National Defense Industrial Association Strike, Land Attack and Air Defense Division

Surface Warfare (SUW) Phase III Study

Executive Summary Report

Prepared for

OPNAV N86
Surface Warfare Directorate

Contract: NSIA/Navy Agreement (NDIA)

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Table of Contents

List of Figures

INTRODUCTION

Over the past years from 1999 to 2006, the NDIA (National Defense Industrial Association) Strike, Land Attack and Air Defense (SLAAD) Division had been tasked by the Chief of Naval Operations, Director of Surface Warfare (N86), to evaluate the surface threat and the capability of the naval surface force to meet that threat. As a consequence, this current SUW Phase III Study follows a progression of past surface warfare studies known as Phase I and Phase II.

The Phase I study was completed in 2002 and concentrated on evaluating BLUE ship's self-defense capability against multiple RED small boat attacks. The Phase II study was successfully concluded in 2005 and was focused on evaluating the BLUE surface force capabilities and deficiencies on force-on-force engagements. Figure 1 is a summary chart comparing Phase I and Phase II studies with respect to the threat considered, time frame involved, assessment tool used, and the conclusions and recommendations reached.

Comparative Summary of Past SUW Studies

Description	SUW Phase I Study, 1999- 2002	SUW Phase II Study, 2003- 2005
Threat	Swarm of high-speed, maneuvering small boats equipped with short-range un-stabilized weapons (1000 yds effective range)	Multiple, high-speed boats, large boats; RED SAGs; weapon launches also from shore
Time Frame	2002-2009	2008
Assessment Tool	SC21 Surface Warfare Model	NSS (Naval Simulation System) to analyze results of TACSITs (Tactical Situations)
Conclusions	•Requirements for SUW mission: - Layered defense - Precision auto-tracking - Missile guidance capability beyond 2 nm self-defense layer - Gun stabilization - Integrated multi-spectral sensor suite • Key is high performance minor caliber gun system (MCGS)	• Maintain current ship SUW load-out • Maintain SSN SUW Capability against high-end surface threats
Recommend-ations	•Field Phalanx Blk 1B in all ships with littoral mission • Demonstrate SUW capability for RAM and ESSM	• Improve long-range/OTH self-defense capability • Integrate dissimilar sensor systems into the combat system to reduce reaction time • Develop improved capability to discriminate between target and land for OTH weapons • Develop small precision OTH weapons with target discrimination capability

Figure 1: Comparative Summary of Past SUW Studies, Phase I and Phase II

Note that the attack by high-speed boats has remained a concerned threat in both prior studies, as it still is today. The phase II study recognized the need for an OTH (Over-the-Horizon) weapon with target discrimination capability and for the integrations of combat and sensor systems to reduce reaction time. The ongoing development of NLOS/PAM (Non-Line-of-Sight/Precision Attack Missile) fulfills the requirement of an OTH weapon for surface warfare.

Naval Simulation System (NSS) emerged as the promising M&S (Modeling & Simulation) tool for assessing the results of the Phase II study and was used for the Phase III study as well.

OBJECTIVES and TASKING

Objectives

The overall objective of the SUW Phase III Study was to evaluate the BLUE Surface Force for force protection and self defense and describe the operational capabilities required for the SUW family-of-systems. Note that "force protection" was added as a possible mission to investigate.

Tasking

Tasking was provided by the Navy N86 Sponsor in a letter dated 20 January 2006 which in summary requires this study to;

- Examine the evolving SUW threat (including asymmetric) and the Navy's surface warfare capability, both offensive and defensive, to cope with that threat in the 2012 time frame
- Evaluate threats in confined waterways, choke points, and harbors
- Address operational concepts, gaps, deficiencies, and capabilities required for future surface force and self-defense protection systems
- Pay particular emphasis to preventing saturation of ship's force protection systems
- Consider both organic and non-organic assets employed by the surface force
- Recommend areas that need improvement and a quantifiable set of requirements
- Submit recommendations in February 2007

Additional guidance was conveyed by the sponsor in a Terms of Reference letter of 2 February 2006. In summary:

- Use the NSS as the M&S tool
- Provide inputs to the NSS that need improvement and updating
- Conduct liaison with supporting agencies provided by N86

- Consider as a framework to the asymmetric threat of the GWOT three conditions: (1) pre-attack (e.g., readiness), (2) MOOTW (Military Operations Other Than War; e.g., situational awareness) and (3) attack (e.g., rapid response to rocket, artillery, and mortar)
- Address the TACSITs offered: ships in transit, in the littoral, and in harbor/port or at anchor.
- Provide the Navy protection options for the TACSITs assessed

BACKGROUND

Study Team Participants

NDIA established a study team organization of experts in the field of surface warfare. Figure 2 shows the extent of involvement from government and industry.

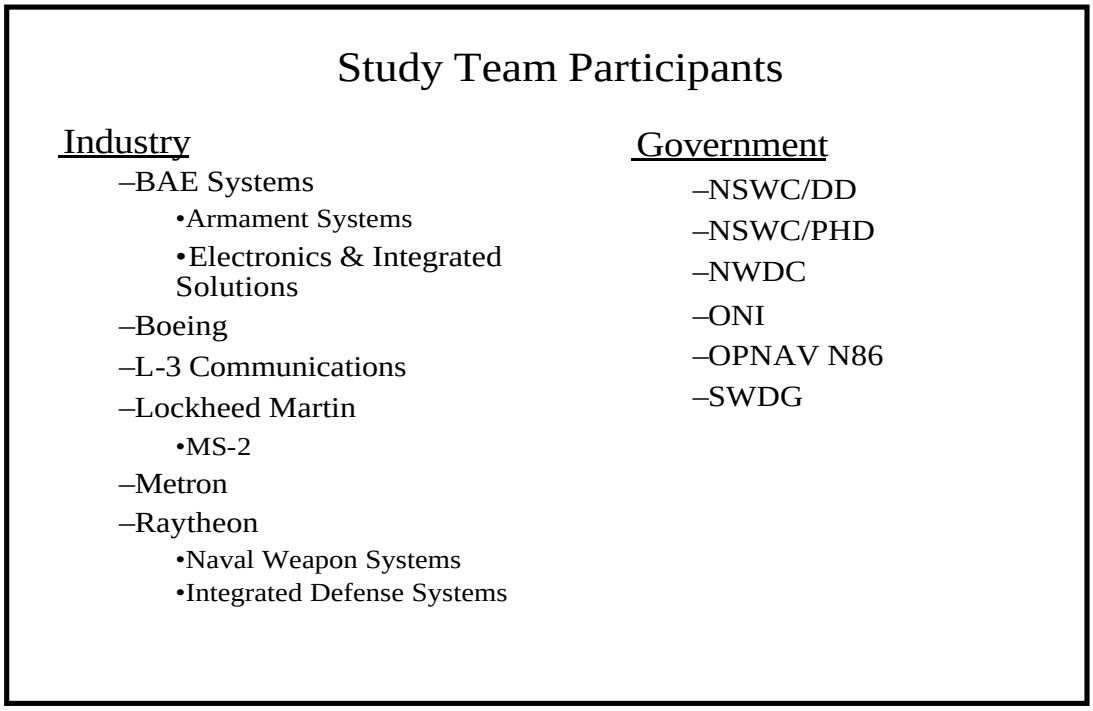

Figure 2: SUW Phase III Study Participants

Study Team Organization

Figure 3 shows how the study team was structured and identifies the team leaders. The study tasks were divided into three functional groups: (1) systems engineering group that developed the database for input into the NSS (Naval Simulation System); (2) systems assessment group that developed the TACSITs (Tactical Situations), ran the NSS, and together with the other group assured that the NSS results were consistent and credible; and (3) the study reporting group that collected the written inputs from the two groups, and collated and edited them to produce the final report.

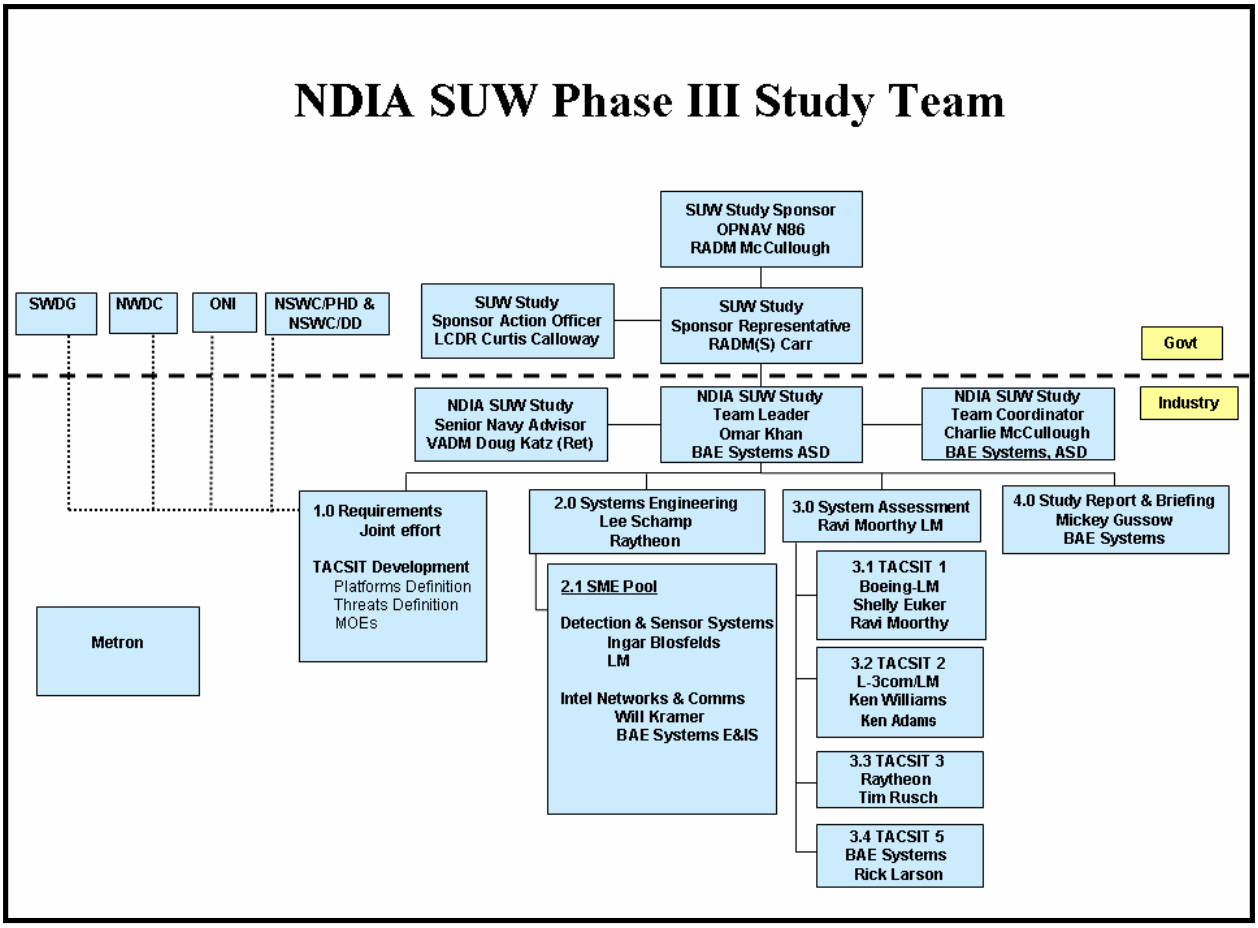

Figure 3: SUW Phase III Study Team Organization

Naval activities of SWDG (Surface Warfare Development Group), NWDC (Naval Warfare Development Group), ONI (Office of Naval Intelligence), NSWC/PHD (Naval Surface Warfare Center/Port Hueneme Division), and NSWC /DD (Naval Surface Warfare Center/ Dahlgren Division) provided essential data, expertise, and guidance throughout the study. Contractor Metron is the developer of NSS.

Study Schedule

Figure 4 shows the schedule of events for 2006 and 2007. The critical milestone to brief the N86 sponsor in February 2007 was met.

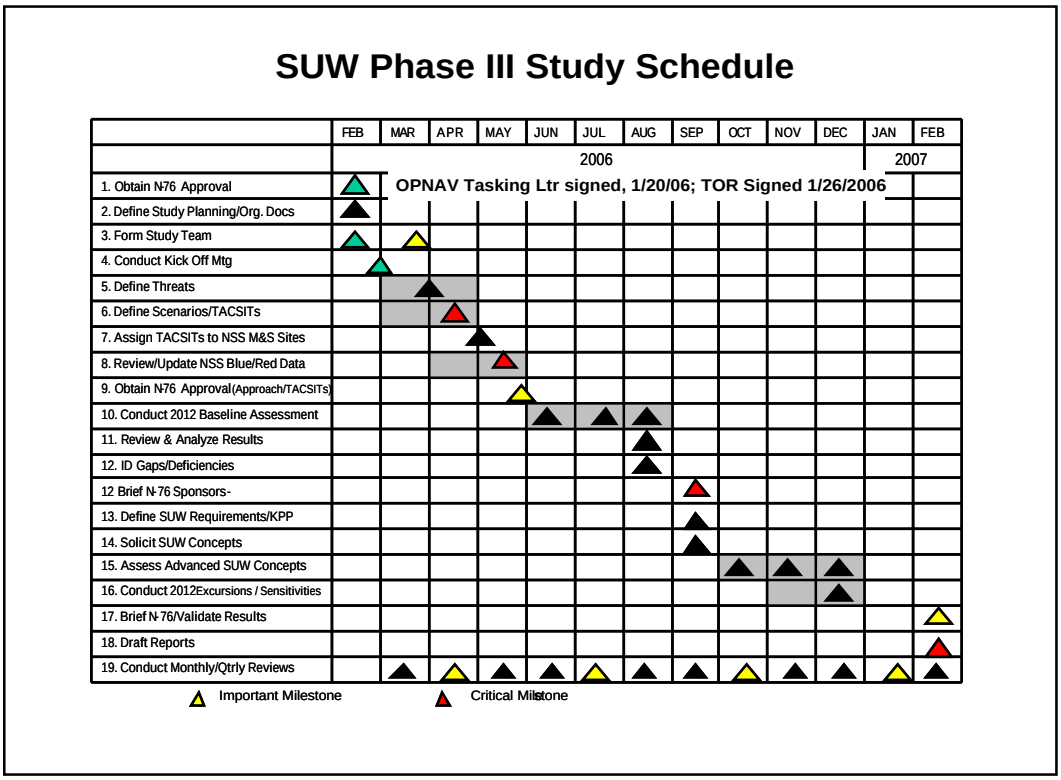

Figure 4: Schedule for SUW Phase III Study

TACSIT DEVELOPMENT

TACSIT Presentation

Four classified TACSITs or detailed scenarios were developed with excursions for each. Figure 5 identifies the TACSITs and excursions, and the industry team members responsible for their analysis. In order to get the Fleet perspective on the TACSITs, they were first reviewed by the OPNAV N86 staff, and then revised in meetings with SWDG, NWDC, and ONI before being approved and released for implementation by the SUW study team. The TACSITs were situated in the year 2012 in a region of interest to US Naval Forces.

TACSIT Descriptions and Excursions

TACSIT	Team	Description	Excursions
1	Boeing/ Lockheed Martin	In-port Threat Scenario	• Included additional host nation asset
2	L-3 Com/ Lockheed Martin	Protection of High Value Asset	• Added PAM to LCS • Added 2nd LCS with / without PAM • Modified loadouts on LCS and one loadout on LHD/DDG • Repositioned LCS
3/4*	Raytheon	Chokepoint Transit at Night	• Added PAM to LCS • Change PAM Sensitivity
5	BAE Systems	Opposed Mine Clearance Operations	• Replaced one LCS MIW with LCS SUW (with PAM)

* TACSITs 3 & 4 were combined for reasons of similarity

Figure 5: TACSIT Description and Excursions

The format for presentation included:

- Summary quad chart showing objective, baseline force (BLUE/RED), map of area, assessment results, and capability gaps
- Story line
- Assumptions
- BLUE/RED force lay down
- Scenario timeline
- Metrics or MOEs
- Baseline performance/results
- Excursions (with format similar to that of baseline)
- Capability gaps
- Conclusions
- Recommendations

TACSIT Implementation Process

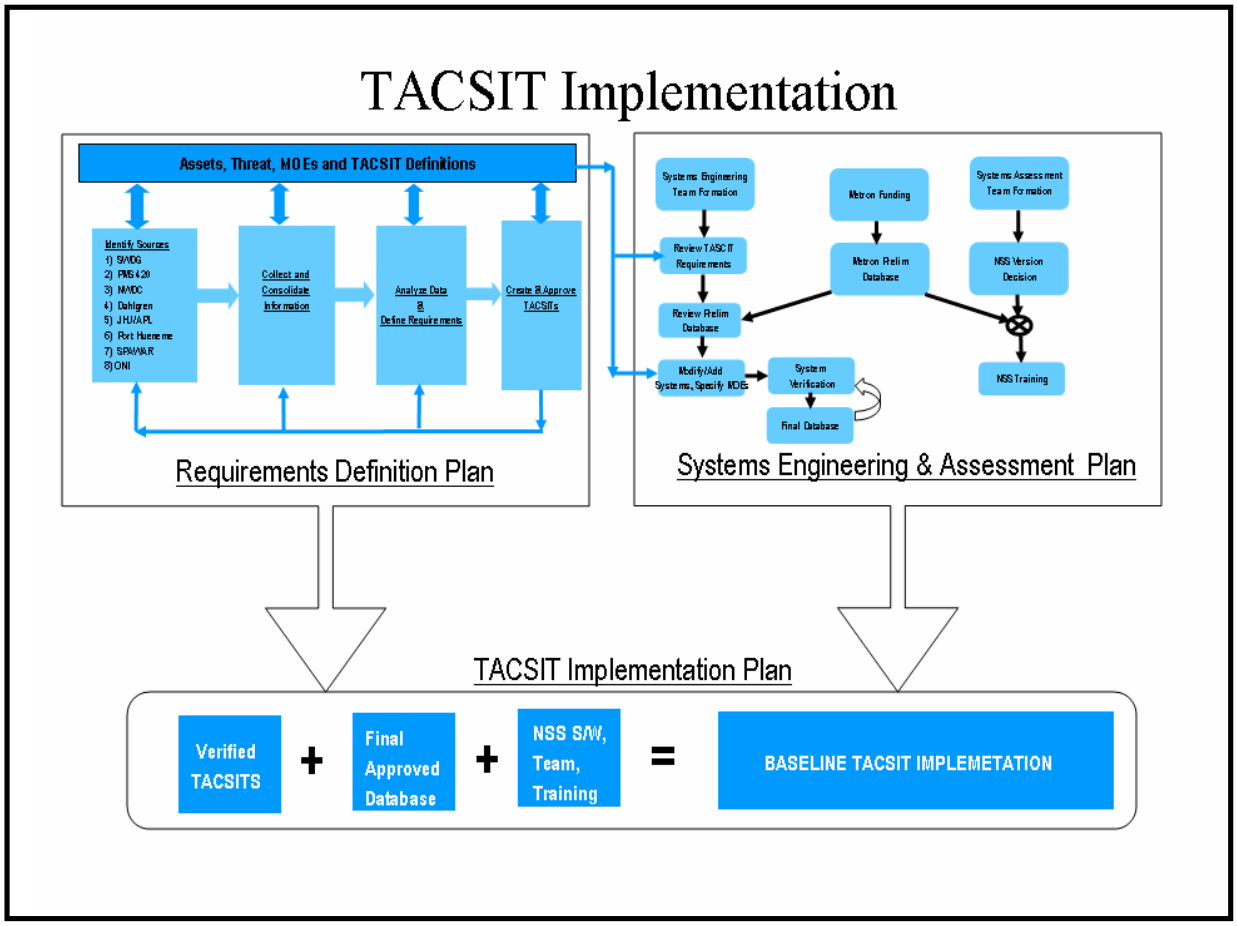

Figure 6: TACSIT Implementation Process

Figure 6 is a block diagram representing the TACSIT Implementation process. TACSITs were implemented by the interaction and convergence of three plans: requirements definition plan, systems engineering and assessment plan, and the TACSIT implementation plan.

Defining requirements and developing tactical situations is a parallel process in which information is mutually fed and refined between the requirements and the TACSIT process. The process itself consists of four steps with feedback loops. The first step for generating requirements is to identify the sources of information. The second step is to collect and collate the information. The third step, based on the information provided, is to analyze the data and define the requirements, that is, to identify the BLUE/RED assets that will have a role in the TACSITs, project the threat to 2012, denote the MOEs for assessment, and define the scenarios. The fourth step is to create and approve the TACSITs and have them reviewed often as the study progressed.

Once the BLUE/RED assets are identified, the basic task of the systems engineering group is to provide a reliable database as inputs to the NSS. To expedite the process, a series of comprehensive spreadsheets were generated showing:

- Different configurations of BLUE ship/air platforms and for each its specific equipment or system arrayed under the categories of detect, control, communications, engage, and excursions from the baseline systems
- Expected engagement range for BLUE weapons vs. RED platforms
- Expected detection range for BLUE sensors vs. RED platforms

Many sessions were held to assure that the database was accurate. The task of the systems assessment group was to assure that the results from the running of the NSS for the series of TACSITs were credible.

The combined efforts of SWDG, Metron, the Systems Engineering group and the Systems Assessment group were sought to review and validate the TACSITS, create the database and implement the baseline TACSITs and their excursions. The TACSIT implementation process was highly disciplined to endure credibility of results.

Study Assumptions

To define the boundary conditions, a set of assumptions was formulated by the SUW team and approved by the Navy sponsor. Figure 7 enumerates the assumptions.

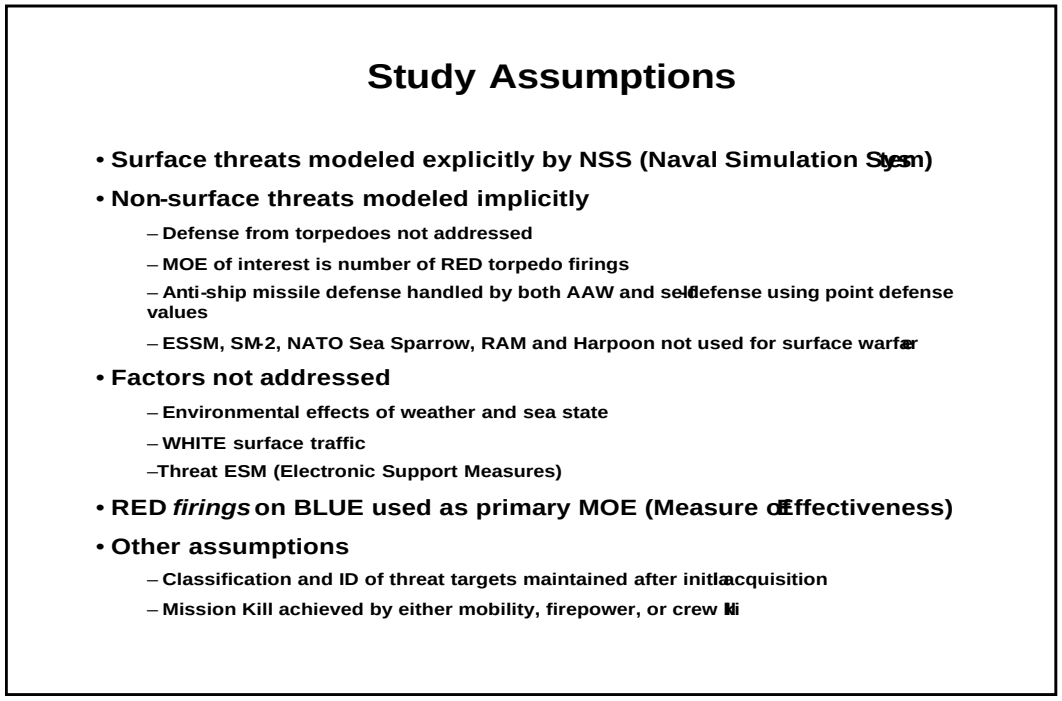

Figure 7: Study Assumptions

Surface threats were simulated within NSS -- a tool that had proved its reliability in the previous phase of the SUW study. Interest in torpedo firings was restricted to the number of firing opportunities that RED torpedo boats had on BLUE ships, thus highlighting BLUE surface force vulnerability to torpedo attacks.

NSS was not used to simulate AAW engagements. Weapons such as ESSM (Evolved Sea Sparrow Missile), SM-2 (Standard Missile Type 2), and RAM (Rolling Airframe Missile) were not explicitly played against ASCM (Anti-Ship Cruise Missile) threats. Rather, the combined effect of the AAW systems was aggregated into a single value for each threat type. NSS then determined if an ASCM was able to reach the target and defeat the point defenses. Harpoon was not used because RED boat targets were too small to be detected by Harpoon. Inadequate time and resources precluded assessing the effects of weather, sea state, threat ESM, and of the presence of WHITE surface traffic.

The parameter of RED *firings* on BLUE was used as a measure of effectiveness (MOE) instead of *kills* by RED, due to the uncertainty of the lethality of RED weapons and the lack of survivability data on BLUE ships.

DATABASE ASSURANCE for NSS

Assuring the credibility and consistency of the database for the NSS was a significant time-consuming effort for the SUW team. This section on Database Assurance is covered in some detail as a guide for analysts who will use NSS as their M&S tool for future studies.

Database Management

NSS Capabilities and Limitations

NSS is a powerful simulation tool with broad capabilities to analyze naval warfare. It is a force-on-force simulation that requires comprehensive training and experience to use correctly. The range of experience of the Phase III study team analysts varied from extensive prior use to new users. The more experienced users provided oversight and ready assistance to new analysts. Metron, as the NSS developer, was instrumental in solving problems encountered in TACSIT implementation, developing work-arounds for issues that were not immediately resolvable, and entering new data into the database for BLUE and RED systems added since the Phase II study.

As is common in force-on-force simulations, NSS must make many simplifications to sensor and weapons in order to limit the run-time for a complex scenario. Designers of the simulation selected methods to capture the first-order performance of systems in limited fidelity. Some higher fidelity options in NSS were not exploited in the study

either because it was judged to be unnecessary or the use would require more inputs and time than were available in the study schedule.
Following are examples of limits in fidelity that affect results but are common in these large simulations:

- The sensors aboard each platform are 100% fused in our TACSITs, creating an environment that is desired in the future, but perhaps not fully obtainable.
- RF sensors are able to track each object within firm track range without regard for antenna beam-width that could result in several closely-spaced objects being tracked as a single object.
- RF sensors use the free space radar equation to calculate detection range so there are no low altitude issues of multi-path, anomalous propagation (e.g., ducting, fades), and glint related to surface targets.
- Missiles are represented as constant velocity rounds.
- NSS does not model explicit weather conditions that could degrade performance, like sea state, fog, rain, or sand storms.
- Assured communications between assets—every message sent is received with no latency.

Time and Resources Required

The most time-consuming aspects of using a tool like NSS are (1) attempting to verify that database values are correct (i.e. generating correct results), (2) finding needed information for new systems not currently in the database, and (3) setting up BLUE and RED tactics to make assets behave and respond as the analyst thinks they should. For example, in the case of TACSIT 3 in this study, the analyst worked full time for about 4 months to get the essential elements playing as desired.

Database Review and Update

Diligent efforts by many study members helped update and improve the accuracy of the database to give useful results in our SUW scenarios. Despite that, it would not be proper to call the database "verified" or "validated." Such an objective would be an enormous task in itself and was well beyond the scope of the limited resources and schedule for the study. There were some questions raised that were never fully resolved and data requested that was only partially filled, so in those cases the only means to complete the study was to make assumptions and move ahead.

Difficulties of Configuration Control

Database configuration control is another area where time forces an approach that is not ideal. All analysts were provided a common database, updated by Metron in 2006. After that, changes to the database were incorporated by individual analysts at each industry site because there was not time to wait for a new common database to be generated and sent out. As a result, each analyst made changes to his/her database where needed for his/her TACSIT and as new platform and system performance data from Subject Matter Experts became available. Numerous interim reviews were held by the study team. One of the objectives was to identify places where assumptions and input data diverged

between the various TACSITs. At the completion of the study, the database files from each site were compiled into one common disk for redistribution to each analyst, so that each analyst could re-create a result if needed.

Systems Engineering and Assessment Effort

Systems engineering and assessment functions include:

1. Assure that the NSS analysts have the necessary inputs for the NSS simulation to implement and analyze the TACSITs provided by the customer.
2. Identify each of the RED and BLUE assets from the TACSITs and further define the system elements that could contribute to the detection, control, and engagement of the threats, and the communications links available.
3. Identify performance data for systems that were not in the NSS database from the Phase II study; identify potential sources of that data; and request support to fill in the missing data.
4. Identify additional sensors and weapons that might be available after 2012 that would deal with any gaps in the baseline equipment.
5. Create TACSITs covering subject areas as specified in the section on TACSIT Implementation Process.
6. Generate a timeline of the engagement process from the time a target enters the scenario until it is killed or the scenario ends; this was used as a check to verify that the engagements later occurring in NSS had appropriate steps and delays.
7. Gather from available Subject Matter Experts, available to the study team, the expected top-level performance of the BLUE systems so that when the first NSS runs were reviewed, a "sanity check" could be done of the results.
8. Gather and review the available real-world test reports from SUW tests and pull top-level performance from sensors and weapons; this serves as the current performance; review by study team helped adjust NSS inputs to reflect reality, with some allowance for expected fixes and improvements to the systems, if known.
9. Review the results generated by analysts to assure results were consistent with the best information available to the study team.

STUDY CONCLUSIONS and RECOMMENDATIONS

Detailed study conclusions and recommendations derived essentially from the analysis of each of the TACSITs can only be summarized generically in this unclassified Executive Summary Report. The performance of the LCS (Littoral Combat Ship) played a major role in selected TACSITs.

Conclusions

- Addition of NLOS/PAM or other similar shipboard systems in the LCS SUW Module would significantly improve self-defense and force protection capabilities.
    - (Navy PAM has a 178-mm diameter (7”), a 40-km (21.6 nm) maximum range requirement, and multiple seeker modes to provide target acquisition.)
    - (LCS core weapons permanently installed on all LCS's include: Mk-49 RAM launcher or Sea RAM, 57-mm naval gun system, and a 50-cal machine gun. SUW Mission Module adds 2 30-mm guns and NLOS/PAM.)
- SUW LCS can perform a tactical role as a component of a SAG (Surface Action Group) or as escort to MIW (Mine Warfare) LCS.
- BLUE layered defense for surface warfare against RED mass boat attack proved effective.
- Coordination of BLUE surface and air assets against RED surface threat is a requirement for surface warfare.
- Rounds were wasted due to lack of target engagement coordination.

Recommendations

- Accelerate NLOS/PAM or other similar shipboard capability in LCS as a component in its SUW Module.
- Investigate the feasibility of installing NLOS/PAM or a similar capability on major combatants.
- Add SUW LCS, one or more than one, with or without NLOS/PAM, as a tactical component in a force protection group or as escort to MIW LCS.
- Explore all options to improve protection of BLUE ships in host nation ports.
- Continue to use the tactical principle of layered defense for surface warfare.
- Exploit coordination of surface and air assets for surface warfare defense.

- Integrate weapon and sensor systems to improve coordination and reduce reaction time.

- Explore other firing doctrines to increase the number of firing opportunities.

Other SUW Phase III Documents

The detailed descriptions of each TACSIT and the assessment results, conclusions, and recommendations from each TACSIT are documented in the Classified NDIA SUW Phase III Study, dated May 2007. Interested parties should contact the OPNAV POC LCDR Curtis Calloway at telephone no. (703) 604-7653, email address curtis.calloway@navy.mil.

In addition to the Classified Study Report, appendices were produced and delivered to OPNAV N86 containing the compressed database for each TACSIT. The compressed databases contain the TACSITs that were created, analyzed, and reported by the SUW study team.

APPENDIX

Glossary of Terms

ASCM	Anti-Ship Cruise Missile
ESM	Electronic Support Measures
ESSM	Evolved Sea Sparrow Missile
GWOT	Global War on Terrorism
LCS	Littoral Combat Ship
M&S	Model & Simulation
MCGS	Minor Caliber Gun System
MIW	Mine Warfare
MOE	Measure of Effectiveness
MOOTW	Military Operations Other Than War
NDIA	National Defense Industrial Association
NLOS/PAM	Non-Line-of-Sight/Precision Attack Missile
NSS	Naval Simulation System
NSWC/DD	Naval Surface Warfare Center/Dahlgren Division
NSWC/PHD	Naval Surface Warfare Center/Port Hueneme Division
NWDC	Naval Warfare Development Center
ONI	Office of Naval Intelligence
OPNAV	Office of the Chief of Naval Operations
RAM	Rolling Airframe Missile

SAG	Surface Action Group
SLAAD	Strike, Land Attack and Air Defense
SM-2	Surface Missile Type 2
SME	Subject Matter Expert
SUW	Surface Warfare
SWDG	Surface Warfare Development Group
TACSIT	Tactical Situation