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

Surface Warfare (SUW) Study

Executive Summary

Prepared for

OPNAV N76
Surface Warfare Directorate

Contract: NSIA/Navy Agreement (NDIA)

Date: 29 April 2005

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1 Overview/Background

This paper serves as an unclassified, executive summary of the results of Phase II of the Surface Warfare (SUW) Study, first requested by OPNAV N76 in May of 1999. Phase I of this study was successfully concluded early in 2002 and was focused on evaluating a single BLUE ship's capability for self-defense against multiple RED small boats. In March of 2002, OPNAV N76 requested that NDIA (National Defense Industrial Association) conduct a second phase to the SUW Study. Phase II was to be focused primarily on BLUE capabilities and deficiencies in Theater force-on-force surface engagements. The objective of the study was to view the SUW mission area as an interactive family of systems, and to consider both Organic and non-Organic systems in the BLUE surface Force. To accomplish the objective, multiple scenarios, with many scenarios featuring a multi-threat environment, were to be developed and modeled. The inputs to the model were to be analyzed by the industry participants and government organizations to provide the most accurate picture of BLUE surface warfare capabilities for the years 2009, 2014, and 2020. The models would then run multiple times to develop statistically valid results, which could then be used to identify capabilities and deficiencies for each TACSIT (Tactical Situation). The results would then be compared to make general recommendations in the area of surface warfare. The time frame for the analysis was scaled back to only the 2009 time frame (excluded 2014 and 2020 time frame) early in 2004, with the Sponsor's approval, due to the complexity of the analysis and the unavailability of data for the out years.

NDIA established a Study Team Organization that included experts in the field of SUW to address this request. Figure 1 shows the extent of involvement from government and industry. Over 95 organizations were initially involved with Phase II, although 12 core entities ultimately performed the bulk of the study effort. Figure 2 shows how the study team was structured to deal with the various phases of the study.

Figure 1: SUW Study Team Participants

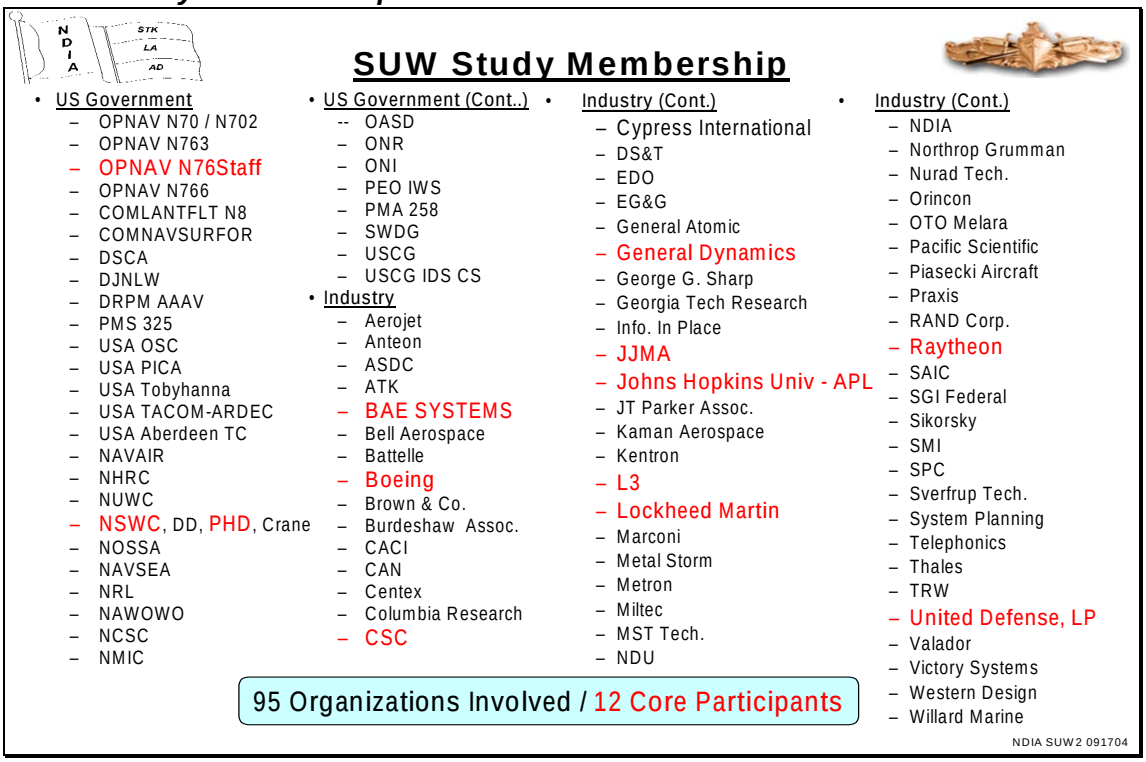
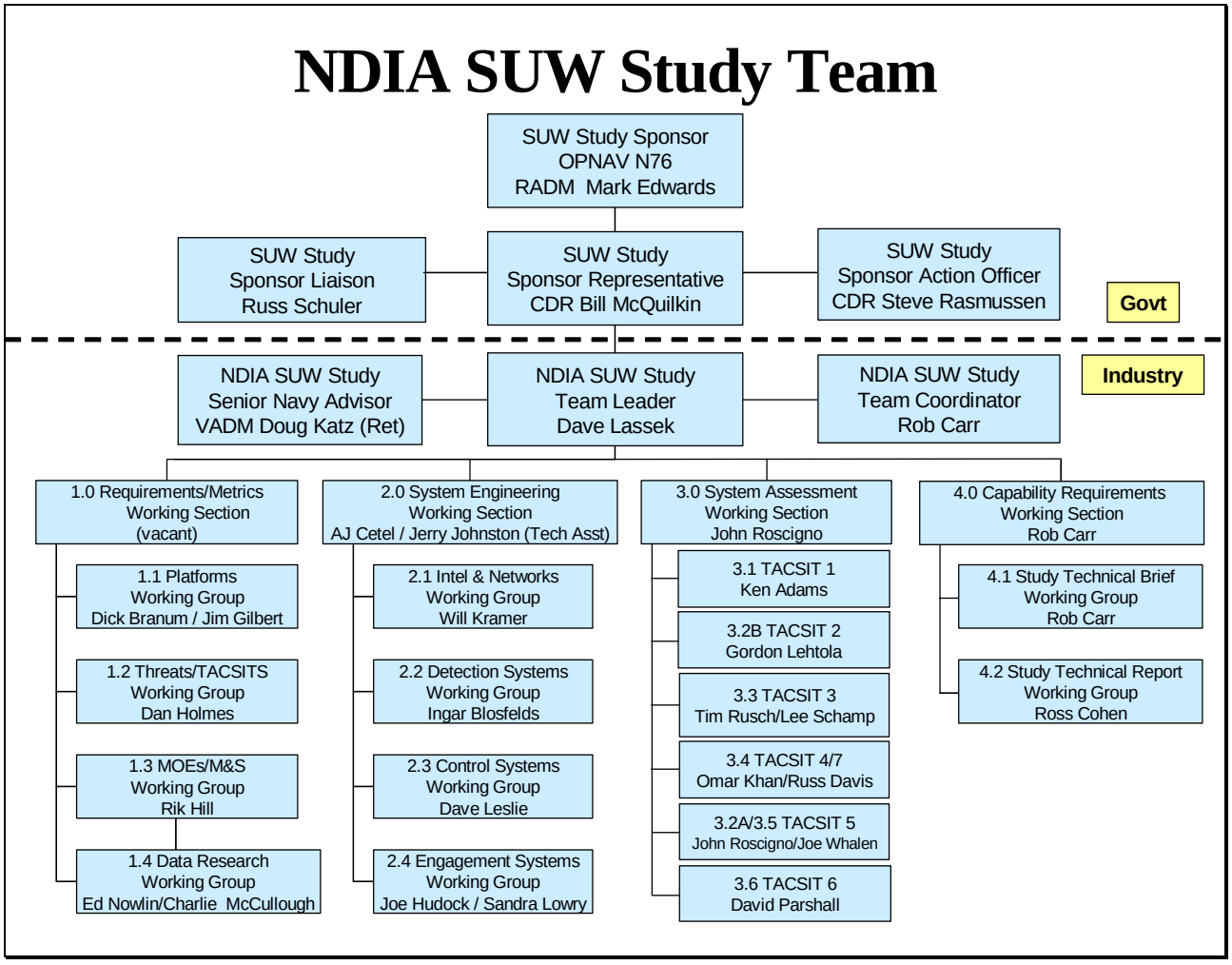


Figure 2: SUW Phase II Study Organization



2 Study Development

2.1 Assumptions/Boundary Conditions

Once a team structure was defined, the boundary conditions on this phase of the SUW study were solidified. A set of preliminary assumptions were formulated by the team and baselined in the fall of 2002. In January 2004, these assumptions were revisited and updated, and submitted to the Sponsor for approval in April 2004. Figure 3 shows the assumptions that were originally baselined in 2002 compared to the final assumptions, which were approved in April 2004. Additional modification of the Phase II assumptions occurred as CY 2004 evolved. It was directed by the Sponsor that no ICD (Initial Capabilities Document), CDD (Capability

Development Document), as required by the Joint Capabilities Integration and Development System (JCIDS), or CRD (Capstone Requirements Document) development would occur as part of this study effort. In addition, it was decided that any analysis for the year 2020 would be completed in a subsequent phase, when updated TACSITs as well as updates to RED and BLUE data in the NSS (Naval Simulation System) database would be available.

Figure 3: SUW Phase II Study Assumptions

No	Assumptions (SEP02)	Revised Assumptions (APR04)
1	SUW study team will support N76 SUW CRD development	SUW study team will support Sponsor SUW JCIDS ICD / CDD or CRD development
2	All US Theater SUW Capable Forces Will Be Included in Analysis	No revisions
3	JP1-02 SUW Definition Requires Reinterpretation for Littorals	
	A. Study to include all waterborne surface threats, including swimmers	A. No revisions
	B. Study to include coastal land-based threats as counter-battery mission	B. No revisions
	C. Study will not include airborne threats as they are TAMD mission	C. No revisions
	D. Study will not include undersea threats as they are USW mission	D. No revisions
	E. Study will not include threats to ships at anchor or in port as they are AT / FP mission	E. Force Protection is part of Sea Shield and is now included in study
4	Study will work with ONI & DIA to document the SUW threats	No revisions
5	Study TACSITs will be based on OPNAV PR05 MCP data through 2020. N76 approved	Study to develop new TACSITs based on PR05-07 MCP data for 2009 and 2020 timeframes.
6	Study team will select M&S tool based on community input and obtain N76 approval	No revisions, Sponsor approved NSS as M&S tool
7	Study participants will be recruited from qualified US govt. / industry organizations	No revisions
8	The SUW CRD material will be consistent with other relevant DOD & DON documents	Study will follow new JCIDS ICD / CDD documentation process
9	Probability of Mission Success is the primary MOE, supporting MOEs will be derived from DOD studies	No revisions
10	Current and planned SUW capabilities in all US forces will be addressed.	No revisions

Note: Modeling tools did not provide for analysis relating to swimmers, therefore in the final analysis, swimmers were not included (ref. Assumption 3A)

No	Assumptions (SEP02)	Revised Assumptions (APR04)
11	Analysis to prevent BLUE-on-BLUE & collateral damage will be attempted	No revisions
12	SUW engagements boundaries are threat weapon range plus minimum keep out range	No revisions
13	Study will not conduct any cost analysis	No revisions
14	System capabilities, improvements, & emerging technologies will be addressed for three timeframes	System capabilities, improvements, & emerging technologies will be addressed for two timeframes
	A. Near Term: 2003 – 2009	A. Near Term: 2009
	B. Mid Term: 2010 – 2015	B. Mid Tern: None
	C. Long Term: 2016 - 2020	C. Far Term: 2020
15		Study will address SUW mission from Sea Shield perspective
16		Study priority is detail analytical accuracy, defendable within the OPNAV review process
17		Study will not address political factors and begin all operations with ROE of weapons free given threat identification & intent
18		Study will address MATERIAL and DOCTRINE solutions only from DOTMLPF prospective

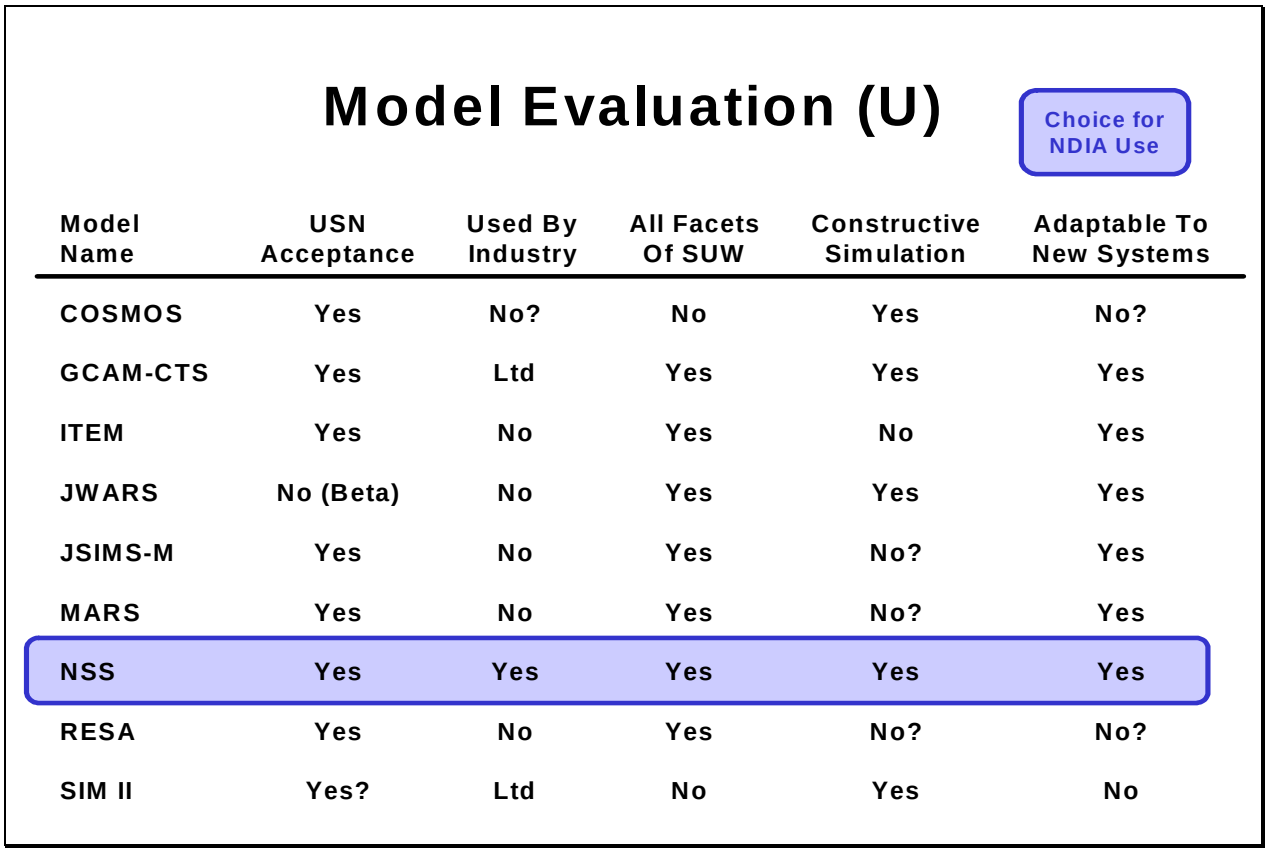
Note: Model chosen (NSS) did not consider BLUE-on-BLUE collateral damage prevention analysis. (ref. Assumption 11)
Only Near Term timeframes completed in this phase of the study (ref. Assumption 14)

An overriding assumption was that the study was to address the entire Surface Warfare Mission Area, but should ignore the AAW (Anti-Air Warfare) and ASW (Anti-Submarine Warfare) threats. All SUW threats to BLUE surface platforms were to be modeled, including RED surface combatants and small craft, slow, and low-flying aircraft. Air superiority was assumed for the BLUE Forces. Underwater and land based systems were included only as they affected the Surface Warfare theater. All BLUE surface platforms, missile and gun systems, aircraft (both manned and unmanned), sensor systems, space assets, munitions, and undersea systems, subject to the previous constraints, were to be included. These assumptions drove decisions on model selection, the database, and the methodology for the study effort.

2.2 SIMULATION TOOL

As the analysis would be conducted through simulation of actual theater level engagements in each of the identified TACSITs, an appropriate modeling tool was required. The study group identified the criteria with which to conduct a trade-off between the several different Modeling and Simulation (M&S) tools that have been used by the US military for various analyses in the past. Figure 4 shows the various M&S tools considered and the high level criteria that were used for evaluation.

Figure 4: Candidate Models and Evaluation Criteria



Model Evaluation (U)

Choice for NDIA Use

Model Name	USN Acceptance	Used By Industry	All Facets Of SUW	Constructive Simulation	Adaptable To New Systems
COSMOS	Yes	No?	No	Yes	No?
GCAM-CTS	Yes	Ltd	Yes	Yes	Yes
ITEM	Yes	No	Yes	No	Yes
JWARS	No (Beta)	No	Yes	Yes	Yes
JSIMS-M	Yes	No	Yes	No?	Yes
MARS	Yes	No	Yes	No?	Yes
NSS	Yes	Yes	Yes	Yes	Yes
RESA	Yes	No	Yes	No?	No?
SIM II	Yes?	Ltd	No	Yes	No

Question mark signifies attribute not fully known / investigated.

As can be seen from Figure 4, the NSS (Naval Simulation System) was the only M&S tool that satisfied all the evaluation criteria established by the SUW Study group. Metron, Incorporated, located in San Diego, California, under NAVAIR Contract No. N00039-01-D-2202, supports the NSS Model. NSS is one of the Navy's Course of Action (COA) tools that has been used extensively over the past few years in multi-warfare and C4I (Command, Control, Communications, Computers, & Intelligence) simulations. It provides capability to extract detailed information at the system/subsystem level from a theater level simulation, and was in widespread use among the companies enrolled in the SUW Phase II Study.

Once the recommended model for the study was approved by the Sponsor, the companies that volunteered to perform the analyses ensured that they each procured or updated to a common version of the software, so that a common version of the database could be employed at all simulation sites. Each company was responsible for training their analysts on the tool. In addition, during the first week of June 2004, the entire System Assessment team for the SUW Study completed a joint training exercise at Metron in preparation for modeling the SUW TACSITs.

2.3 DATABASE DEVELOPMENT

The NSS model employs a classified database, which was used to support all the TACSIT analysis efforts for the SUW Phase II Study. The classified database includes detailed data for all current USN surface, subsurface and airborne platforms, and the weapon systems employed

on each platform. Source information regarding system characteristics for each item included in the database is provided in the NSS Database. The characteristics and performance data for the RED platforms and systems in the classified database have been used in numerous studies conducted by the US military. No modifications were made to the RED elements of the database except those required to add missing platforms and/or systems specifically required to support the TACSITs. Previous US Classified studies that have employed the NSS Model using this classified database include, CPF N64 OPLAN Analysis, Global Wargame '99,'00, and '01,AF GMTI AoA (AF SMC), NAVAIR's MMA Analysis, POM-06 FORCEnet Assessment (N81/N70), PR-07 Campaign Analysis (N81/N70) and the Network Centric Warfare Study.

The BLUE elements of this database were thoroughly reviewed by the subject matter experts of the industry partners in this Study to verify the accuracy of the data contained in the database and the validity of the data for the 2009 timeframe. The BLUE database used by Johns Hopkins University / Applied Physics Lab (JHU/APL) for its MCP (Mission Capability Package) Analysis was compared to the BLUE SUW database contained in NSS and found to be consistent. Figure 5 shows a number of the specific systems that were common to and addressed in both studies, and weapon systems that were unique to each.

The SUW Study Group added an LCS (Littoral Combat Ship) platform to the database, whose characteristics were supplied by the Navy. The overall study approach taken for the SUW Study Phase II effort was consistent with previous studies commissioned by N76. Figure 6 illustrates the parallel and comparable elements of both this study and the MCP Study undertaken by JHU/APL.

Figure 5: Common and Unique Systems used in MCP and NDIA Phase II Studies

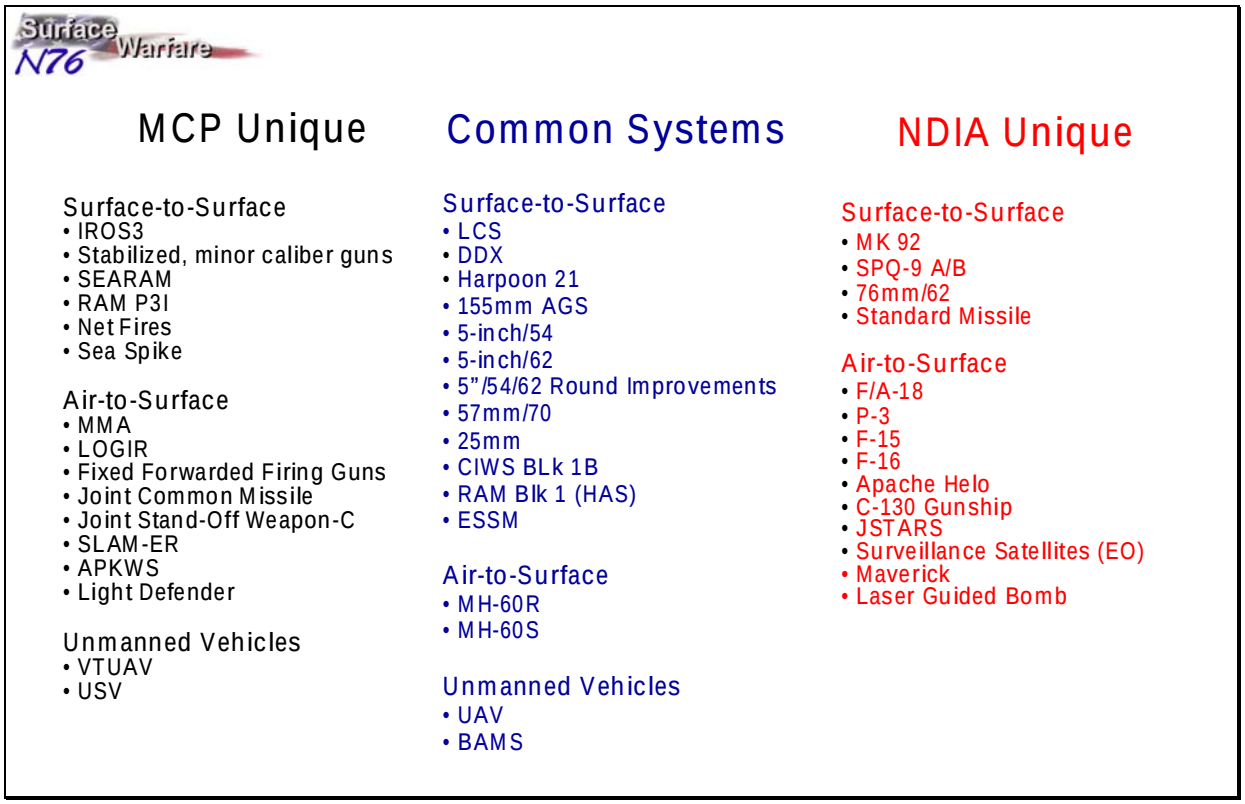
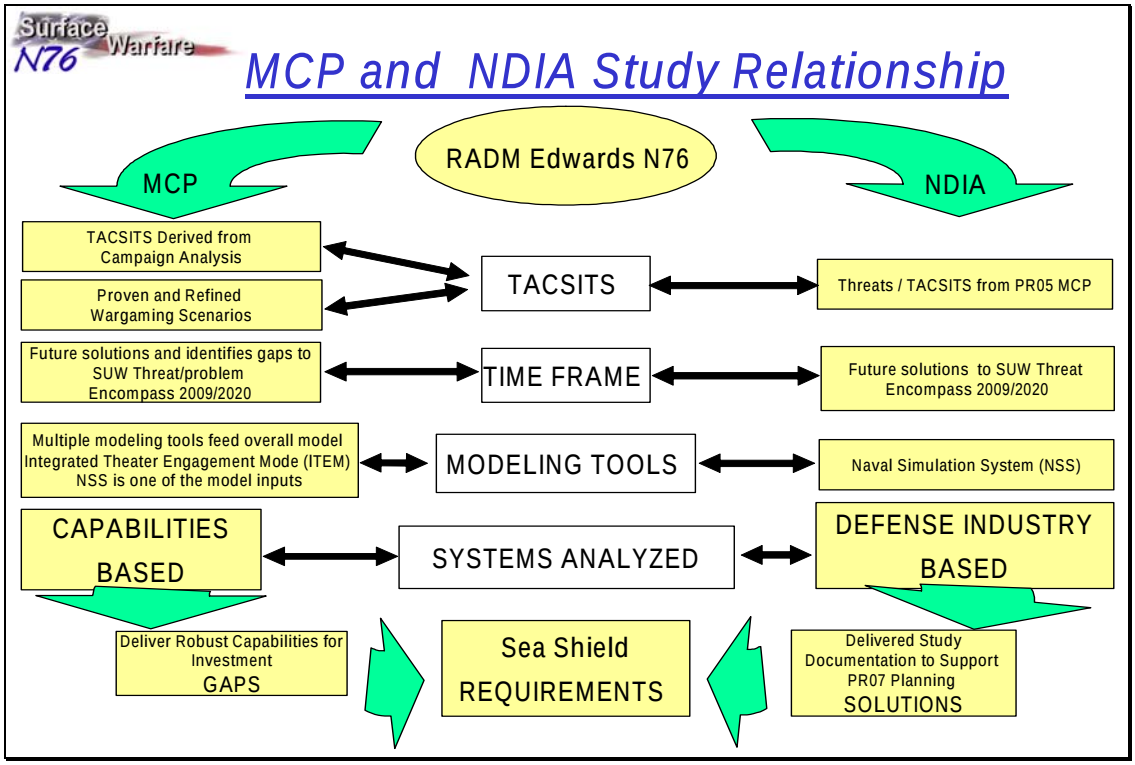


Figure 6*: SUW Study Phase II Comparison with MCP Study*



2.4 TACSITs

Classified Tactical Situations (TACSITs) or detailed scenarios were derived from MCP 2005 data. In order to get the Fleet perspective on the TACSITs, they were first reviewed with the OPNAV N76 staff, and then revised in meetings with Norfolk Fleet commands, including representatives from SWDG (Surface Warfare Development Group), SURFLANT (Surface Forces Atlantic), CARGRU 8 (Carrier Group Eight), and the 2nd Fleet, before being approved and released for execution by each of the NSS modeling sites. The TACSITs were situated in the year 2009 in one of two areas, identified here as either WESTPAC (W) or MIDEAST (E), the specific geographic locations being classified. Originally, Phase II included six TACSITs, but as a result of continuous dialogue with the Navy, the list grew to a total of 11 TACSITs, shown in Figure 7, of which six occur in the MIDEAST, four occur at WESTPAC, and one is independent of the location. As the details of the TACSITs themselves are classified, only the title, generic geographic location and the company performing the actual model development and simulation are identified.

Figure 7*: SUW Study Phase II TACSITs*

SUW Study TACSIT Analysis

TACSIT	AOR	Description	Company	Status Green Complete, Red Deleted
1A	E	Multiple Red Small Boats // Blue Surface Combatants and MCM	LM	Complete
1B	E	Multiple Red Large Boats // Blue Surface Combatants and MCM	LM	Similar to TACSIT 1A – Less Tgts – Sim Ranges
2A	W	Multiple Red PTGF Boats // Blue Surface Combatant	L-3	Similar to TACSIT 2B/4
2B	W	Red SAG // Blue SAG	Boeing	Complete
3A	E	Red Patrol Craft, Small Boats Large Raid // Blue Surface Combatants	Raytheon	Similar to TACSIT 1A
3B	E	Red FACs, Corvettes, PTGs // Blue CSG	Raytheon	Complete
4	W	Multiple Red FACs & PTGs Boats // Blue Surface Combatants	UDLP	Complete
5	W	Disabling Fire in South China Sea	L-3	No known USN Rqmt
6A	E	Multiple Red PTGFs // Blue TAOE	JJMA	Similar to TACSIT 7
6B	E	Red Shore Batteries // Counter Battery by Surface Combatant	JJMA	Complete
7	E /W	Red Small Boat // Blue TAOE at Anchor	UDLP	Complete

LM = Lockheed Martin, UDLP = United Defense, JJMA = John J. McMullen

3 STUDY EXECUTION

The 11 TACSITs identified in section 2.4 were distributed among six participants who volunteered analysts' time, and the capital expense associated with the NSS model, in order to execute the study. The six participants were:

- Lockheed Martin Maritime Systems & Sensors, in Moorestown, NJ
- Boeing Company, in St. Louis, MO
- Raytheon Missile Systems, in Tucson, AZ
- United Defense, Armament Systems Division in Fridley, MN
- L-3 Ocean Systems, in Sylmar, CA
- John J. McMullen Associates, Inc., in Alexandria, VA

The analysts from these companies worked very closely over the roughly ten months that the simulations were actually run, conducting teleconferences once a week, and meeting in person at least monthly. The six sites used either version 3.1 or 3.3 of the NSS model. It was verified by Metron that the different versions of the NSS program held by the sites would not result in different results on any given TACSIT run. The key item affecting TACSIT results was maintaining a common database between the sites, on which Metron maintained configuration management. A meeting held in Norfolk on 26 May 2004, with SWDG proved invaluable for reviewing the tactics which BLUE forces would employ in each TACSIT.

Each site employed a uniform approach in modeling and reporting on their TACSITs. Every TACSIT effort was reviewed between analysts (peer review) prior to reporting out to the study team at large. Each analyst had to document and walk through the following items for their analysis: simulation objective, summary of the TACSIT storyline, a listing of the BLUE and RED assets used in the simulation, a geographic display of the initial set-up of the simulation displaying the starting locations of all assets, any simulation specific assumptions made by the analyst, the detailed tactics employed by both the RED and BLUE forces in the simulation, and a timeline of the model, showing what time –driven events were taking place.

From Figure 7, TACSITs 1A, 2B, 3B, 4, 6B, and 7 were completed and form the basis for the recommendations made in the classified presentation. TACSIT 5 was discontinued in August as it was determined by the Sponsor that there was no known, written U.S. Navy requirement for disabling fires. TACSITs 1B, 2A, 3A, and 6A were discontinued as it was felt that no new information would be gained from completing the efforts that would not be gained from those TACSITS which actually were completed.

4 STUDY RESULTS AND RECOMMENDATIONS

Detailed study results from each of the TACSIT M&S efforts as well as the overall study findings and recommendations are classified and can only be summarized generically in this report. Copies of the detailed classified presentation packages have been provided to the Sponsor. Each NSS TACSIT site conducted their portion of the modeling effort in a consistent, structured manner and their results were thoroughly reviewed by the entire Study Team and the Sponsor. Each TACSIT site used specific MOE's (Measure of Effectiveness) and conducted a number of NSS runs to obtain their quantitative results. The results of each TACSIT were analyzed and used to identify and explain BLUE SUW capability gaps. Qualitative findings and conclusions, based on these results as well as on any interesting observations made during the simulation runs were also developed by each of the NSS sites. Generalized recommendations indicated by the completed TACSIT simulations are presented below in an unclassified manner:

- **Maintain At Least the Current SUW Weapon Capability and Quantity**
- **Maintain SSN SUW Capability Against High End Surface Threats**
- **Improve Longer Range/OTH Defense Capability to Prevent Saturation of Self Defense Systems**
- **Improve Persistent Over The Horizon (OTH) Tactical Capability for Detection, Control, Engagement and Assessment Functions (Integrated ISR)**

- **Complete Intra-ship Combat System Integration to reduce reaction time and fuse all shipboard sensor data, including own-ship Offboard assets.**
- **Develop Target / Land Discrimination Capability for OTH Surface Weapons**
- **Develop Small Precision OTH Weapon with Target Discrimination Capability to Engage Low End Surface Threats**

The detailed descriptions of each TACSIT and the results, conclusions and recommendations from each TACSIT are reported in the Classified NDIA SUW Phase II Study Report (April 2005). Interested parties should contact OPNAV N76 POC LT Mike Cole at (703)604-7661 / joseph.cole@navy.mil.

In addition to the classified Study Report, appendices were produced and delivered to OPNAV containing:

1) The Compressed Database for each TACSIT
2) Measures of Effectiveness (MOE) files for the TACSIT runs

The compressed databases contain the TACSITs that were created, analyzed and reported by the TACSIT team. The database requires NSS to run and/or view the TACSIT scenarios.

The output of the TACSIT runs are presented in the MOE files section in Microsoft Excel format. These MOE's form the basis of the results reported in the Classified NDIA SUW Phase II Study report.