD Review focused on an effective TMD architecture within anticipated funding constraints. To achieve this goal, candidate systems were prioritized and BMC4I improvements and interoperability were emphasized.

The Joint Staff TMD Review recognized the short to medium range TBM threat as the currently existing threat driver in TMD. Consequently, the first priority for TMD development was rapid deployment of PATRIOT PAC-3 and the AEGIS Area system. The Review stated that warfighting requirements necessitated development and deployment of Navy Area TBMD, even in situations where PATRIOT is available. Funding for THAAD and NTW was "capped" by the JCS Review until these systems demonstrated the maturity of their different technical approaches.

The threat posed by longer range, more stressing TBMs was assessed as a threat that would emerge early in the next century. Consequently, THAAD and Navy Theater Wide (NTW) development could both be slowed without greatly adding risk.

STUDY 5

Ballistic Missile Defense Program Review (BMD PR)

To add to the analytical effort conducted in the TMD Capstone COEA and in support of the FY 97 President's Budget submission on ballistic missile defense programs, the Undersecretary of Defense (Acquisition and Technology) directed the initiation of a Ballistic Missile Defense (BMD) Program Review (PR). A Steering Group headed by USD (A&T) and the Vice Chairman, Joint Chiefs of Staff supervised the BMD PR. USD (A&T) Strategic and Tactical Systems headed the working group.

This six month effort assessed the capabilities of U. S. TMD systems (including cruise missile and ballistic missile defenses), the National Missile Defense program, as well as technologies under development. Programs were presented by technical and program office briefers who were asked to provide details on schedules, cost estimates, program accomplishments, program goals and anticipated program contribution to missile defense. Factors such as the evolving missile threat, Congressional guidance, the impact of the Anti-Ballistic Missile Treaty and other issues were used to modulate discussions and decision making.

Discussion

The BMD Program Review reiterated the Department of Defense TBMD program priorities stated in Defense Secretary Aspin's 1993 Bottom Up Review (BUR) as: defend first against short to medium range missiles (capability provided by PATRIOT and Navy Area); continue to develop programs, as a second priority, for defense against longer range theater missile threats (capability provided by THAAD and Navy Theater Wide). The Program Review stated a renewed emphasis on finding responses to the cruise missile threat.

The Review specifically cited the appropriateness and benefits of evolving existing systems for the TBMD mission. Specific outcomes of the BMD Program Review included:

- An additional $150M over the FYDP for Navy Area TBMD.
- Increased funding for NTW ($600M over the FYDP). Reemphasized the Blue Ribbon

Panel's commitment to an AEGIS-LEAP Intercept (ALI).

- Slowed the rate of spending for THAAD, with a recommendation to focus additional attention on risk management. Over the FYDP, the BMD PR reduced THAAD funding by $2B.

- A stated intention to increase emphasis on BMC4I for TMD. While integrated BMC4I systems improved system effectiveness and reaction times to a wide variety of threats, the BMD PR assessed BMC4I to have a real near-term pay off in the effort to improve cruise missile defenses.

Finally, the BMD PR structured BMDO program priorities as follows:

1. Area / Lower Tier systems (PATRIOT PAC-3 and Navy Area)
2. Theater Wide/Upper Tier systems (THAAD & NTW)
3. NMD
4. Technology base development

On the subject of technology base, the BMD PR supported a strong BMD technology base as a hedge against future threat development. The Review perceived the technology base effort as a path to providing block upgrades to existing systems over time, keeping pace with threat developments. A strong technology base could reduce the risk of system upgrades, lowering development costs and reducing upgrade development schedules.

Summary of BMD PR Findings on Navy Systems

The Ballistic Missile Defense Program Review reaffirmed the Department of Defense prioritization of TBMD systems development. Area TBMD systems (PATRIOT PAC-3 and Navy AREA) remained the first development priority, followed by development of Theater (THAAD and NTW) systems.

Both Navy Area and Navy Theater Wide TBMD were provided with substantial additional funding as a result of the BMD PR. AEGIS Area TBMD received an additional $150M over the FYDP and Navy Theater Wide (NTW) funding was increased by $600M over the FYDP.

STUDY 6

Quadrennial Defense Review (QDR)

The National Defense Authorization Act for fiscal year 1997 required a comprehensive examination of U. S. defense needs between 1997 and 2015. The review assessed potential threats, strategy, force structure, readiness posture, military modernization, defense infrastructure, and other elements of defense programs. The Quadrennial Defense Review (QDR), the first major post-Cold War comprehensive review of America's future defense needs since the 1993 Bottom Up Review, was a one year review effort resulting from the FY97 legislation.

The QDR reiterated the importance of the threat by stating that, "The proliferation of weapons and technologies will continue. Of particular concern is the spread of Nuclear, Biological and Chemical (NBC) weapons. These weapons may be delivered by ballistic missiles, which are continuing to proliferate at an alarming pace."

All major defense acquisition efforts were assessed during the QDR. Warfighting contribution, cost effectiveness, test results, relevance to the projected threat and other factors were used to evaluate acquisition efforts. U. S. Ballistic Missile Defense

acquisition programs, including Navy Area Defense and Navy Theater Wide (NTW), were all evaluated during the QDR process.

Discussion

The QDR favorably endorsed both Navy Area TBMD and Navy Theater Wide (NTW). The final report of the QDR states, "The QDR reaffirmed our approach to the high priority Patriot Advanced Capability-3 and Navy Area Defense lower tier systems, Navy Theater Wide upper tier system, and the Airborne Laser program."

This positive endorsement was in sharp contrast to the Department's assessment of other TBMD acquisition efforts. In Secretary Cohen's message to the Congress forwarding the QDR in May 1997, he wrote, "We have decided to slow the Army's Theater High Altitude Area Defense [THAAD] System because of serious technical problems. Shifting the deployment date from 2004 to 2006 improves stability in the program, lowers risk, and allows us to explore using common components with the Navy Theater-Wide missile defense program." [The common component study is reported in this White Paper, titled "Commonality Alternatives System Study (CASS)"]

On the subject of MEADS, the QDR reported, "The MEADS program, a cooperative theater missile defense effort with Germany and Italy, is currently unfunded beyond FY 1998." In the QDR, the Department decided to fund the program through FY 1999.

Conclusions on the QDR

Although the QDR had a broad scope well beyond a review of TBMD systems, the QDR became the guide post for U. S. defense efforts that is still in place today. Navy Area Defense and NTW both received favorable endorsements during the QDR. The QDR:

- Reaffirmed the commitment and approach to PATRIOT PAC-3, Navy AREA, and Navy Theater Wide TBMD.

U.S. Army's Patriot

- Delayed THAAD two years, from a projected First Unit Equipped (FUE) date of 2004 to 2006.
- Proposed an additional study of commonality alternatives for THAAD and NTW.
- Left MEADS unfunded beyond FY99.

COMMONALITY ALTERNATIVES SYSTEM STUDY

The Commonality Alternatives System Study (CASS) convened in July, 1997, at the direction of the Defense Planning Guidance (DPG), to examine the cost savings and technical risk reduction potential of a common upper tier interceptor/kill vehicle for use by the Army and the Navy. Although the Quadrennial Defense Review (QDR) had recently advocated commonality between THAAD and Navy Theater Wide (NTW), the urge to achieve commonality was not a new notion in the Department of Defense. The CASS was the third study of it's kind in the Department.

Arleigh Burke Class AEGIS Destroyer Firing a STANDARD Missile

The first study that evaluated the potential for a "common missile" for the Navy and the Army, based upon the THAAD design, commenced in 1992. This "THAAD/AEGIS Compatibility Study" recommended that the Army THAAD development continue unencumbered by Navy requirements. Several features of the Army THAAD design, including system integration with the X-band Ground Based Radar (GBR) and use of liquid hypergolic Divert and Attitude Control System (DACS) fuel in the Kinetic Kill Vehicle (KKV) were not optimized for use in the Naval system. This initial evaluation of the proposal to modify THAAD for the Naval environment revealed that:

- a "common missile" would significantly reduce the Army THAAD system performance with the Ground Based Radar (GBR).
- an approach advocating "common missile components" was achievable, with added costs. The study found potential Navy benefits from some Army THAAD design features, while others would require replacement with components more suitable for the Naval environment and integration to the Navy system (including AEGIS and the Vertical Launching System). A Solid Divert and Attitude Control System (DACS) might be preferable to the Navy in place of the Army's liquid DACS. The Cost Analysis Improvement Group (CAIG) issued a report saying, "differences in operational environments and potential costs in disrupting the present Army program are large enough to make us skeptical that going beyond some common components would be worthwhile."

The services agreed to continue to make available THAAD engineering data to support ongoing compatibility analyses.

The second major THAAD study relative to the Navy commenced in 1994. This "AEGIS/THAAD Commonality Study" again assessed the "technical requirements for use of the Army THAAD on an

AEGIS ship." The study results reiterated the findings of the previous study and advocated the continued engineering data exchange effort between the services and their contractors.

As a result of these THAAD studies, the Army and the Navy had been involved in assessing THAAD's potential applicability to the Navy almost continuously between 1992 and 1997.

In 1997 the CASS evaluated the benefits, capabilities, costs and risks associated with the development of a single interceptor for use in both the Army and Navy "Upper Tier" systems. The common upper tier alternatives included:

- Marinized THAAD: an Army THAAD modified for use in the Navy's AEGIS Weapon System.
- NTW LEAP: the Navy NTW configuration modified for use in a modified Army THAAD launcher and system.
- Boosted THAAD: THAAD kill vehicle modified to comply with Navy shipboard requirements, with the Navy MK-72 booster and a larger 21 inch diameter second stage rocket motor.
- Advanced Kill Vehicle (AKV): a derivative of the KV formerly called AIT, with the Navy booster and a 21 inch diameter second stage rocket motor.
- Exoatmosheric Kill Vehicle (EKV): an EKV re-sized for the tactical mission with the Navy booster and 21 inch diameter second stage rocket motor.

Discussion

Three of the CASS alternatives were eliminated due to safety concerns, inability to meet service Operational Requirement Document (ORD) specifications, or technical risks beyond the acceptable limits of programs currently in development. Marinized THAAD failed to satisfy the Navy NTW ORD because it could not accomplish the ascent phase NTW mission. Marinized THAAD also presented shipboard safety limitations including the potential for launcher plenum burn through during a restrained missile firing. The Advanced Kinetic Vehicle (AKV) was evaluated as too immature in technology development to warrant insertion in any ongoing acquisition effort. The Exoatmospheric Kill Vehicle (EKV) presented shipboard safety concerns due to liquid hypergolic Divert Attitude Control System (DACS) fuels. The nature of the liquid fuels was considered beyond the scope of shipboard safety restrictions.

The two remaining alternatives, NTW LEAP and Boosted THAAD, presented unique restrictions which militated against their selection as common weapons for the Army and Navy. NTW LEAP lacked the endo-atmospheric intercept capability called for in the Army Upper Tier ORD. The Boosted THAAD required focal plane and maneuver system modifications for Navy use that added significant schedule delays and costs to the THAAD development program. Moreover, the Boosted THAAD would require THAAD launcher redesign and limit launcher missile capacity to four B-THAAD vice eight THAAD per launcher.

At the conclusion of the CASS in October, 1997, BMDO together with the Army and Navy Program Executive Officers (PEOs) for the represented systems, signed a final CASS report which stated in part, "The near term emphasis on evaluating Common Interceptor/Kill Vehicle alternatives for Navy Theater Wide (NTW) and Theater High Altitude Air Defense (THAAD) is disruptive to both programs and detracts from a collaborative, affordable, integrated, technical program emphasizing Common Component Technology Insertion (CCTI)." The CASS recommended that future consideration of commonality would become a part of the BMDO AKV technology program for future common technology insertion via CCTI. Additionally, the CASS recommended that THAAD and NTW development should continue as currently designed and planned.

Summary of Findings of the Commonality Alternatives System Study (CASS)

The CASS reaffirmed both the Army's technical approach to THAAD development and the Navy's technical approach to LEAP development. THAAD

variants proposed for introduction into the AEGIS Weapon System and Vertical Launching System (VLS) failed to meet the Navy's performance requirements as specified in the Operational Requirements Document (ORD). Conversely, LEAP variants proposed for adaptation to the Army's THAAD program failed to meet Army ORD requirements.

The CASS urged strongly that the development of both THAAD and NTW were required by military necessity and needed to be developed without interruption or delay. The final report of the CASS stated: "There is a significant need to provide TMD upper tier capability, both land and sea based, now. There is a great tendency to perturb programs by adding new requirements or responding to new threat projections. These perturbations almost always delay programs.... Since both programs are in critical phases, both the NTW and THAAD programs should proceed without perturbation. The programs as well as the requirement process should be structured to allow for block upgrades and to allow for additional new requirements in an orderly fashion."

The CASS endorsed the continued development of the two Kinetic Kill Vehicles, (KKV) one for THAAD and one for NTW (LEAP) as a wise "hedge." The rationale developed by the CASS stated that, in the event one KKV failed to demonstrate capability, the other KKV left an alternate path toward Upper Tier/Theater Wide KKV system engineering.

The final report of the CASS was endorsed in October 1997 by the BMDO Deputy for Theater Air and Missile Defense, the BMDO Chief Engineer/Architect, the Army Program Executive Officer (PEO) for Air and Missile Defense, the Navy PEO for Theater Air Defense, and the Air Force Director, Global Power Programs. The Director, BMDO, signed the CASS final report, sending it to the DoD Director of Strategic Systems. The CASS was the third in-depth DoD level engineering analysis looking for potential cost savings between the Army THAAD design and the Navy AEGIS LEAP. Substantial savings were never identified. The Navy continued to assess the operational impact of adapting THAAD for the Navy Theater Wide mission during the Navy TBMD COEA Phase II.

At the conclusion of the CASS, both the Army and the Navy committed to continue efforts to seek common components and technologies that could be candidates for future insertion into the THAAD and NTW systems.

STUDY 8

NAVY TBMD COEA PHASE II

In September 1996 a Cost and Operational Effectiveness Analysis (COEA) on the Navy Theater Wide (NTW) TBMD system concepts was initiated. Because the Navy had previously conducted an Area TBMD COEA, the NTW work continued the analytical effort and is referred to as the "Phase II COEA." The Phase II COEA lasted more than one year, completing early in 1998.

Participants in the NTW COEA included the Naval Surface Warfare Center, Dahlgren; Johns Hopkins University, Applied Physics Labratory; Naval Air Warfare Center, China Lake; the Center for Naval Analyses; and the Defense Nuclear Agency. The Army was represented by the Space and Missile Defense Command (SMDC), Huntsville, Alabama. Other government and industry centers of expertise supported the COEA as required.

DISCUSSION

The COEA evaluated the capability of the AEGIS Weapon System, with modifications proposed to support the NTW mission, along with candidate interceptor alternatives. Four interceptor alternatives were assessed in detail.

SM-LEAP. This design proposes to integrate the BMDO developed Lightweight Exoatmospheric Projectile (LEAP) with the basic SM-2 Block IV propulsion system to achieve an NTW system capable of exoatmospheric intercepts. An excursion alternative to this design ("SM-LEAP Excursion") offered more performance by replacing the SM-2 Block IV propulsion second stage with a new, larger, rocket motor design.

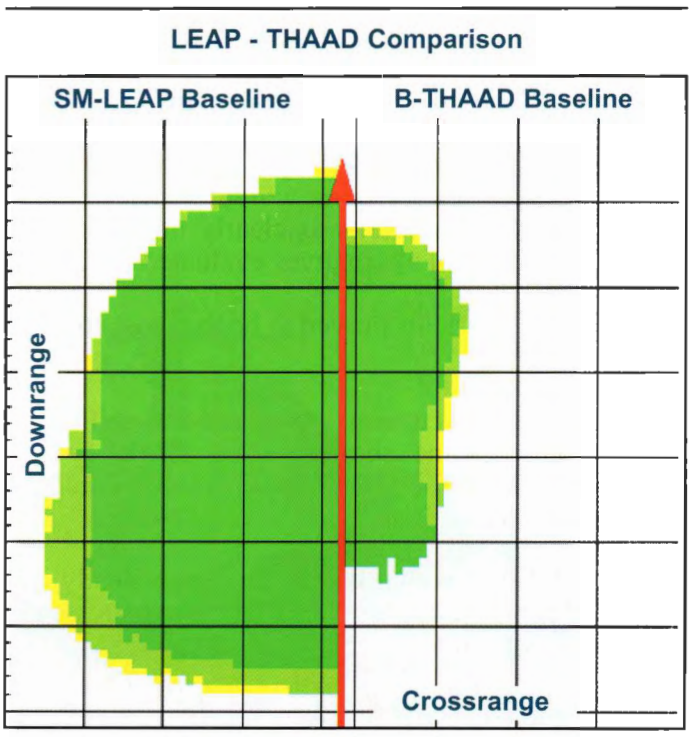
"Marinized" THAAD. This alternative offered to modify the Army designed Theater High Altitude Area Defense (THAAD) for the marine environment and to integrate the missile into the Navy Vertical Launching System (VLS) and AEGIS Weapon System. Performance of this missile, referred to as M-THAAD, would closely resemble the performance predicted by the Army for THAAD, including the ability to achieve endo and exo intercepts.

Boosted THAAD. This alternative proposed to integrate the Army's THAAD design with a booster, like the Navy MK-72 booster, to provide increased performance. This missile, referred to as B-THAAD, provided both exo and endo intercept capability. As an excursion to this design ("Boosted THAAD Excursion"), a variant was evaluated with a solid divert and attitude control systems (DACS) and a Mercury Cadmium Telluride (HgCdTe) focal plane array (FPA) vice the THAAD Indium Antimonide (InSb) FPA.

New Missile. This alternative proposed a new design kill vehicle and propulsion system to improve performance.

The AEGIS Weapon System was evaluated for its ability to:

- Initiate and maintain track on the TBM
- Support missile engagement of the TBM
- Detect and support engagements of multiple TBMs



Discussion

The M-THAAD alternative was eliminated for further analyses early in the COEA process because this alternative could not meet the requirements of the Navy Theater Wide (NTW) Operational Requirements Document (ORD). The new design missile, though intriguing, proved to be too immature a concept relative to the other system alternatives. The new design missile also had significant additional development costs and schedule delays that made the alternative difficult to compare to the four system alternatives assessed in detail: SM-LEAP (baseline), SM-LEAP (excursion), B-THAAD (baseline), and B-THAAD (excursion).

The AEGIS Weapon System, with the design modifications proposed for the TBMD mission, supported all the interceptor alternatives. Additionally, AEGIS provided very large operating areas for the NTW TBMD mission. The COEA Phase II found during analyses of AEGIS that:

- Discrimination, both the system's ability to put lethal objects into the field of view, and selection of the lethal object in time to permit KW intercept, was adequate for all system alternatives. The COEA determined that threat countermeasures could be mitigated with larger field of view sensors, two color seekers, and greater sensor sensitivity.

Indian Prithvi Ballistic Missile

- In high density TBM raids, AEGIS radar resources could be stressed for short periods of time. This was found to be mitigated using techniques such as radar sectoring and sensor netting (Cooperative Engagement Capability (CEC)). Increased Kill Weapon (KW) divert propulsion also mitigated radar loading at the system level.

End game effectiveness, the ability to achieve a hit on the TBM, was adequate for all system alternatives. Additionally, the probability of damage given a hit resulted in destruction of most payloads for all the system alternatives. For chemical submunition payloads, more massive KWs proved to be more effective. When battle space comparisons were made, SM-LEAP was preferred to both M-THAAD and B-THAAD. When operational areas were compared, SM-LEAP was preferred to both M-THAAD and B-THAAD. The SM-LEAP (excursion) was preferred to the B-THAAD (excursion) for both battle space and operational area.

Schedule was not a major discriminator between the system alternatives. The B-THAAD (baseline) was found to have the earliest assessed deployment date. Development time required prior to deployment for SM-LEAP alternatives and B-THAAD (excursion) were slightly longer but within the error margin for risk.

Development cost of all the systems alternatives were within 10% of each other. SM-LEAP had the lowest assessed development cost, followed closely by the B-THAAD (baseline). Both SM-LEAP (excursion) and the B-THAAD (excursion) had slightly higher development costs.

Life cycle costs were assessed as within 10% of each other. The more advanced SM-LEAP (excursion) and B-THAAD (excursion) costs were assessed as about $400-500M more than the SM-LEAP (baseline) and the B-THAAD (baseline).

Summary of Results from the NTW COEA

The summary of results from nearly twelve months of intense analytic effort, modeling and simulation, yielded the following conclusions about the Navy Theater Wide TBMD system alternatives:

- AEGIS allows the large kinematic battlespace of Theater-Wide interceptors to be exploited.
- Exoatmospheric intercepts are effective in defending large regions against weapons of mass destruction.
- Ascent and mid-course engagements add a new "tier" to joint TBMD. By allowing engagement of the threat TBMD along its entire trajectory, kill opportunities are increased in most scenarios.
- Ascent and mid-course engagements provide containment of out-of-theater threats.
- Theater-Wide interceptors can be in high demand early in a conflict from ships located near the TBM launch point and along the TBMs mid-course trajectory.
- B-THAAD (baseline) was clearly inferior to the other system alternatives evaluated.
- SM-LEAP variants proved to be the most cost effective.
- B-THAAD (excursion) provided the ability to counter some shorter range TBMs not engageable by the SM-LEAP alternatives, but at an added cost risk.
- SM-LEAP (baseline) was the least costly, with high effectiveness and margin to counter the evolving threat.
- SM-LEAP (excursion) provided the best per-

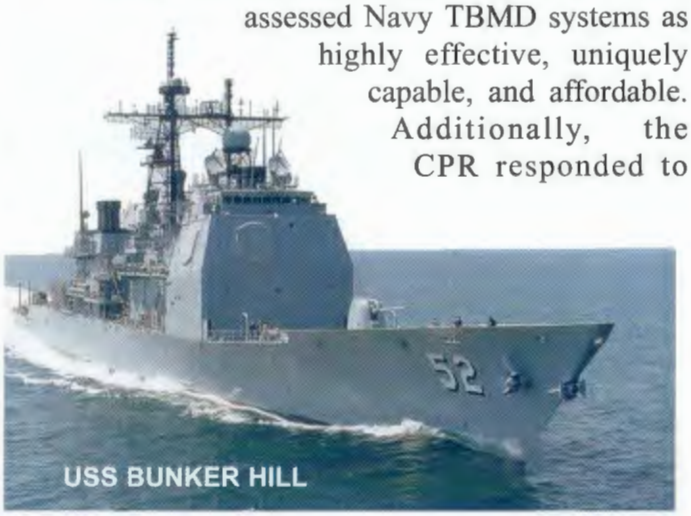
formance against the longest range threats, with the most design margin and greatest operational flexibility. SM-LEAP (excursion) however, also added cost to the SM-LEAP (baseline).

- Although not a specific finding of the study, COEA members realized during the course of their work a new perspective on NTW. Most previous analytic efforts had assessed the value of making intercepts early in the TBM trajectory. The COEA Phase II took this analytic approach, but also viewed the situation from the perspective of ships located along the TBM flight paths. Ships close to the TBM launch site made detections sooner, fired their missiles sooner, and intercepted the TBM earlier in flight. Modeling showed that NTW could defend huge geographic regions when located in a vast operational area near the TBM launch site, with slightly smaller defended areas when intercepting TBMs from operating areas along the flight path or near the intended TBM target. The COEA Phase II emphasized the operational flexibility of ships at sea, able to "shoot on the move," as they perform the TBMD mission as well as their other assigned warfare roles.

STUDY 9

COMPREHENSIVE PROGRAM REVIEW

In October, 1996, the Secretary of the Navy and Chief of Naval Operations directed a Comprehensive Program Review (CPR) of Navy TBMD. The Assistant Secretary of the Navy (Research, Development and Acquisition) and the Office of the Chief of Naval Operations (OPNAV) were assigned the task of crafting a "plan to accelerate the fielding of credible sea-based AREA and THEATER-WIDE TBMD systems." The CPR responded to the direction of previous studies including the Blue Ribbon Panel, Ballistic Missile Defense Program Review, TMD Capstone COEA, Joint Staff TMD Review, and other studies, which assessed Navy TBMD systems as highly effective, uniquely capable, and affordable. Additionally, the CPR responded to Congressional urging to improve Navy TBMD Program schedules (for Area and NTW) in order to deploy capability sooner to counter the threat. This "urgency of need," and the Navy's ability to respond, had been highlighted when China launched M-9 missiles into international waters near Taiwan and USS BUNKER HILL (CG 52) rapidly repositioned to provide tracking.



USS BUNKER HILL

DISCUSSION

The CPR assessed the total scope of management initiatives and actions that could be taken to accelerate the Navy TBMD effort. Assessment areas included systems engineering, test and evaluation, BMC4I, organization and staffing, insertion of TBMD into the shipbuilding and refit programs, training, risk management and the application of acquisition reform to the Navy TBMD effort.

During development of the CPR, an "evolutionary deployment approach" became a central element in Navy TBMD program planning. The evolutionary deployment approach recommends a low risk, reasonable investment approach to achieving ever increasing NTW capability. The first tenant of the evolutionary deployment approach states that Navy

TBMD development must evolve from the existing Navy TMD base exemplified in the AEGIS Weapon System, STANDARD Missile, and Vertical Launching System. This portion of the evolutionary approach has existed since Operation Desert Storm and serves as the bedrock of the Area TBMD effort. By modifying the AEGIS computer programs and STANDARD Missile (to provide the SM-2 Block IVA missile), the Navy is on a path to provide initial AREA TBMD capability in the FY99 time frame. Previous studies including the Blue Ribbon Panel and the Joint Staff TMD Review endorsed this approach.

The second facet of the evolutionary deployment approach is to build from AEGIS AREA TBMD to achieve NTW capability. By continuing to modify the STANDARD Missile (including the integration of LEAP), extending the modifications to the AEGIS Weapon System, and by adding follow-on capability enhancement through BMC4I, the Navy approach for NTW offers significant capability at a reasonable cost. The Comprehensive Program Review seized upon the Blue Ribbon Panel's priorities (ALI, then NTW UOES (Block I), then NTW tactical (Block II)); along with the Defense Department's acknowledgment of evolutionary acquisition approaches ((USD(A&T) memo dated 27 January 1997; subject: Evolutionary Defense Acquisition), to offer an even lower risk technical approach to achieving NTW TBMD at an accelerated pace. The CPR recommended the Navy:

- Complete the AEGIS-LEAP Intercept (ALI). Demonstrate a hit with LEAP. Conduct parallel risk reduction and systems engineering both to lessen ALI risk and to enhance the ability to move from ALI toward an initial deployed system. In keeping with the recommendations of the Blue Ribbon Panel and other assessments, technical maturity and test success rather than program schedule should drive the program.

- Build from ALI, risk reduction results, lessons learned, and systems engineering to achieve an "NTW Block I" capability. NTW Block I would address the preponderant threat with the best system effectiveness given schedule and resources available. In keeping with the Joint Staff TMD Review which predicted a future need for fewer interceptors, the CPR recommended a Block I system deployment of four ships and 80 missiles in the FY 02-05 time frame.

- Finally, after beginning the Block I initial deployment, the CPR recommended improvements be made to NTW system capability to keep pace with the threat. This system, called Block II NTW, would be engineered to defeat the emerging longer range and more stressing threat set of FY 06 and beyond. The numbers of ships to receive NTW Block II and the number of Block II interceptors to be built would depend upon further assessment of the threat and the operational requirement.

Specific CPR Initiatives

The Comprehensive Program Review made thirty-three specific recommendations that implement the details of the "Evolutionary Deployment Approach." Specifically, the CPR had a direct impact on several actions since initiated by the Navy to provide a fully integrated Navy strategy to accelerate TBMD deployment, including decisions to:

- Speed the installation of AEGIS AREA TBMD capability into the fleet to provide more TBMD capable ships sooner. To do this, commercial computer processors were selected over previously intended Military Specification (MILSPEC) equipments in some cases, and some STANDARD Missile BLOCK IV missile design features were retained in the BLOCK IVA where performance gains were minimal and potential schedule delays were lengthy.

- AREA TBMD computer program baselines were "forward fit" into the ARLEIGH BURKE (DDG 51) class shipbuilding program to provide more TBMD capable ships sooner and to lower AREA TBMD installation costs.

- Direct the rapid deployment of initial TBMD capability. To achieve this, two AEGIS Cruisers were identified as the "Linebacker" AREA TBMD ships. These ships become the first fleet ships to become TBMD deployable assets in FY00.

- Commence upgrades at the Navy's designated TBMD test range, the Pacific Missile Range

Facility (PMRF) at Barking Sands, HI, to support TBMD testing.

- Restore Cooperative Engagement Capability (CEC) funding into the E-2 Aircraft program
- Investigate the possibility of designating one AEGIS cruiser as a TBMD test ship, in order to lower costs and shorten at-sea developmental testing.
- Allocate Fleet asset Block IV missiles to support near term TBMD testing. This decision permitted 30 Block IV missiles to become assets in the Block IVA/SM-3 LEAP test effort two years prior to the anticipated acquisition date of newly manufactured missiles.
- Convert TERRIER Missiles for use as TBMD targets. This program permits the Navy to modify TERRIER Missiles retired from the fleet inventory to provide a low-cost and readily available training target.
- Modify missile build-up and test assets. This decision resulted in the modification of under-utilized Navy facilities in Hawaii to convert to missile build-up facilities in support of fleet and PMRF requirements. The conversion would reduce missile build-up and check out time at substantial cost savings.
- Initiate "Acquisition Reforms" such as Cost as an Independent Variable (CAIV), teaming, tailoring and commercial practices.
- Develop the Cruiser Conversion Plan. This reprioritization of over $1.2B of Navy resources provided the necessary engineering foundation to prepare AEGIS cruisers to receive NTW installations on an accelerated schedule.

E-2 Aircraft Will Receive Cooperative Engagement Capability (CEC)

- Restore funding for early fleet installations of BMC4I improvements to support TBMD including installation of the Cooperative Engagement Capability.
- Establish an Area Air Defense Commander (AADC) prototype demonstration and test facility. AADC was cited as "essential for both Joint Integrated Air Defense and TBMD Command and Control."
- Merging of the AEGIS and Theater Air Defense acquisition organizations to streamline TBMD engineering and acquisition.
- Establish the Navy-wide priority and importance of deploying TBMD at a rapid pace.

Area Air Defense Commander (AADC) Development Prototype Lab

Summary of the Comprehensive Program Review's Impact

The Comprehensive Program Review (CPR) of Navy TBMD was a watershed event that assessed all aspects of the Navy TBMD program in an effort to create the most disciplined, cost effective, yet rapid deployment of the vitally needed Navy TBMD capability. The evolutionary deployment approach provides the lowest risk technology development path, in the most cost effective manner. More than thirty total management initiatives and action occurred as a result of the CPR.

The final approval of CPR action items by the Chief of Naval Operations and the Secretary of the Navy occurred in April 1998. The endorsement letter signed by the SecNav and CNO stated: "The Navy recognizes the pressing operational requirement to deploy TBM defenses at sea to counter the existing TBM threat to forces ashore....Our focus is shifting from experiments and proof of concept demonstrations to full scale development and deployment...The Department of the Navy is committed to executing the AEGIS AREA TBMD Program [and] we are committed to the earliest deployment achievable for the AEGIS Theater Wide Program."

Summary of TBMD Studies Concerning Navy Theater Wide

Between 1994 and 1998, nine key Department of Defense and Navy studies assessed various aspects of NTW. The military operational necessity for this system, system effectiveness, cost effectiveness, development and technology risks were repeatedly evaluated. Every study endorsed progress to date and strongly supported development of NTW. Several urged an acceleration of NTW development.

Alternative NTW system designs were suggested several times. These alternative designs were analyzed in efforts to find the most capable system, with the best balance between technical risk and development cost. Every study supported the Navy approach and system design.

The profound findings of these studies reemphasize the value of Navy Theater Wide to the deployed U. S. Commanders-in-Chief (CINCs) and U. S. allies and friends. Furthermore, these studies have shaped the development and deployment path for NTW that the Navy is executing. A summary of these nine studies, viewed together, shows that the Navy and BMDO have thoroughly analyzed every aspect of Navy TBMD system development. The NTW development plan includes the testing and risk reduction required to ensure timely and efficient delivery of this unique TBMD combat capability to our fighting forces at sea.

The nine studies impacting Navy Theater Wide TBMD are summarized below.

Concept Evaluation and Integration Study (CEIS)

- Confirmed the findings of preliminary SPY-1 and AEGIS system TBMD studies and TBM tracking events indicating AEGIS TBMD capability.
- Validated the AEGIS Area system as highly capable of destroying TBMs with planned modifications.
- Reaffirmed the anticipated STANDARD Missile (Block IVA) capability against TBMs.
- Examined and eliminated proposals to modify ERINT/PAC-3 interceptors to fulfill the Navy TBMD mission.
- Recommended, for the first time, the rigorous

adherence to an "evolutionary deployment approach" for Navy TBMD. Advocated evolving AEGIS Area TBMD from the existing AEGIS system, including the SM-2 Block IV STANDARD Missile and existing BMC4I. Advocated a further evolution of AEGIS Area to achieve NTW.

- Concluded that the projected NTW defended area "footprint" had "an entirely different character" from any previously evaluated Army or Navy TBMD system. NTW's ability to attack TBMs in ascent, midcourse and descent, resulted in "footprints" yielding "large geographic areas of coverage behind the ship."

- Assessed THAAD as less capable than the AEGIS LEAP interceptor for the NTW mission.

- Found no obstacles to ABM Treaty compliance for AEGIS Area or NTW.

- Recommend pursuit of sensor netting including Cooperative Engagement Capability (CEC) as a valuable targeting enhancement for TBMD.

Blue Ribbon Panel

- Recommended expeditious development of the AEGIS LEAP Intercept (ALI) demonstration.

- Recommended strict adherence to the system engineering principles used in AEGIS development.

- Recommended sequential program objectives and focus, starting with the AEGIS LEAP Intercept (ALI) demonstration, proceeding to a UOES AEGIS-LEAP NTW capability (Block I), and finally to the more robust tactical NTW system (Block II).

TMD Capstone COEA

- Assessed Navy systems (Area and NTW together) as vital to defending critical assets ashore, with attrition of 75-85% of the overall threat. Protection of Sea Ports of Debarkation (SPODs) and Air Ports of Debarkation (APODs) achieved by Navy TBMD with 90% effectiveness during war gaming using DoD models and scenarios.

- Naval forces provided "defense in depth" which resulted in increased shot opportunities, higher probabilities of kill, and reduced missile inventory requirements.
- Naval TMD forces provided the only defense during all forcible entry and amphibious scenarios.

- Deployment of Naval TBMD significantly reduced the burden on airlift and sealift caused by ground based TBMD deployment, especially in the early days of a crisis.

- Naval forces with NTW provided the most attractive method of defending distant critical assets, such as Guam, Okinawa, and Japan from the threat of TBMs. In some overseas crisis scenarios, such as the defense of Taiwan, NTW provided the only viable defense option.

- Navy TBMD assessed as effective against the entire range of threats. AEGIS Area TBMD optimized for short to medium range TBMD; while NTW optimized for the longer range TBM threat.

- NTW proven effective in defending inland assets due to ascent phase intercept capability and inland reach.

- Navy systems could be positioned without regard to the Forward Line of Troop (FLOT) movement, thereby continuing to provide vital asset protection regardless of land battle progress.

- Navy TBMD included cruise missile protection due to the proven effectiveness of the AEGIS system.

- Because of their operational flexibility, tactical mobility and logistics independence, Navy TBMD systems can be on station on short notice and without reliance on airlift.

- BMC4I improvements resulted in more efficient interceptor use and inventory management, but BMC4I failed to "replace" any defense system elements.

- Composite tracking networks like Cooperative Engagement Capability (CEC)

expanded critical asset coverage and protection, especially in the early stages of conflict.

- Naval TBMD provided defended asset coverage comparable to that of a fully deployed ground TBMD architecture.

- Navy TBMD could be provided at one half to one third less than the cost of land-based TBMD architectures.

Joint Staff TMD Program Review

- Made PATRIOT PAC-3 and the Navy AREA program the number one TBMD development priorities in DoD.
- Recommended continued development of multi-role systems capable of cruise missile and TBM defense (like AEGIS Area).

- Delayed THAAD and NTW to mature the programs at a relatively even pace. Recommended a fly-off in the 2002/2003 time frame.

- Refocused TMD BMC4I. Recommended a vigorous approach to deploying netted distribution (CEC-like) systems. The JCS, as executive agent for BMC4I development, was tasked with providing a joint service architecture.

Ballistic Missile Defense Program Review

- Added an additional $150M over the FYDP for Navy Area TBMD.

- Increased funding for NTW by $600M over the FYDP. Reemphasized the Blue Ribbon Panel's commitment to an AEGIS-LEAP Intercept (ALI).

- Slowed the rate of spending for THAAD, with a recommendation to focus additional attention on risk management. Over the FYDP, the BMD PR reduced THAAD funding by $2B.

- Recommended an increased emphasis on BMC4I for TMD. While integrated BMC4I systems improved system effectiveness and reaction times to a wide variety of threats, the BMD PR assessed BMC4I to have a real near-term pay off in the effort to improve cruise missile defenses.

- Structured BMDO program priorities as follows:

  1. AREA/Lower Tier systems (PATRIOT PAC-3 and Navy AREA)

  2. Theater Wide/Upper Tier systems (THAAD and NTW)

  3. NMD

  4. Technology base development

Quadrennial Defense Review

- Reaffirmed the commitment and approach to PATRIOT PAC-3, Navy AREA, and Navy Theater Wide TBMD.

- Delayed THAAD two years, from a projected First Unit Equipped (FUE) date of 2004 to 2006.

- Proposed an additional study of commonality alternatives for THAAD and NTW.

Commonality Alternatives System Study

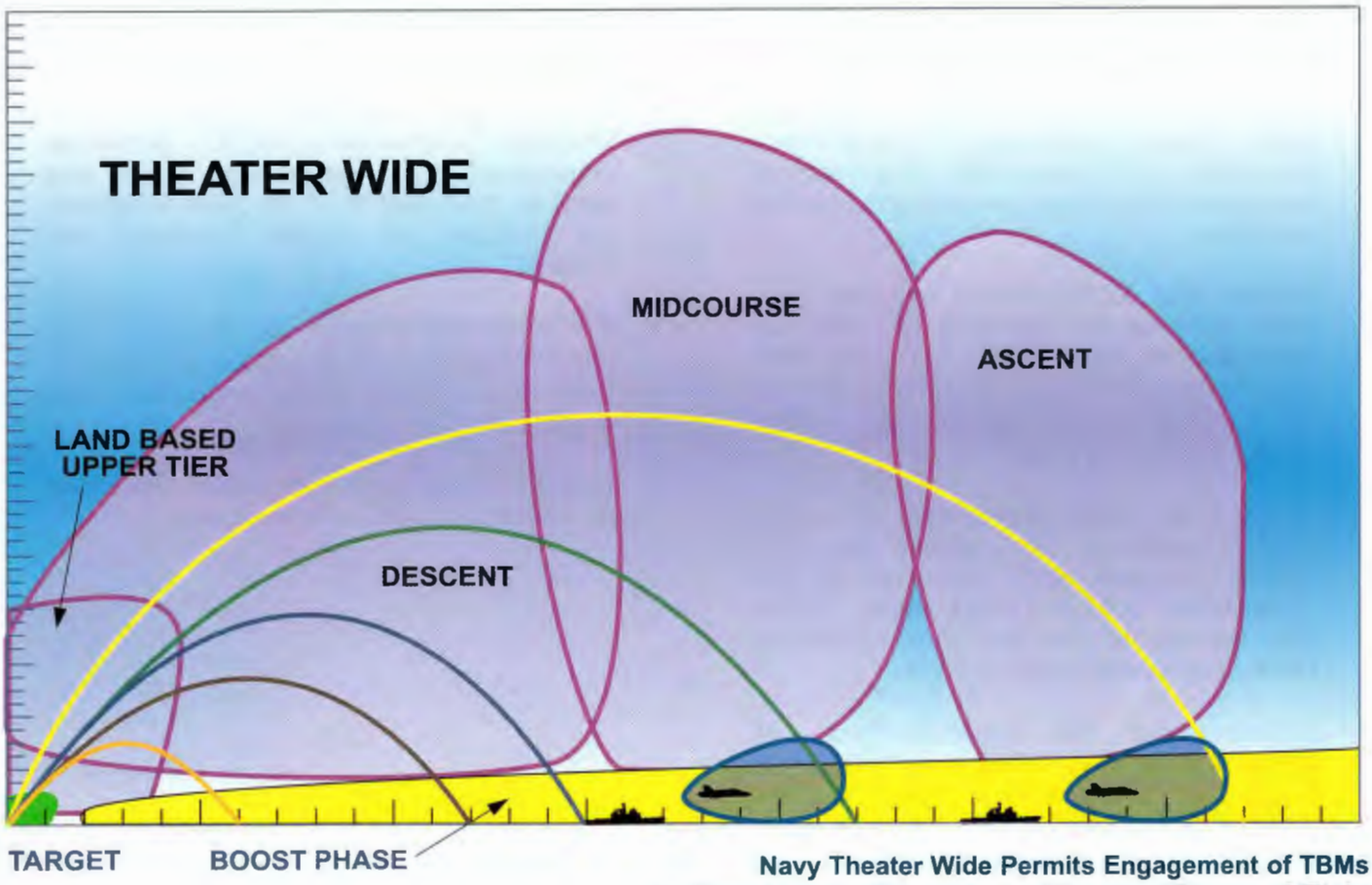
- Reaffirmed both the Army's technical approach to THAAD and the Navy's technical approach to LEAP.

- Found that THAAD variants proposed for introduction into the AEGIS Weapon System and Vertical Launching System (VLS) failed to meet the Navy's performance requirements as specified in the Operational Requirements Document (ORD).

- LEAP variants proposed for adaptation to the Army's THAAD program failed to meet Army ORD requirements.

- Strongly urged the development of both Army THAAD and Navy AEGIS LEAP (NTW). Reaffirmed that both systems were required by military necessity and needed to be developed without interruption or delay.

- Recommended the programs as well as the



Navy Theater Wide Permits Engagement of TBMs in Their Ascent, Midcourse, and Terminal Stages of Flight

requirements process be structured to allow for "block upgrades" and to allow for additional new requirements in an orderly fashion.

- Endorsed the continued development of the two Kinetic Kill Vehicles (KKV), one for THAAD and one for NTW (LEAP) as a wise "hedge." The rationale developed by the CASS stated that, in the event one KKV failed to demonstrate capability, the other KKV left an alternate path toward Upper Tier/Theater Wide KKV system engineering.

Navy TBMD COEA Phase II

- Found that AEGIS supported the large kinematic battlespace of Theater-Wide interceptors.
- Ascent and mid-course engagements were found to add a new "tier" to joint TBMD. Ascent and mid-course engagements provide containment of out-of-theater threats.
- THAAD and THAAD variants were clearly inferior to the SM-LEAP design for the Navy mission.
- SM-LEAP variants proved to be the most cost effective NTW interceptor alternative.
- SM-LEAP provided an evolutionary growth path for countering longer range and more complex TBM threats.
- The COEA Phase II again reiterated the NTW potential for defense of large geographic regions against TBMs and WMD.

Comprehensive Program Review

- Reaffirmed the "evolutionary deployment approach" as the most cost effective, lowest risk development path for Navy TBMD.
- Reaffirmed the commitment of the Navy to deploy NTW expeditiously.
- Strongly endorsed the ALI demonstration program.

- Provided "more TBMD ships sooner" in response to the endorsed urgent requirement.

- Established the "cruiser modernization program" to prepare these ships for the introduction of the NTW capability. Reprioritized more than $1B in Navy resources for cruiser conversion.

- Directed that AREA TBMD computer program baselines be "forward fit" into the ARLEIGH BURKE (DDG 51) class shipbuilding program to provide more TBMD capable ships sooner and to lower AREA TBMD installation costs.

- Directed the rapid deployment of initial TBMD capability. To achieve this, two AEGIS Cruisers were identified as the "Linebacker" AREA TBMD ships. These ships become the first fleet ships to become TBMD deployable assets in FY00.

- Recommended the commencement of upgrades at the Navy's designated TBMD test range, the Pacific Missile Range Facility (PMRF) at Barking Sands, HI, to support TBMD testing.

- Recommended the designation of one AEGIS cruiser as a TBMD test ship, in order to lower costs and shorten at-sea developmental testing.

- Allocated Fleet asset Block IV missiles to support near term TBMD testing.

- Recommended conversion of excess TERRIER Missiles for use as TBMD targets.

- Recommended modification of missile build-up and test assets. Suggested the modification of under-utilized Navy facilities in Hawaii for missile build-up in support of fleet and PMRF requirements. Reduced missile build-up and check out time at substantial cost savings.

- Recommended initiation of "Acquisition Reforms" such as Cost as an Independent Variable (CAIV), teaming, tailoring and commercial practices in the Navy TBMD acquisition effort.

- Recommended funding for early fleet installations of BMC4I improvements to support TBMD including installation of the Cooperative Engagement Capability.

- Endorsed the establishment of an Area Air Defense Commander (AADC) prototype demonstration and test facility. AADC was cited as "essential for both Joint Integrated Air Defense and TBMD Command and Control."

- Recommended merging the Navy's AEGIS and Theater Air Defense acquisition organizations to streamline TBMD engineering and acquisition.

- Established the Navy-wide priority and value of deploying TBMD at a rapid pace.