NAVY THEATER WIDE (NTW)

Navy ACAT I-D Program

Total Number of Systems:	4 Ships, 80 Missiles
Total Program Cost (TY$):	$5,493M
Average Unit Cost (TY$):	$11.275M
Milestone II:	1QFY04
Full-rate production:	3QFY07

Prime Contractor

Raytheon Missile Systems Company (missile)
Lockheed Martin Government Electronic Systems (AEGIS Ship)

SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2020

The Navy Theater Wide (NTW) system is a response to the vulnerability of U.S. forces and protected populations to the ballistic missile threat. The mission of NTW is to provide upper-tier protection against medium to long-range threats. NTW will provide the capability to intercept Theater Ballistic Missiles from exoatmospheric ascent phase through exoatmospheric descent. The NTW system contributes to three of the four ***Joint Vision 2020*** operational concepts: ***full-dimensional protection, precision engagement, and dominant maneuver***. NTW supports:

- ***Full-dimensional protection*** by defeating incoming exoatmospheric ballistic missiles to assist in controlling the airspace.

- ***Precision engagement*** by contributing to a Theater Ballistic Missile Defense (TBMD) family of systems that can locate TBMD targets, provide command and control, engage targets, and assess level of success.

- ***Dominant maneuver*** by applying information, engagement, and mobility capabilities to accomplish an upper-tier TBMD defense.

The NTW program consists of the Standard Missile-3 (SM-3) and upgrades to the AEGIS Weapon System. The SM-3 evolves from the SM-2 Block IV booster and sustainer motor by the addition of a third-stage rocket motor and fourth-stage kinetic warhead with a solid-fuel divert and attitude control system guided by an infrared focal plane array seeker. The AEGIS Weapon System will be modified to enable longer-range, exoatmospheric theater ballistic missile detection, tracking, discrimination, and engagement.

BACKGROUND INFORMATION

The genesis for NTW was the TERRIER Lightweight Exoatmospheric Projectile (LEAP) demonstration program, which occurred from September 1992-March 1995. The TERRIER LEAP program consisted of four modified TERRIER missile flight tests. Two flight tests occurred without targets, and two flight tests occurred against targets. The two intercept attempts failed. One of the failed intercepts was due to a software error and the other was due to battery failure. However, sufficient technical progress was made to warrant further development work and the AEGIS LEAP Intercept (ALI) program was created. The objective of the ALI program is to demonstrate intercept of a ballistic missile target in exoatmospheric flight.

Milestone I occurred in spring 1999. The Program Definition and Risk Reduction test program and TEMP were approved. The FY99 TEMP outlines the test strategy for a Block I development plan. The NTW Block I system will use an SM-3 missile with a single-color, long-wave infrared seeker and an upgraded AEGIS Weapons System that will include high-range resolution and a new signal processor for added radar discrimination capability against separating targets. The Block I missile in its final form will defend against TBMD and Anti-Air Warfare (AAW) targets. Research is advancing for the potential development of a Block II missile with improved infrared and radar discrimination capability; however, there is currently no funding for development and acquisition of the Block II system. Funded plans for a Block II system feature a two-color infrared seeker, improved propulsion (axial and divert), and the integration of a high-power radar into the AEGIS Weapon System.

As part of the revised Upper Tier Strategy of 1999, major changes to the NTW Block I program plan and TEMP have been in work to facilitate earlier fielding of system capability. This modified program plan proposes an evolutionary acquisition strategy that divides Block I development as outlined in the FY99 Program of Record into three smaller development increments (Block IA, IB, and IC). Block IA contingency capability defeats non-separating and simple separating threats; Block IB is a single-mission (TBMD-only) capability that defeats all Block I TBMD threats; and Block IC is a multi-mission (AAW and TBMD) capability that satisfies the requirements of the Block I system under the FY99 Program of Record. Under the modified plan, the ALI project will continue with project objectives and flight test matrix unchanged. Research toward a Block II system with enhanced discrimination and lethality capabilities will continue as well.

TEST & EVALUATION ACTIVITY

The Navy Theater Wide program is currently in the ALI program flight test phase. The ALI flight test series consists of nine missile firings from 4QFY99-3QFY02. The first two flights, Control Test Vehicle-1A (CTV-1A) and Flight Test Round-1 (FTR-1), were SM-3 missiles flying on trajectories against simulated targets. The third flight, FTR-1A, will repeat the objectives of the unsuccessful FTR-1 flight and may briefly acquire a single-stage ARIES target with the IR seeker. The fourth flight, FTR-2, will obtain seeker characterization data of the ARIES target with target intercept possible. FTR-3 through FTR-7 will be ARIES target intercept attempts.

Following ALI testing, the evolutionary program plan proposes nine firings as part of a developmental test/operational assessment (DT/OA) phase during FY04-06. These DT/OA firings will be descent and ascent phase engagements against threat-representative, non-separating targets and ascent phase engagements against threat-representative, separating targets. A minimum of three flight tests will support the OA, the results of which will be used to evaluate the production readiness of the Block I missile.

In September 1999, the Navy conducted the ALI CTV-1A flight test from the Pacific Missile Range Facility on Kauai, HI. CTV-1A demonstrated airframe stability and control of the SM-3 missile through second/third stage separation. In July 2000, the Navy conducted the second ALI flight test, FTR-1, from the Pacific Missile Range Facility. The primary objective of the test was to maintain airframe stability and control of the SM-3 through kinetic warhead separation using the third-stage rocket motor. The FTR-1 third-stage failed to separate from the second stage following second-stage burnout, and the primary objective was not achieved. An FTR-1A shot in 2QFY01 will attempt to complete the FTR-1 primary objective.

The Navy is developing the LFT&E strategy for NTW. In late 1996, the Navy instituted a multi-year pre-Milestone II SM-3 Lethality and Analysis Program, in conjunction with the ALI program, to reduce risks associated with missile lethality. The lethality program includes:

- Light-gas gun testing with sub-scale replicas of the kinetic warhead.
- Target vulnerability model development.
- Direct-hit lethality sled testing.
- Hydrocode analyses.
- Other ancillary tests and analyses.

Those tests and analyses also support the development and design validation of SM-3 as well as the Verification, Validation and Accreditation of computer models used to evaluate its lethality.

There was no lethality testing of SM-3 in FY00. Navy SM-3 activities focused on building test targets for FY01 testing and getting the test facilities ready to conduct three SM-3 Direct Hit Sled Tests (scheduled for 3QFY01) and a Light Gas Gun Test Series. Other activities for FY00 included aimpoint selection and lethal volume analyses (using hydrocodes), end game model development, and flight test support (primarily ALI damage predictions). Navy NTW tests and analyses are scheduled to continue through 2003.

TEST & EVALUATION ASSESSMENT

NTW faces several technical challenges:

- Ascent phase intercept. This will be attempted during DT/OA flight testing prior to the fielding of Block IA contingency capability.

- Infrared seeker obscuration. The potential obscuration of the infrared seeker by the kill vehicle Solid-fuel Divert and Attitude Control System (SDACS) propellant plume is an identified risk area to the program.

- Infrared seeker discrimination. A single-color, vice a two-color system may limit the capability of the infrared sensor to discriminate target reentry vehicles from debris, such as fuel chuffing or target plume, and from separating stages, such as booster tanks and attitude control modules.

- AEGIS radar detection and tracking. The AEGIS radar is designed for acquisition and tracking of relatively large aircraft targets and may have insufficient power to autonomously acquire low-signature ballistic missile targets at long-range. External cueing of the radar may ameliorate this challenge.

- SDACS development. Development of critical technologies unique to the NTW program, such as SDACS non-legacy hardware, poses a risk to the program because of the lack of prior flight-test qualification.

The Navy is conducting an extensive ground test program to characterize the effects of infrared seeker obscuration and will collect in-flight data during the ALI phase. To fully understand the effects of obscuration, it is essential to test during periods of solar illumination of the propellant plume. In response to DOT&E's concerns regarding the effects of solar illumination, a daytime flight test has been incorporated into the ALI test series.

During the past year, risk reduction efforts involving the single-color infrared seeker showed continued progress via the SM-3 Captive Carry program on the Airborne Surveillance Test bed (AST). AST carried an SM-3 infrared seeker assembly on several tests involving targets of opportunity. The Captive Carry test bed has allowed the program to characterize the SM-3 Block I infrared sensor and develop Radio Frequency (RF) to Infrared (IR) handover algorithm development software to be used in flight testing.

To further reduce the potential risk associated with the IR seeker, the development of two-color seeker technology should be accelerated. Two-color technology would significantly improve seeker discrimination over the proposed Block I capability. This technology shows promise and has the potential to be incorporated into the program during Block I development.

As part of the NTW Block II risk-reduction effort, two radar prototypes are in development: an X-band high power discriminator and a solid-state SPY-1E radar. The X-band system is a ship add-on radar based on THAAD radar technology; the SPY-1E radar, which is an S-band solid-state multi-function radar, is an upgraded replacement to the existing SPY-1 radar. In the near-term, simultaneous development of both radar prototypes will continue until a preferred option is identified. Full program funding of radar development could allow fielding of a Block II radar system to coincide with Block IA fielding under the evolutionary program plan. Early development and fielding of a Block II radar system could greatly reduce the risk associated with the Block I radar system by improving its detection range and object resolution.

During the past year, ground-test qualification of critical NTW technologies has met with mixed results. Recent SDACS ground testing has revealed faults, which will delay the first ALI intercept attempt by at least six months. One of the primary faults pertains to the rhenium coating of the fluidic ball divert valves of the SDACS main thruster assembly. A mismatch in material thermal expansion properties caused the rhenium coating to crack and delaminate during ground tests. The SDACS is the final element requiring verification prior to intercept. The Navy is taking steps to isolate the faults and apply and verify corrective actions, which include assembling a technical review team of senior independent experts to review both the design and execution of the current SDACS. The ALI flight test matrix has also been modified with fewer design changes during the early part of the ALI phase. In contrast, ground-test qualification has gone well for the third-stage rocket motor—another non-legacy hardware element of the SM-3. An earlier problem with the third-stage rocket motor has been corrected, and six successful ground tests have been conducted in the past year with no impact on schedule.

The SM-3 Lethality and Analysis Program is building a solid foundation for future LFT&E activities. The program is addressing many of the lethality issues early on and developing test techniques that can be employed in future lethality testing.

The effort during the past year to re-baseline the NTW program to facilitate earlier acquisition posed immediate challenges to adequate operational testing before production. To address DOT&E's concerns in this area, OA firings before the start of LRIP have been incorporated into the re-baseline plan. The results of the OA flights should provide an adequate assessment of Block I system effectiveness and suitability for the production decision. Also, in response to DOT&E's concerns on the lack of separating-target flight testing before Milestone II in the FY99 Program of Record, funding has been re-directed to accelerate the development of the common signal processor. The common signal processor is required for testing against separating targets. As a result, flight testing against separating targets will occur earlier than planned in the FY99 Program of Record and before LRIP under the re-baseline plan.

NTW has received recent attention for its possible role as a sea-based option and/or supplement to a land-based National Missile Defense (NMD) system. However, to accomplish the NMD mission, several elements of the baseline NTW program would require major upgrades.

- ***Radar*** – The AEGIS AN/SPY-1 B/D radar is not capable of supporting NMD-class engagements due to its limited detection and tracking range for strategic (long-range) ballistic missiles and their reentry vehicles. In order for the NTW ship to support its own NMD engagements, a major upgrade to the AEGIS radar is required. The aperture size, beam width, frequency, and bandwidth of the SPY-1 radar are unsuitable for NMD. The small aperture size would severely limit the detection capability of the radar against long-range NMD threats. The large SPY-1 beam width would degrade the track accuracy required for a small predicted "hand-over basket" for the NMD kinetic warhead. Likewise, the SPY-1 frequency and bandwidth are not optimized for discrimination of NMD targets in mid-course flight. Alternatively, an adjunct radar could be added to the ship (e.g., a steerable single-face

X-band radar mounted to the ship. Upgrading the SPY-1 radar or adding an adjunct radar would be a major modification.

- ***Missile*** – To utilize the current NTW SM-3 for the NMD mission would require major propulsion upgrades. The NTW Block I SM-3 lacks the velocity required for ascent or mid-course intercepts of long-range ballistic missiles (intermediate and intercontinental ballistic missiles [IRBMs and ICBMs]). The burnout velocity of the SM-3 missile is less than half of that required for mid-course engagements of high-velocity NMD targets. Using the current Block I SM-3 to conduct NMD engagements would result in an inadequate defended area.

- ***Kinetic Warhead*** – Several major upgrades or a full re-design are required before the NTW kinetic warhead (KW) could be used for the NMD mission. The NMD mission requires the KW or the kill vehicle (KV) to be nuclear hardened. The current NTW KW does not meet this requirement. Engaging the most difficult NMD threats would require the NTW KW to have capabilities similar to those found in the NMD exo-atmospheric kill vehicle (EKV). For the NMD mission, the current NTW KW lacks the required NMD endgame performance due to the limited detection range of its IR seeker and the lack of divert velocity available with the current divert and attitude control system. A second color for the IR seeker would also be required to achieve adequate endgame discrimination for advanced IRBM and ICBM threats.

Based on the above major shortcomings, DOT&E does not consider NTW or a near-term (within 5 years) upgrade of NTW to be a viable sea-based NMD option. This conclusion is supported by an ongoing Concept Definition Study (CDS) conducted by the Ballistic Missile Defense Organization (BMDO) and the Navy that, in general, assumes the above modification in the missile, KW, radar, and BM/C^3. BMDO and the Navy formed a CDS team in August 1999 to respond to the congressional Fiscal Year 2000 National Defense Authorization Act, which requests a report evaluating options for supplementing NMD architecture with sea-based assets. A separate report to Congress on the results of Part I of the Naval NMD CDS has been drafted and is currently being coordinated within the Department of Defense.

RECOMMENDATIONS, CONCLUSIONS AND LESSONS LEARNED

The proposed evolutionary acquisition strategy poses inherent challenges to adequate operational testing supporting production and fielding of each Block upgrade. The program philosophy (to date) that incorporates operational testing into the flight test matrix, in advance of production, is strongly encouraged and supported.

Future flight test success and/or schedule pressures have the potential to curtail flight testing that might otherwise provide valuable risk-reduction. The potential for a schedule-driven approach that prematurely curtails flight testing to advance the program is a concern.

The current funding levels for the Block I program have forced the Navy to focus on the early fielding of Block I at the expense of developing Block II technologies. The two-color IR seeker and high power discrimination radar are slated for the objective Block II system, which is intended to address the 2010 threat. However, the advanced IR seeker and radar systems are funding, not technology constrained, and could be fielded early in conjunction with the Block I systems. The addition of either the two-color seeker or the advanced radar would greatly improve the effectiveness of the Block I system against certain classes of existing threats. Developing and fielding NTW Block I, knowing it will only partially address the existing threat at fielding, remains a concern. The technology to achieve the Block II system is available and should be incorporated as soon as possible.