Calhoun: The NPS Institutional Archive

DSpace Repository

Faculty and Researchers | Faculty and Researchers' Publications

2009-03

Team 1: Applying Automated Red Teaming in a Maritime Scenario

Han, Alan Wong Chin; Chung, Sim Wee; Lian, Chua Ching; Kiat, Lim Yeng; Chin, Shian Kang; Lijun, Carol Teo; Lampe, Thorsten; Hingston, Philip; Abbott, Ben

http://hdl.handle.net/10945/35626

This publication is a work of the U.S. Government as defined in Title 17, United States Code, Section 101. Copyright protection is not available for this work in the United States.

Downloaded from NPS Archive: Calhoun

http://www.nps.edu/library

Calhoun is the Naval Postgraduate School's public access digital repository for research materials and institutional publications created by the NPS community. Calhoun is named for Professor of Mathematics Guy K. Calhoun, NPS's first appointed -- and published -- scholarly author.

Dudley Knox Library / Naval Postgraduate School
411 Dyer Road / 1 University Circle
Monterey, California USA 93943

Team 1: Applying Automated Red Teaming in a Maritime Scenario

TEAM 1 MEMBERS

Alan Wong Chin Han, MAJ. – Lead
SAF Ops Research Office, Singapore

Sim Wee Chung, CPT. – Lead, Contact[1]
SAF Ops Research Office, Singapore

Chua Ching Lian, Mr.
DSO, Singapore

Lim Yeng Kiat, Mr.
DSTA, Singapore

Kang Shian Chin, Mr.
DSTA, Singapore

Carol Teo Lijun, Ms.
DSTA, Singapore

Thorsten Lampe, Mr.
EADS, Germany

Philip Hingston, A/P.
ECU, Australia

Ben Abbott, LT.
NPS, USA

INTRODUCTION

With shipping at the heart of the global economy, maritime security is required to ensure freedom of the seas and to facilitate freedom of navigation and commerce. Faced with an array of threats from the terrorists and criminals, nations should stand united and share in the responsibility for maintaining maritime security. In IDFW 15, our team will focus on anchorage protection and continue our works from IDFW 14.

AIM

This study aims to:

- Continue to evaluate the usefulness of Automated Red Teaming (ART)[2] in Blue Ops Planning.
- Gather feedback for development of Automated Co-Evolution (ACE) framework

BACKGROUND

Initial Scenario Set-up. In this baseline scenario, the Blue forces conducted patrols to guard against threats on anchorage. There were several commercial ships anchored in the protected area. The Red forces will attempt to penetrate the Blue defense and inflict damages on the anchored vessels, using various approaches. Any damages to the commercial shipping will deal a severe psychological blow to the Blue defense force. The initial set-up of experiment was as shown in Figure 1 below.

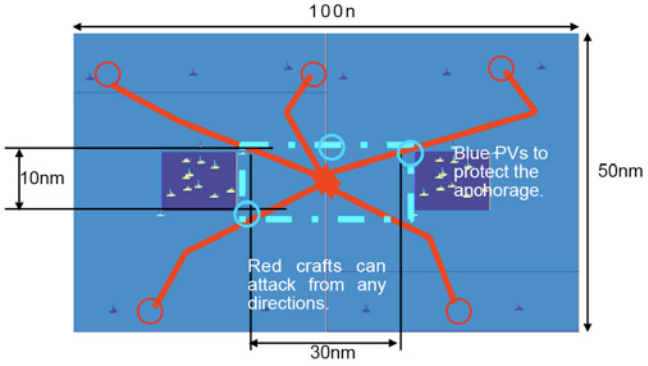

Figure 1: Baseline Blue/Red Plans

KEY ASSUMPTIONS

The following key assumptions were made for this scenario:

Area of Operations (AO). The AO was assumed to be an anchorage in open waters away from the sea lines of communications (SLOC) and main shipping traffic. As such, the neutral shipping was not modeled.

Environmental Conditions. It was assumed that the operations were conducted in dark hours with favorable weather conditions and sea state.

Communication Links. The Blue force was assumed to have full communication link and perfect IKC2. As for the Red force, it was assumed that the individual boats were operating in accordance to mission plans with full communication links.

KEY MODELING PARAMETERS

Blue Forces. The blue force consisted of three patrol vessels (PVs). The following modeling parameters were assumed.

- Patrol Vessels. Each PVs was assumed to conduct normal patrol at 8 knots and give chase at a maximum speed of 16 knots. The PVs were also assumed to be capable of neutralizing the Red boats by closing in within 2 nm. The dynamics of the close water combat was not modeled. A summary of the key specifications of the Blue PVs was as follows:

PV Speed [Patrol] (knots)	8
PV Speed [Chase] (knots)	16
PV Detection Range (nm)	6
PV Identification (ID) Range (nm)	2

Table 1: Specifications of Blue PVs

[1] For more information contact: CPT Sim Wee Chung, toonsim@yahoo.com.sg

[2] ART was developed by DSO-ORL to find an optimal solution for individual sides in a two-sided scenario, using evolutionary algorithms

- Red Forces. The Red boats were modeled as small fishing boats with a maximum speed of 16 knots and loaded with explosives. These boats were assumed to be without any onboard sensors and have a detection and identification range of 2 nm.

Maximum Speed (knots)	16
Detection/ID Range (nm)	2

Table 2: Specifications of Red Boats

- Neutral Commercial Shipping. The neutral commercial ships in the anchorage were assumed to be anchored.

MEASURE OF EFFECTIVENESS

The MOE was:

- Number of Successful Red attacks on Neutral Commercial Shipping
- Mean Red Attrition
- Mean Neutral Shipping Destroyed

METHODOLOGY

Manual Teaming

Blue vs Red. The team members were divided into 2 groups to refine both Blue and Red plans. This was meant to simulate realistic ops planning with minimum intelligence inputs. Both groups underwent several rounds of deliberations and fine-tuning before finalizing their plans. We also captured some of the interim plans to facilitate discussions for the subsequent ACE framework.

Blue Team

Enhanced Inner Patrol. The blue team decided to concentrate own forces within the anchorage area to provide a more responsive and all-round protection on the anchored shipping. A broad deployment concept for the enhanced Blue patrol plan was as shown in Figure 2 below.

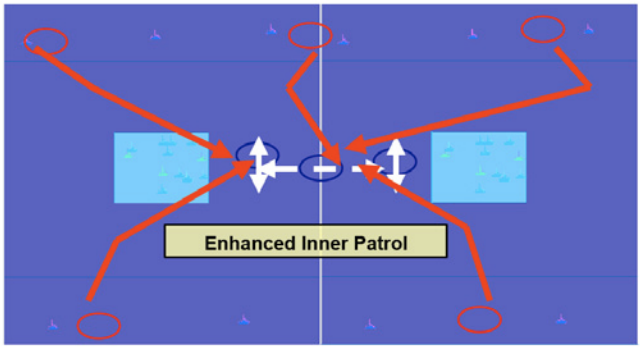

Figure 2: Manual Blue Plan

Red Team

Saturation Strategy. The red team decided to fully utilize their numerical advantage and launch a simultaneous attack on the anchorage area to saturate the Blue forces. A schematic of the red attack plan was as shown in Figure 3.

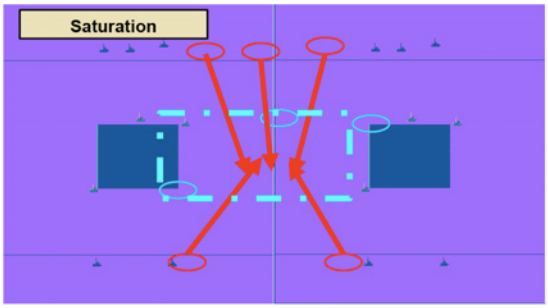

Figure 3: Manual Red Plan

RESULTS AND ANALYSIS

Blue ART Tactics

Multiple-layered Defence Strategy. The ART-generated Blue plan surprised the team initially with a tactic that seemingly made little operational sense to deploy. It took the team a while to decipher and understand the plan better. The ART tactic suggested two border patrols at the northern and southern edge of the anchorage area while the last patrol vessel deployed in a crossover patrol pattern to achieve a multiple-layered defence strategy. The ART-generated Blue plan was as shown in Figure 4 below.

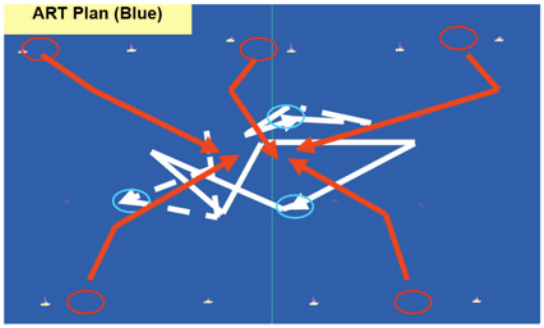

Figure 4: ART Blue Tactics

Red ART Tactics

Simultaneous Pin-point Attack. Similar to the Manual Red Attack Plan, the ART-generated tactic proposed a simultaneous red attack towards the centre of the anchorage area with re-attack flexibilities. This would cater for cases where the anchored vessels were dispersed nearer to the anchorage edges. The ART tactic for the red team was as shown in Figure 5 below.

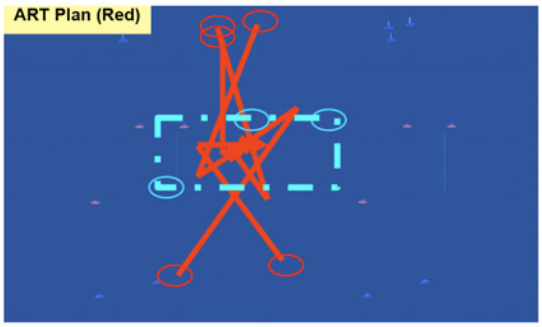

Figure 5: ART Red Tactics

ART Complements Manual Teaming

From the results below in Table 1, it was evident that there was marked improvement in all 3 MOEs for the manual blue and red plans after evolving the intangibles using the ART framework. In addition, the ART-generated Blue tactics produced a significant 98% drop in red mission success and a 99% drop in neutral shipping attrition. As for the ART-generated Red attack plan, the results also showed a drop of 83%in red attrition and 105% increase in the mean number of neutral shipping destroyed. We could therefore conclude from all the above observations that ART not only complemented the manual teaming efforts, it also provided alternate plans for considerations, which might otherwise, be overlooked or non-intuitive.

SUMMARY OF FINDINGS

Automated Red Teaming

Through the exercise during IDFW 15, several valuable feedbacks were received from the team members.

Title is misleading. Firstly, some of the team members found the title "ART" misleading as it seemed to suggest a fully automated process to optimize against multiple plans. This would actually be addressed in the ACE framework. In addition some team members had the impression that ART could only be used to optimize red plans to generate the worst-case scenarios for the blue plans. Instead, ART was developed as a tool to optimize individual sides in two-sided scenarios, using evolutionary algorithms.

Surprises from ART. Secondly, it was interesting to note that the ART had produced plans that were non-intuitive and might not make much operational sense. This led to remarks like "well.. it could be an art itself to decipher ART generated tactics." and "what a surprise!". Nonetheless, ART could be applied to generate alternate plans that might not be intuitive but effective.

Useful Tool to Complement Manual Ops Planning. Finally, the team members found ART as a useful tool to complement manual ops planning. This is consistent with our findings from the last workshop and further strengthens our belief in the applications of the ART framework.

Automated Co-Evolution

During IDFW 15, the team had lengthy and in depth discussions on some of the challenges ACE would faced in its development. Below was the list of questions raised during the discussions:

- How to choose the fittest solution for multiple objectives optimization?
- What if Blue and Red Teams had different end objectives?
- How to achieve optimization for multiple-sided scenarios?

The ACE development team would take into considerations the above challenges to add robustness in the ACE framework.

CONCLUSIONS

This study has discussed some of the strengths and weaknesses of the ART framework. Despite its limitations, the ART framework is highly recommended to be used to complement ops planning efforts. In addition the report has also discussed about potential challenges of the ACE framework.

	Baseline	Blue Plan		Red Plan		Blue ART	Red ART
		Manual	ART	Manual	ART		
Aggressiveness	-60	-60	74	-60	-14	-22	-4
Cohesiveness	-100	-100	-50	-100	-40	85	-16
Determination	60	60	9	60	33	-58	45
Red Mission Success	100%	82%	45%	100%	100%	2%	100%
Red Attrition	2.77	3.98	4.48	1.96	1.83	4.97	0.48
Neutral Attrition	2.21	1.06	0.52	3.05	3.15	0.03	4.52
% Drop (Red Mission Success)	-	16%	55%	0%	0%	98%	0%
% Increase (Red Attrition)	-	44%	80%	(29%)	(34%)	79%	(83%)
% Drop (Neutral Attrition)	-	52%	76%	(38%)	(43%)	99%	(105%)

Table 1: Summary of Results

LOOKING AHEAD

The team will be continuing our effort on the development of the Automated Co-Evolution (ACE) framework.