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Maritime domain awareness in the South China Sea: an operational picture design

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THESIS

MARITIME DOMAIN AWARENESS IN THE SOUTH CHINA SEA: AN OPERATIONAL PICTURE DESIGN

by

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March 2018

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Maritime domain awareness (MDA) is a crucial U.S. Navy operational function, with significant long-term strategic overtones, especially in the South China Sea (SCS) region. Socio-economic issues plague the SCS, including overfishing, piracy, and energy usage, and have forced many countries to disregard borders, laws, and economic exclusionary zones (EEZ). These actions have caused numerous vessels of interest (VOIs) to turn off required positioning systems to participate in illicit activities. This thesis builds upon the concept of operations (CONOPS) developed in year one of a multi-year project in order to create an exercise plan for use during the 2018 naval exercise Southeast Asia Cooperation and Training (SEACAT). Advances in commercial satellite imagery programs will enhance and improve situational awareness in the MDA realm for the Association of Southeast Asian Nations (ASEAN) countries adjacent to the SCS. The research focuses on utilizing a variety of unclassified software programs. These programs provide interested parties with additional tools that improve the capabilities of the partner nations to improve information sharing on both cooperative and non-cooperative MDA tracks.

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MARITIME DOMAIN AWARENESS IN THE SOUTH CHINA SEA: AN OPERATIONAL PICTURE DESIGN

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ABSTRACT

Maritime domain awareness (MDA) is a crucial U.S. Navy operational function, with significant long-term strategic overtones, especially in the South China Sea (SCS) region. Socio-economic issues plague the SCS, including overfishing, piracy, and energy usage, and have forced many countries to disregard borders, laws, and economic exclusionary zones (EEZ). These actions have caused numerous vessels of interest (VOIs) to turn off required positioning systems to participate in illicit activities. This thesis builds upon the concept of operations (CONOPS) developed in year one of a multi-year project in order to create an exercise plan for use during the 2018 naval exercise Southeast Asia Cooperation and Training (SEACAT). Advances in commercial satellite imagery programs will enhance and improve situational awareness in the MDA realm for the Association of Southeast Asian Nations (ASEAN) countries adjacent to the SCS. The research focuses on utilizing a variety of unclassified software programs. These programs provide interested parties with additional tools that improve the capabilities of the partner nations to improve information sharing on both cooperative and non-cooperative MDA tracks.

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LIST OF ACRONYMS AND ABBREVIATIONS

AAR	after action report
AFRICOM	Africa Command
AI	artificial intelligence
AIS	automatic identification system
AOI	Area of Interests
AOR	area of responsibility
APAN	All Partners Access Network
ASEAN	Association of Southeast Asian Nations
C2	command and control
C7F	Commander, United States Navy 7th fleet
CBP	Customs and Border Protection
CENETIX	Center for Network Innovation and Experimentation
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CNO	Chief of Naval Operations
COA	course of action
COBP	Code of Best Practices
CONOPS	concept of operations
COP	common operational picture
CSI	Container Security Initiative
CTF	Commander, Task Force
CTI	Coral Triangle Initiative
C-TPAT	Customs-Trade Partnership against Terrorism
DOD	Department of Defense
DoN	Department of Navy
DoT	Department of Transportation
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States
ECS	East China Sea
EEZ	economic exclusionary zone

EIA	Energy Information Administration
EPC	Event-driven process chain
EU	European Union
FON	Freedom of navigation
GDP	gross domestic product
GEOINT	geospatial intelligence
GPS	Global Positioning System
HQ	headquarters
IEA	International Energy Agency
IFC	Information Fusion Center
IM	Instant Message
IMB	International Maritime Bureau
IMINT	imagery intelligence
IMO	International Maritime Organization
IPC	initial planning conference
IPT	integrated product team
IT	information technology
IUU	illegal, unreported and unregulated
IW	Information Warfare
JSON	JavaScript Object Notation
KML	Keyhole Markup Language
LE	law enforcement
LRIT	Long Range Identification and Tracking
MDA	maritime domain awareness
MM	Maritime Militia
MMEA	Malaysian Maritime Enforcement Agency
MSA	Maritime Security Awareness
MSL	mean sea level
MSSIS	Maritime Safety and Security Information System
MTX	multi-thread experiment
NARA	National Archives and Records Administration
NATO	North Atlantic Treaty Organization

NCW	Network Centric Warfare
NGA	National Geospatial-Intelligence Agency
NII	Non-intrusive Inspection
NPS	Naval Postgraduate School
OBP	Oceans Beyond Piracy
ONR	Office of Naval Research
RAA	remote advise and assist
ReCAAP	Regional Cooperation Agreement on Combating Piracy and Armed Robbery against Ships in Asia
RIMPAC	Rim of the Pacific
RMP	Recognized Maritime Picture
S2ME2 ANTX	Ship-to-Shore Maneuver Exploration and Experimentation Advanced Naval Technology Exercise
SAM	surface-to-air missiles
SAR	synthetic aperture radar
SCI	San Clemente Island
SCS ECS	South and East China Seas
SCS	South China Sea
SEA	Southeast Asia
SEACAT	Southeast Asia Cooperation and Training
SEARCCT	South East Asian Regional Center for Counter-Terrorism
SITREP	situational report
SOP	standard operating procedure
SPAWAR	Space and Weapons Research
SPOTR	Surveillance, Persistent Observation, and Target Recognition
SSE	Sensitive Site Exploitation
TAA	train, advice, and assist
TEU	Twenty-foot Equivalent Unit
U.K.	United Kingdom
UAS	unmanned aircraft system
UAV	unmanned aerial vehicle
UISS	Unclassified Information Sharing Service

URL	uniform resource locator
USV	unmanned surface vehicle
UUV	unmanned underwater vehicle
UW-16	Unmanned Warrior 2016
UxV	unmanned vehicle
VEO	violent extremist organizations
VOI	vessel of interest
VRMTC	Virtual Regional Maritime Traffic Centre
VS-16	Valiant Shield 2016

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I. INTRODUCTION

Maritime domain awareness (MDA) is a crucial U.S. Navy operational function, with significant long-term strategic overtones, especially in the South China Sea (SCS) region, home to several billion people. This chapter gives an overview of MDA and the specific SCS region, with a focus on overfishing, piracy, and energy usage, three of the biggest existing and emerging challenges in that ocean region. We argue that increasing unclassified maritime domain awareness capabilities within the South China Sea (SCS) will improve regional stability and security. This thesis aims to prepare for operational experimentation to achieve those aims.

A. SYNOPSIS

A synopsis of the concept of operations (CONOPS) by our thesis predecessors, Erik Lavoie and Erin Wreski, help conceptualize this year's research (Lavoie and Wreski, 2016). The CONOPS focused on MDA in the South and East China Seas (SCS & ECS). There are multiple reasons the United States has a vested interest in these regions. The military is the leading reason; Freedom of navigation (FON) and protection of our allies are of the highest concern to the United States. However, in addition to the military, there are multiple systemic socio-economic issues with which the United States is concerned, especially regarding the oceans. Water covers twice as much of the Earth as land, and countries are responsible for protecting the oceans' resources and all people who traverse these oceans. There are few international agreements on what can and cannot be done regarding the vast ocean areas, or on whose duty it is to protect these assets and in which areas. Significant levels of corruption can be seen over a spectrum of socio-economic issues: overfishing, piracy, and energy usage are a particular focus of this thesis. David Rosenberg, a professor with the Department of Political and Social Change in the Research School of the Pacific and Asian Studies at the Australian National University, explains the United States' desire to achieve "maritime domain awareness"—a comprehensive picture of everything that moves on the world's oceans. This is a goal of the U.S. security officials

who want ships to be wired so their locations, speeds, ports, and cargo can be tracked with precision, as now occurs globally within air traffic control systems (Rosenberg, 2009).

Rosenberg elaborates how piracy in Southeast Asia (SEA) has cost the world economy $25 billion a year (Rosenberg, 2009). Piracy raises insurance rates, restricts trade, and increases tensions on shore and land. Many countries in SEA fall victim to piracy such as Indonesia. The Indonesian government estimates that their country loses $4 billion a year alone to illegal fishing. Unregistered foreign vessels often conduct illegal overfishing and entice pirating (Rosenberg, 2009, pp. 47–50). The information on these criminal ships is often not shared among countries. A common tool to identify ships and track ship movements, utilizing existing data such as current location, crewmembers, and anticipated port visits, is needed. Is there a ship that is violating international law? Is there a ship that is known for human trafficking? Are there fishing fleets that are well outside their territorial waters or exclusive economic zone (EEZ)? The answers to these questions would be useful to all naval law enforcers and military.

Currently, maritime security initiatives for the SCS are fragmented. Each country that is part of the Association of Southeast Asian Nations (ASEAN) alliance typically operates to serve immediate self-interest, when a more collaborative approach would be beneficial. Vessel of interest (VOI) data is held in segmented areas of certain agencies. This segmentation can lead to inconsistent, fragmented or mismanaged information-sharing and possible security risks. These risks can be reduced by adopting policies that encourage information sharing, making data available to those who readily need it. (Obama, 2012, p. 4).

President Obama noticed the need for responsible information sharing in 2012, and the need has only increased. Unfortunately, sharing information is not easy in our current culture, so tools and training need to be employed to assist the process. Software like SeaVision can aid in the “shareability” of information for nautical vessels. The data will be in a raw form. There will not be modifications to the data, or filtering it will simply be the output. This is useful as commercial companies can run into sensitive or political security concerns when providing information only on specific vessels. The responsibility rests with the respective country to set up its own alerts for VOI. The availability of all raw

data accommodates the requesting country, without targeting any specific country, which will be discussed in more detail in the following chapters. In brief, it is up to the specific nations to decide how to categorize the generic satellite imagery it pulls from SeaVision. The commercial companies will not do any targeted information gathering, since targeting specific vessels may indicate other knowledge gained through classified means. Although there are many unclassified MDA software tools and vendors, we chose SeaVision for the previously stated reasons. In addition to those reasons, it is convenient to build upon previous research using the same software, we have experience with SeaVision, and we have built a repertoire with the engineers who update SeaVision. There are different limitations on all the software options; such as very expensive subscription requirements and extended storage/bandwidth requirements. SeaVision eliminates these limitations for our use. Information sharing is an important concept of MDA and multi-nation exercises are excellent opportunities to practice this. The annual Southeast Asia Cooperation and Training (SEACAT) exercise, hosted in Singapore, is one such opportunity. The exercise has been growing for 15 years and has evolved as the leading multi-nation information sharing exercise in the region.

We anticipated the needs of potential SEACAT 2018 participants by analyzing previous year's after action report (AAR) and through it, developed a model for information sharing experimentation. The model lays a foundation, defining roles and responsibilities of key personnel. We then describe a realistic scenario as an intelligence brief which will be used during the SEACAT exercise boarding exercise. The combination of the model and the brief address two areas of concern we have identified from the AAR, which are communication tools and a common information sharing portal. With the guidance we provide on how to incorporate these two tools in chapter 4, these steps can then be used to build a standard operating procedure (SOP) for future exercises. Throughout the process, we continuously utilized SeaVision as our primary tool. The goal of this thesis is to show how increased collaboration with SeaVision will enhance and improve situational awareness in the MDA realm for the ASEAN countries adjacent to the SCS to police their waters. This thesis is a foundation for information sharing experiments. Our design theory will work both in the near term and for an expanded campaign of

experiments which leverages the ongoing SEACAT exercises. As Wreski and Lavoie explain, the result of their CONOPS is to share information from multiple sources in the form of a customizable and automated MDA COP. This will build trust and collaboration with foreign nations (Wreski & Lavoie, 2016). Trust and classification concerns are discussed later.

B. SOCIO-ECONOMIC ISSUES

There are a multitude of socio-economic issues in the SCS and ECS regions, but we chose to discuss three in detail that are of high concern to the United States: overfishing, piracy, and energy usage. These issues are not solely focused on any one particular country, and the severity of the issues ranges from country to country, highlighting the benefits of information sharing. Because of the complexity and fluidity of a country's concern at a specific time, this information sharing needs to be customizable. Andrew Tan, Professor in Social Sciences—New South Wales states that the issues in Asian waters cannot be defined by a single problem, country, or subject. The complex problems are a conglomerate of the different cultures and assertiveness or passivity of the countries willing to intervene (Tan, 2013). These issues cause concern for all nations involved. More often than not, these countries take a passive role when dealing with maritime issues, because they do not have the resources to handle the issues or simple do not care. If they are not being directly impacted at the moment, it is easy for countries to not react, even if what is happening is near their borders. Furthermore, since these countries often demonstrate passivity even when they do react, their weak response causes uncertainty, which can exacerbate the issues.

One of the issues that all ASEAN countries are concerned with is maritime security; as different countries have varying levels of military strength and economic resources, they have realized that a cooperative security view may be beneficial. Researchers Khalid, Ang, and Joni of the Center for Maritime Economics and Industries, Malaysia, explain how:

> There have been many efforts at the bilateral and regional levels among nations in SEA to enhance security and navigational safety. Among the initiatives aimed at enhancing security in the waterway include:

> 1) The formation of enforcement agencies such as the Malaysian Maritime Enforcement Agency [MMEA], which looks after the safety of vessels transiting Malaysian waters and protects its [EEZ].
>
> 2) The introduction of Long Range Identification and Tracking (LRIT) of ships initiative by the Maritime Security Committee of International Maritime Organization (IMO)—LRIT enables ships to identify each other's registration and the type of cargo being carried.
>
> 3) The establishment of an agreement on information exchange and communication procedures, a treaty of mutual assistance in criminal matters and regional forum on measures against terrorism, counter-terrorism and transnational crime. To this end, agencies such as South East Asian Regional Center for Counter-Terrorism [SEARCCT] and the Regional Cooperation Agreement on Combating Piracy and Armed Robbery Against Ships in Asia [ReCAAP]. (Khalid, Ang, & Joni, 2009, pp. 4–15)

There are a multitude of other initiatives, but despite their abundance, the initiatives still lack collaboration. In 2017, the rate of incidents was very high, and more needs to be done to combat crime in the region. An effective way to intervene on crime is by learning how to recognize and combat it. SEACAT provides an avenue to accomplish crime intervention. SEACAT has changed names several times throughout the past 15 years. The initial name in 2002 was "Southeast Asia Cooperation Against Terrorism." In 2012, it was renamed after the scope of training was expanded. As stated in the 2017 AAR by Commander, Task Force (CTF) 73, the mission of SEACAT was "designed to address shared maritime security challenges in the Southeast Asian region by bringing together liaison officers from Singapore, Brunei, Malaysia, Indonesia, Philippines, Thailand, Vietnam, Sri Lanka, Myanmar, Bangladesh, and the United States" (CTF 73, 2017, p. 2). These security measures are not limited to the military; they affect all native people in the region and, on a broader scale, the region's allies and partnerships, essentially affecting all nations. Therefore, it is essential to expound on the nautical socio-economic issues. In a statement from the ASEAN Secretariat:

> A lack of concrete action in respect to many problems including maritime piracy, illegal drugs and terrorism has generated criticism of ASEAN's lack of progress on non-traditional security threats. There's also concerns about other human security issues such as pandemics, and environmental hazards. (Tan, 2013, p. 231)

It is clear that action needs to be taken to address not only the socio-economic issues of the region but the security threats that come with them.

1. Overfishing Problem

Fishing disputes are a significant type of maritime conflict that threatens regional stability, commerce, and individual livelihoods. These disputes can quickly turn extremely hostile and attempts to mitigate potential disputes are warranted. Fishing disputes are common in many areas in this region involving multiple nations in various incidents. The commonality is that there is not enough fish to support the demands of any one country. This causes fishermen to violate ecological laws and EEZs. Security is often lacking in these areas, so it is enticing to fishermen. Disputes between countries often escalate quickly and can even turn political. China has taken to addressing this with their maritime militia (MM); although a supposedly passive "agency" they are often aggressors and have been known to harass other nation's fishermen. Are they participants in a plan to bridge a gap in China's strategic and political motives? Are they a group that can enforce China's objectives without the backlash and restrictions of a typical military? Zhang, an associate research fellow with a China Programme, answers these questions in the affirmative. These fishermen are not victims or innocent bystanders but are actually part of a bigger picture, a MM who are set to conduct a "people's war" (for China) if a conflict does occur (Zhang, 2016, p. 65). This "people's war" would give China's government the option to intervene using their MM or stay out of the conflict for political issues.

It can be considered a good tactic; the fishermen are essentially providing additional coverage over a large area while freeing up the military for more important tasking. China is not the only country that does this; Vietnam, the Philippines, and Brunei, among others, also utilize their countries' fishermen as a pseudo show of force in contested waters (Zhang, 2016). He then explains how China routinely "deploys its fishermen and [commercial] vessels to confront other countries' maritime forces" (Zhang, 2016, p. 65). These fishermen get a variety of incentives to do this including fuel vouchers and ship building subsidies. However, it seems that they do little more than "challenge" other vessels in areas perceived to be in their territory. The government does not provide the MM weapons or law enforcing

ability. Vessels then challenge the MM authority by continually navigating through the ECS and SCS. The United States routinely patrols these seas and executes (FoN) exercises so as to keep these sea-lanes open.

Though China makes multiple attempts to keep others out of the areas it perceives as belonging to it, China faces depleting fishery resources in its inshore waters and has begun taking steps to mitigate this by instituting fishing pauses. These efforts to protect its own waters lead to China's fishermen violating laws governing international waters. (Zhang, 2016). In fact, "29,600 Chinese fishing vessels illegally entered South Korean EEZs in 2014, up more than sixteen percent from the previous year. China continuously violates the EEZs of other countries, including South and North Korea, Russia, Indonesia, and Palau." (Zhang, 2016, p. 67). China is taking steps to address these violations by installing Beidou (similar to GPS) on fishing vessels to monitor these vessels in efforts to keep them out of other country's EEZs. A tracking device is only useful when it can track, however. All modern systems, such as Beidou, GPS, and automatic identification system (AIS), can and commonly are simply turned off by the crewmembers (Zhang, 2016, p.68). Lack of broadcasting can even be passive due to lack of maintenance or damage to the system. For these reasons, an enhanced tracking system should be utilized. Such a system would be independent of the boat's broadcast and capable of tracking vessels that desire not to be detected (often known as dark vessels).

Tracking systems can help secure EEZs but can also serve to protect endangered species. As observed by the Down to Earth (DTE) publication (DTE, 2016), Tanmen fishermen, the leading MM in China, overharvest giant clams, coral and sea cucumbers. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) protect giant clams as a first-class protected animal in China (DTE, 2016). Unfortunately, these restrictions have not prevented any of the fishermen from causing massive damage to the giant clam population and their coral reef habitats. There is a strong possibility that these fishermen alone have essentially caused the extinction of these creatures in the SCS.

Additionally, the sea cucumber population is rapidly declining. The Australian Centre for International Agricultural Research recently conducted an elaborate study on the sea cucumber in hopes of saving this vital commodity from becoming extinct:

> In South-East Asia, important sources of sea cucumber are Indonesia, the Philippines, Vietnam, Thailand and Malaysia, with Singapore and Hong Kong being major export destinations. The product is popular among oriental consumers due to its alleged ability to improve vigour and cure ailments. Sea cucumber aquaculture is a recurring priority in development aspirations for Asian and Pacific island nations, driven by the depletion of stocks from overfishing and the subsequent loss of livelihoods and export dollars. (Hair, Pickering, & Mills, 2011, p. 3)

High demand for these animals causes increased overfishing leading to rising prices. The allure of rarity causes more overfishing in an endless cycle until irreparable damage or extinction occurs.

These are just two examples of the endangerment of species due to overfishing; however, there are many more species that are threatened in these regions. Violators in these areas need to be held accountable for their impact on ecology and security concerns of other ASEAN countries. As Hongzhou Zhang, Associate Research Fellow with China Programme at the S. Rajaratnam School of International Studies, Nanyang Technological University explains, China should strive to promote a regional aquaculture to offset Asia's growing demand for seafood and help deter overfishing (Zhang, 2016, p. 8). A cooperative information-sharing tool would help these countries enhance regional fishery trade responsibly. Known violators could be monitored and fined as appropriate or lose government incentives.

2. Piracy Problem

The sheer geography of the vast SCS is prime for piracy, while the uncoordinated patrols and lack of resources increase the appeal. This massive area touches Malaysia to Indonesia which border the Malacca and Singapore straits, which are major international shipping lanes. A general estimate by the U.S. Energy Information Administration (EIA) is that 85% to 90% of all the oil imported by China and Japan transits these straits (EIA, 2017). See Figure 1 for geographical representation of the Strait of Malacca. The numbers

are enticing to criminal pirates who can stalk the cargo ships and seize the oil on board when the ships are vulnerable, such as when pulling in or out of port or when independently steaming toward a port.

Figure 1. Strait of Malacca chokepoint and piracy lane. Source: EIA (2017).

Piracy is not isolated to one area; neither are only certain ships or cargo targeted. According to anti-piracy group Oceans Beyond Piracy (OBP), which correlates pirate attacks from Regional Cooperation Agreement on Combating Piracy and Armed Robbery against Ships in Asia (ReCAAP), the International Maritime Bureau (IMB), and the Information Fusion Center (IFC), the Asian region saw 129 incidents in 2016; compared to 95 events in African waters (OBP, 2017). The focus of militaries seems to be on the African nations due to the glamorization from Hollywood sources such as the movie *Captain Phillips*. The focus needs to be more concentrated in the Asian regions which have many more incidents. Furthermore, it is not just goods that are being pirated; people are victims, too. According to Neil Thompson of the Diplomat:

> a total of 185 seafarers were taken hostage, and trending up due to ISIS numbers in the Philippines, 2016 also saw a surge in lethal violence affecting the region's seafarers with over 6,000 incidents and an increase in death toll. Asia is now being seen as the principal threat to world shipping it's unfortunate as two-thirds of global shipping occurs within SEA waters. In efforts to halt the piracy, Indonesia, Malaysia, and the Philippines agreed last summer to allow "hot pursuits" of kidnappers and armed robbers by each other's maritime security forces into each country's waters. (Thompson, N., 2017)

All the piracy in the region is a major concern to Singapore whose economy is heavily dependent on international shipping. Singapore is a major hub for international shipping with significant revenue coming from shipping and storing containers. Singapore has a vested interest in the maritime security of the region and, therefore, is taking the lead in security. It is very willing and optimistic to coordinate with allies such as the United States and the United Kingdom (U.K.). Additionally, because of its ideal shipping location, Singapore has the money and resources that some of the other countries in the region do not.

How busy can the Port of Singapore be? According to Hiteshk with Marine Insight, the port "catered to vessels exceeding over one-point-five billion in gross tonnage, making it the world's busiest port" (2015). The same report shows that in 2011 the port "handled almost 30 million Twenty-foot Equivalent Units (TEUs) of containers" and "is categorized as the world's most engaged port for transshipment activities" (Hiteshk, 2015). It would make sense that Singapore is determined not to lose business and is taking the security issues seriously. Singapore has hosted SEACAT for the past 15 years and the exercise continues to grow in number of participants and complexity. This last year included boarding procedures taught by the United States Coast Guard to aid in combating piracy. McCauley elaborates:

> Piracy drains between $7–$12 billion dollars from the economy every year. Recently, well-armed and organized criminal groups have focused their efforts on the oil tankers that exit the narrow Malacca and Singapore straits and venture into the SCS. Here, the territory is vast, law enforcement's resources are stretched, and the potential profits are immense. (McCauley, n.d.)

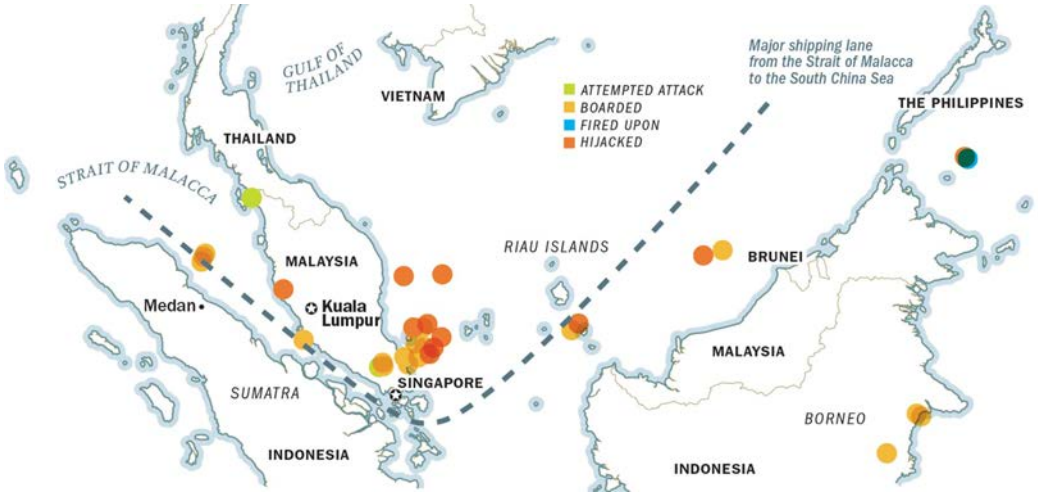

Figure 2. Strait of Malacca Pirating Attacks. Source: McCauley (n.d.).

See Figure 2 for different types of attacks in the Strait of Malacca, with some areas targeted more than others. This financial loss affects not only the ASEAN partners but United States interests as well. Crude oil shortages due to piracy and hijacking cause shortages in oil, causing fuel prices to rise worldwide. Ships, in an effort to protect themselves, may detour from the popular routes, causing them to become more of a target to pirates or delaying arrival time to transfer ports. This may eventually lead to more delays and higher prices for consumers in the United States, perhaps replaying the 1979 oil crisis.

3. Energy Crisis Problem

There has been a rapid increase of energy consumption across the world, but as our ASEAN partners continue expanding their export status with hopes of increasing their economic advantage, the demand for resources will be relentless. As stated by the International Energy Agency (IEA), “the ten ASEAN countries represent one of the most dynamic parts of the global energy system and their energy demand has grown by 60% over the past 15 years” (IEA, 2017). The appeal to outsource cheap labor to ASEAN countries from the United States and the U.K. continues to grow causing a strain on an already stressed energy system.

Though there are many different issues with energy in SEA, this paper will focus on the oil problem. Currently, many of the countries of SEA are able to use the oil reserves

they have on hand. China also has significant reserves in the SCS and Spratley Islands. Unfortunately, these reserves will not be enough for China, given its projected population growth, or even for the smaller ASEAN countries. The IEA predicts a "trajectory of decline [in usage], falling from 2.5 mb/d today to 1.7 mb/d in 2040" (IEA, 2017). Despite a decline in usage and an increase in production from other countries, it is not enough to counter the usage.

The IEA predicts this scenario 22 years from now, but even a 10-year outlook should raise concerns. According to the IEA (2017), there will be a decrease in domestic supply and increasing demand of $300 billion in imports through 2040, 4% of the region's gross domestic product (GDP). Oil net imports are expected at 6.9 mb/d totaling $280 billion (IEA, 2017). One could easily project that the increased demand would have an effect on the other two socio-economic issues that were discussed. Piracy will become more enticing, not just to ships attacking vessels at sea but also at the ports where the oil is unloaded. The demand for fuel can even relate to overfishing as fishing vessels will likely try to catch as many fish as they can when they are out at sea. Furthermore, local fishermen may not get the government fuel subsidies they get now, which could cause problems for the entire fishing industry leading to economic instability and concerns for food availability to the general population.

See Figures 3 and 4 for the expected growth for energy and fuel consumption in the region. The cause for concern is not only the increased demand for the ASEAN countries but the exponential growth of the countries nearby such as China and India, which vastly outnumber the individual population of the smaller countries. The export and import of oil could be seen as very lucrative and easy targets for these larger countries. For these reasons, any tool to aid in protecting these countries' resources would be useful to them.

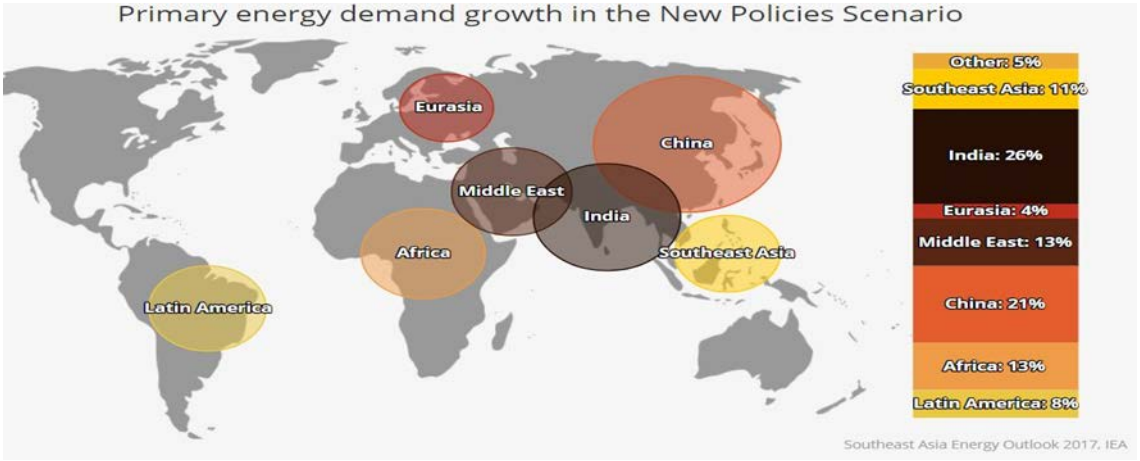

Figure 3. Global Energy Growth Projections.
Source: SEA Outlook, IEA (2017).

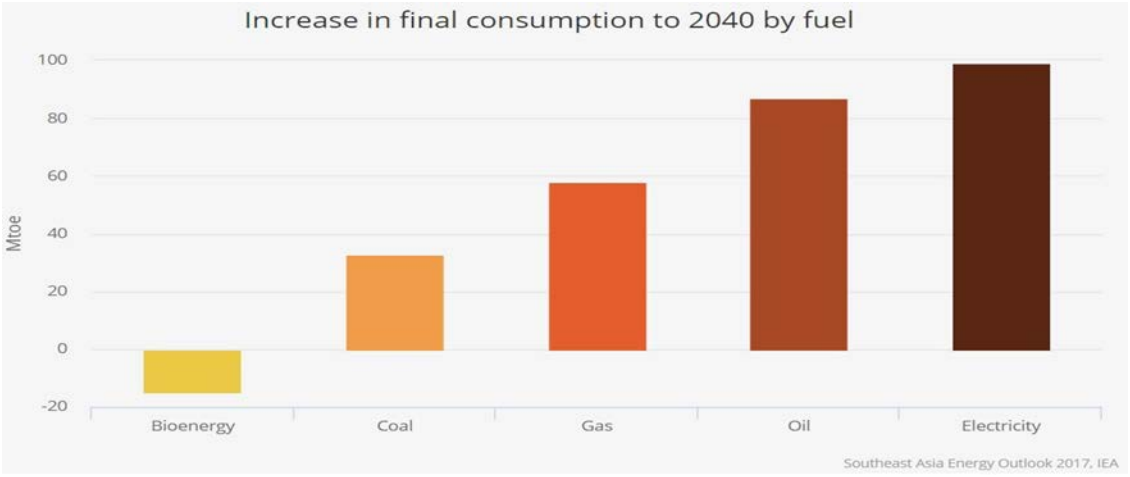

Figure 4. Fuel Types Consumption to 2040.
Source: SEA Outlook, IEA (2017).

These outlooks may appear grim; however, with dedicated measures, they can be effectively managed. Tools like SeaVision, exercise planning and training, and legal deterrence, address these issues and empower our ASEAN partners to protect themselves. The United States will always have a vested interest in the SCS. It is the duty of the populace not only to maintain FON, support Allies, and protect the environment, but also to detour the criminals who disrupt the harmony of the oceans.

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II. LITERATURE REVIEW

A. INTRODUCTION

The maritime domain has become increasingly important to the United States Navy, our government and our global partners, because of its far-reaching implications regarding the safe passage of military and civilian vessels. As stated in our predecessor's thesis, the maritime domain is a place that, if left unguarded, could harbor illegal entities' who intend to bypass laws, disrupt already precarious trade routes, and harm our national security (Wreski & Lavoie, 2016, p. 7). In the year since that thesis was published, these predictions have come true. Territorial disputes among various islands in the SCS are a focal point not only for the United States, but also for China and our ASEAN partners. To put it in perspective, on a yearly basis, "$5.3 trillion of trade passes through the SCS, $1.2 trillion is United States trade; more than half of the world's annual merchant fleet tonnage and a third of maritime traffic worldwide travel through these waters" (Newswire, 2016). The substantial financial investments in these waters for all concerned parties warrant a collaborative approach to the problem.

While our forerunners focused on a concept of operations (CONOPS) applications to improve MDA in the Commander, 7th fleet (C7F) area of responsibility (AOR), our goal is to bridge the gap from theoretical to practical. In Chapter III we will introduce a design to demonstrate the relevancy of these new capabilities to the monitoring of maritime activities. By creating rules to track specific VOI and leveraging the emerging unclassified MDA tool called SeaVision, we plan to demonstrate increased information sharing with coalition partners in an unclassified exercise environment (SEACAT 2018) with partner nations. This literature review explains all the components needed to accomplish this design.

Our literature review focuses on research on the MDA programs currently available. We review different programs' functionalities in order to show the superiority of SeaVision to create a follow-on campaign of experiments which would succeed this initial design. Last, we will explore the joint naval exercises that have used SeaVision, our

chosen MDA program. This exploration shows that SeaVision has not been used altogether among our ASEAN partners or within the SCS. This portion of our research comes from primary sources since the programs and joint exercises have been either recently created or completed. Although there are numerous MDA programs currently on the market and joint exercises use some of these technologies and programs, our research shows that our preferred MDA program, SeaVision, in collaboration with the machine-learning-based tool Surveillance, Persistent Observation, and Target Recognition (SPOTR), has not yet been used to increase information sharing and assist our ASEAN partner nations.

1. Naval Exercises

Naval exercises are a valuable tool for leaders to enact scenarios for their units and staff. Exercises are used to train and prepare personnel for possible future events (Alberts & Hayes, 2005, p. 56). Each exercise has a purpose with a set of specific supporting objectives. The Navy employs a diverse range of vessels, systems, and people while utilizing different tactics, doctrines, procedures and techniques to conduct their exercises (Alberts & Hayes, 2005, p. 56).

2. Operational and Campaigns of Experimentation

Operational experimentation is similar to a scientific experiment because it has a hypothesis and some means to measure either the failure or success of the stated hypothesis. Success or failure in any experiment is important for determining future direction, but for military operations, these factors are crucial to develop tactics. The director of force transformation at the Defense Department, Arthur Cebrowski, VADM, USN (Ret.) outlines the importance in integrating new technology to the warfighter in an experiment as stated, “there is the ability to perhaps obtain some very early pieces of technology, which we can then put in the operating forces and see what it means” (New, 2003). He often regarded this as the co-evolution of technology and tactics.

A campaign of experiments is a set of linked experiments over time. Just as a single experiment has criteria for entrance (starts) and exit (completions) as the campaign evolves, a multitude of experiments works independently or in tandem. Alberts and Hayes stated that this process is empirical and “progress depends upon an accumulation of data and

analytical findings" (Alberts & Hayes, 2005, p. 18). Without data being accumulated and sorted properly, the findings from the experiments may be incomplete, hence rendering the experiment a failure. This thesis will later identify a campaign of experiments that would eventually ensure improved information sharing in support of MDA for ASEAN countries.

B. SYSTEMIC SOCIO-ECONOMIC ISSUES WITHIN THE PACIFIC REGION

Fishing is a primary economic driver for many ASEAN countries. Because of the popularity of fishing both domestically and abroad, anglers have had to travel farther to meet the demand of their customers. For example, an area within the SCS known as the Coral Triangle spans 1.6 billion acres and supports the livelihood of 126 million people (Quilala, 2012). This race for fish is dangerous to the environment and regional economies. Competition amongst the fishing community results in a drive to continuously lower prices. This has led to fatal consequences in the SCS, as shown in the Marine Policy Article *Under the shadow: Forced labour among sea fishers in Thailand*, where fishermen were forced into slavery conditions that could lead to their death (Chantavanich, Laodumrongchai, & Stringer, 2016, p. 1).

Known by multinational organizations such as The Regional Program of Action on Illegal, Unreported and Unregulated (IUU) Fishing; the ASEAN–Southeast Asia Fisheries Development Center Strategic Partnership; and the Coral Triangle Initiative (CTI), atrocities are still occurring all over the SCS (Williams, 2013, p. 259). Combating the overfishing crisis is important because fishermen play roles outside of simply harvesting fish. Anglers, according to Hongzhou Zang, continue to play a political and diplomatic function for their respective countries as seen during the Sino-Vietnamese naval skirmish in 1974 (Zhang, 2016, p. 65). EEZs in which a country has privileged maritime resources rights are being tested more than ever. This has led to fears of a diplomatic solution dissolving into a militarized option since countries have disregarded their neighbor's boundary markings (Mak, 2008, p. ii).

Along with slavery, incidents of piracy within the SCS have increased and plagued the region. Piracy is considered a critical maritime security threat and pirates' motives have

evolved from demanding ransom from shipping companies or governments to committing acts of terrorism to further their political agenda (Amri, 2014, p. 144). Research indicates that some joint level ASEAN anti-piracy operations have occurred, but none involved all members of the ASEAN (Amri, 2014, p. 165).

Another concern is the crucial energy reserves embedded in the SCS and the fight for drilling rights as seen in the Parcel and Spratly Islands where, although China physically occupies them, Vietnam, Taiwan, Malaysia, and the Philippines all claim them for their respective countries (Bouchat, 2012, p. 70). Estimates hold that the SCS is home to "130 billion barrels of oil and 900 trillion cubic feet of gas" (Hong, 2013, p. 32), ahead of the proven reserves of Kuwait, United Arab Emirates, and Russia (Central Intelligence Agency [CIA], 2017). This lucrative area entices piracy and criminal actions; to combat this, countries need the proper tools and training, SeaVision is the first practical step.

C. MDA PROGRAMS

1. Current MDA Programs

MDA programs in the unclassified realm for military and civilian users have become abundant in recent years with the rise of high-speed Internet around the world. Each program listed in the next section shares a common goal of providing respective users with the most accurate MDA picture. This area will list the advantages and disadvantages of some popular MDA programs. The first segment identifies specific MDA programs maintained by the U.S. government. The second segment describes MDA programs operated by foreign nations. The final segment details why we have chosen the MDA program SeaVision, assisted by SPOTR, for our experiment.

While certain MDA programs focus on smaller vessels such as dredgers and fishing vessels, other MDA programs target large vessels such as shipping vessels. The Container Security Initiative (CSI) launched by U.S. Customs and Border Protection (CBP) after 9/11 focuses on cargo containers departing from foreign ports with a United States destination. Administrators use "non-intrusive inspection (NII) technology which includes X-ray imaging, Gamma ray inspection etc., along with other methods like radiation check" (Singla, 2016). Another cargo enforcement-strategy program employed by the CBP is the

Customs-Trade Partnership against Terrorism (C-TPAT). The C-TPAT is a voluntary program with over 11,400 partners that addresses gaps in supply chain logistics to implement best practices and security measures (CBP, 2017). However, C-TPAT is limited by its focus on Canada and Mexico and not our ASEAN partners. Although valuable in prescreening "over 80 percent of all maritime containerized cargo imported into the United States," (CBP, 2014) the CBP is not relevant to our exercise, as we will not be monitoring vessels departing for the United States.

The Maritime Safety and Security Information System (MSSIS) is an invaluable tool in fighting drug smuggling, human trafficking, piracy, and global terrorism. The Volpe Center of the DoT developed MSSIS in 2006 to provide a "low-cost, unclassified, near real-time network that is used to track vessels as they traverse the world's waterways" (DoT, 2017). MSSIS uses the automatic identification system (AIS) from vessels and is currently used by over seventy countries, and is one of SeaVision's main data sources (Foughty, 2015). MSSIS has spread from its intended audiences to the U.S. Naval Forces Europe-Africa / U.S. 6th Fleet to U.S. Northern Command and U.S. Africa Command (AFRICOM), but its influence has not yet reached our SEACAT coalition partners (DoT, n.d.).

Non-United States government entities have also created their own MDA programs to assist with maintaining MDA in specific parts of the world. SafeSeaNet is one of these MDA programs. It is a vessel-monitoring and information system used by the European Union (EU), Norway, and Iceland. It uses AIS along with historical ship positions. SafeSeaNet proves beneficial in providing the estimated arrival and departure times of vessels, information on hazardous goods onboard, ship-security information, and all data on vessels that have been banned from EU ports (European Maritime Safety Agency, 2017). Even though SafeSeaNet provides a multitude of services, the inadequacy of this system is its geographical limitation to European nations.

The Virtual Regional Maritime Traffic Centre (VRMTC) is a program used to "compile information for the Maritime Security Awareness (MSA) and to exchange the Recognized Maritime Picture (RMP) with the countries of the south border of the Mediterranean during the Multi-cooperative Exercises" (Permanente Cell of the European

Maritime Force, 2015). VRMTC goes beyond the normal MDA systems by incorporating forums, chat rooms, and the ability to send encrypted email to other authorized users (Sabatini, n.d., p. 4). While the VRMTC has been incorporated in exercises, it is limited by its lack of geographical reach into the SCS, by its requirement for a new country seeking access to VRMTC to be approved by all the other existing members, and by its inability to "exchange data among different communities" (Sabatini, n.d., p. 4).

Equasis is a free website dedicated to improving maritime quality and safety. The European Commission and the French Maritime Administration created Equasis to address the "lack of transparency in the information relating to the quality of ships and their operators" (Equasis, 2016). Equasis, launched in 2007, has over 43 million connections worldwide. Figure 5 shows a map detailing over 830,000 users accessed Equasis between January 14, 2017 and February 12, 2017, worldwide.

Figure 5. Equasis user activity. Source: Equasis (2018).

While the numbers of page views may be impressive, no countries that participate in SEACAT contribute to Equasis. Japan and South Korea are the only two contributing Asian countries; however, they are not participants in SEACAT. Additionally, the legitimacy of the data is questionable due to Equasis not validating its authenticity before

displaying it on the website, and the data is limited to "safety-related information on ships" (Equasis, 2016).

By comparing the various strengths and weaknesses of these MDA programs, combined with the fact that CTF 73 wants to use SeaVision during SEACAT 2018, we find that SeaVision is the best MDA program on the market for our purposes. SeaVision, as stated by its creator Brendon Providence of the Volpe Center, is a "Google Maps based marine vessel visualization tool," which "takes in positional data from various sources and simultaneously displays them on the same screen in a web browser" (Foughty, 2015). It incorporates AIS like the MSSIS, but it also incorporates other sensors, such as radar, in cases where vessels may want to be unseen or are participating in illicit activities. SeaVision allows feeds of other types of data and also displays near real-time data with "minimal overhead and multi-browser support" (Foughty, 2015). Additionally, SeaVision provides only the data and does not try to solve all analytical issues, but it can be used to support our analysis and that of our partners. According to CAPT. Scot Miller, USN (Ret.):

> SeaVision is designed so the user can easily tailor its employment. SeaVision accepts the vessel's track without regard for their tasking and collection process. If someone knew how and why a particular vessel was tasked and collected on, that might invoke classified sources. Thus, the use of SeaVision scrupulously avoids this task and collection process. The task and collect process is part of the overall intelligence process. The use of this process raises classification issues, and might prevent unclassified information sharing that SeaVision is designed to promote. (S. Miller, personal communication, December 30, 2017)

Significantly for this study, CTF 73, who is coordinating SEACAT, wanted to use SeaVision. Lastly, just like MSSIS, SeaVision access is only granted to nations that are willing to provide data to SeaVision.

SPOTR, while not a MDA program, can assist with maintaining MDA. SPOTR is a program that is used to detect, identify, and track VOI, especially non-cooperative targets, throughout a multitude of environments (Progeny, 2014). Moreover, SPOTR leverages various sensors including air- and space-based imagery and, in the future, synthetic aperture radar (SAR). SPOTR, through its sensors, surveils an assigned area of concern with a fully automatic system. SPOTR works so well that tests have shown that it can even

distinguish between a set of twins due to contrasting marks, scars, and tattoos (Shachtman, 2011). Since both systems are browser based, we believe that this program can be used as an overlay on SeaVision's program to enhance identification of VOI in a specific area in the SCS. This capability will augment SeaVision with a richer data set.

2. Upcoming MDA Programs

Other MDA programs are currently being tested around the world. Ball Aerospace and Spire Global, Inc., on behalf of the National Geospatial-Intelligence Agency (NGA), is developing a program that focuses on the Arctic region. This unnamed system will leverage AIS data with an infusion of geospatial intelligence (GEOINT) data to "establish benchmarks in vessel behavior" (Spire Global, Inc., 2017). This may be worth exploring in follow-on SEACAT exercises.

D. RECENT JOINT EXERCISES/PARTNER BUILDING INVOLVING SPOTR AND SEAVISION

1. SPOTR

According to Dr. Karsten Steinhauser of Progeny, SPOTR has been used during multiple U.S. Navy exercises. These include Valiant Shield 2016 (VS-16), Unmanned Warrior 2016 (UW-16), and Ship-to-Shore Maneuver Exploration and Experimentation Advanced Naval Technology Exercise (S2ME2 ANTX) in April 2017 (K. Steinhauser, email to author, October 20, 2017). The SPOTR website homepage also revealed that SPOTR was successfully implemented during Trident Spectre 2012.

Guam hosted the VS-16 exercise during September 2016. VS-16 was a biennial U.S.-only exercise that combined units from the Navy, Marine Corps, and the Air Force to increase units' ability to train in a joint environment (Sexton, 2016). Progeny deployed one unmanned aircraft system (UAS) off the back of a Navy vessel to identify, search, and detect other vessels in its assigned AOR.

The United States and the U.K. held the UW-16 joint military exercise off the coast of Scotland in October 2016 (Eckstein, 2016). The UW-16 exercise mission was to increase the use of unmanned and autonomous systems to increase maritime capabilities

(Department of Navy [DoN], 2016). Progeny integrated SPOTR with the RQ-21 UAS and deployed it for ship detection from medium altitudes of approximately 2500 feet mean sea level (MSL) (DoN, 2016).

The Office of Naval Research (ONR) and Marine Corps held S2ME2 ANTX at Camp Pendleton, California, during April 2017. S2ME2 ANTX's mission focused on clearing assault lanes, command and control (C2), information warfare (IW), weapons fire support and effects, ship-to-shore maneuver, and amphibious operations (Duffie, 2017). ONR and the Marine Corps used SPOTR in conjunction with multiple drones sent simultaneously for intelligence collection over the water.

U.S. special operations, intelligence and law-enforcement personnel held the Trident Spectre 2012 exercise at Joint Expeditionary Base Little Creek-Fort Story, Virginia. Its mission was to test and evaluate new technologies, from a tactical perspective. (Ericksen, 2016). SPOTR was successfully demonstrated during this exercise (Progeny, 2017).

SPOTR uses cutting-edge computer vision technologies combined with a preset library of vessels of interest (VOI). These background existing images of VOI are used to construct a three-dimensional model of that VOI to match to incoming new images. So, SPOTR can be used with images derived from unclassified commercial satellites or with organically derived naval images from the United States and partner navies.

2. SeaVision

Every year, the U.S. Navy participates in numerous joint exercises with our allies all over the world. These exercises operate with at least one or more partner nations, such as Talisman Saber with Australia (Packham, 2017), but may also be multi-national exercises, such as Saber Guardian, which involves 30 nations and 40,000 service members (Cronk, 2016). The U.S. Navy has incorporated all of its platforms from submarines, surface vessels, and airplanes to cyber and space components. Joint exercises involving MDA as a component have dramatically increased since the U.S. Navy released its Maritime Domain Awareness Concept in 2007 (Mullen, 2007). These exercises have not been limited in scope or geography. Although SeaVision is used worldwide, email

correspondence with Mario Caputo of the Volpe Center reveals that the only naval exercises he was aware of that utilized SeaVision for the purpose of MDA were the Phoenix Express, Cutlass Express, and Obangame Express exercises. A 2015 interview with the creator of SeaVision, Brendon Providence, stated that "outside of regular MDA training, [SeaVision] is used in four MDA exercises per year" (Foughty, 2015). Mario Caputo's emails counter Brendon Providence's claim of four exercises. We will continue to research, but at the present time we cannot determine the name of the fourth exercise.

Phoenix Express was an exercise in the Mediterranean Sea that included Turkey, Croatia, Egypt, Morocco, Italy, Malta, Spain, Mauritania, the Netherlands, Tunisia, Greece, and Algeria. This exercise is facilitated by U.S. Naval Forces Europe-Africa/U.S. 6th Fleet and sponsored by AFRICOM. Phoenix Express' MDA portion "respond[ed] to irregular migration and combat illicit trafficking and the movement of illegal goods and materials" (DoN, 2017a). Additionally, the exercise focused on search and rescue operations, improving information-sharing capabilities, and operational capabilities (DoN, 2017d).

Cutlass Express was a separate MDA exercise sponsored by AFRICOM but conducted by U.S. Naval Forces Africa. Its participating nations included Turkey, the Netherlands, Comoros, Denmark, Djibouti, Kenya, Madagascar, Seychelles, Mauritius, Canada, Uganda, France, and Mozambique (DoN, 2017b). Other participants included the Eastern Africa Standby Force, EU Naval Forces, IMO and CTF 150. The Cutlass Express 2017 iteration focused on scenarios that included the "interdiction of illicit arms, drugs, money, natural resources, WMD material, and people that pose a threat to regional stability, to international partners, or that resource violent extremist organizations (VEO)" (DoN, 2017c).

The biggest multi-national exercise that involved SeaVision was Obangame Express held in March 2017. Sponsored by AFRICOM, Obangame Express held realistic scenarios throughout the Gulf of Guinea and involved over 30 nations from Africa and Europe, including the Economic Community of West African States (ECOWAS) and the Economic Community of Central African States (ECCAS) (DoN, 2017d). While the Obangame Express mission was similar to the previously mentioned exercises, focusing

on collective capabilities to counter illicit maritime activity, it was also unique in testing certain nation's maritime forces to patrol its respective EEZ. This is valuable to our thesis because Obangame Express is similar to SEACAT in that it also involves many countries that differ in cultural values and military priorities. Additionally, the focus on EEZs is a crucial component to SEACAT, along with the disruption of illicit trading throughout the SCS.

E. CONCLUSION

We presented a review of the scholarship on the socio-economic challenges, which include overfishing, piracy, and energy usage in the SCS. We showed how these challenges impact not only the local economies but also the stability of the region and the world. Due to the vast size of the SCS, monitoring illicit activities in the SCS is inherently difficult as nefarious activities continue to proliferate. Enforcers of the law need resources that are free, unclassified, and easily accessible.

Our research has uncovered various MDA programs' advantages and drawbacks and concludes that SeaVision, with the assistance of SPOTR, best meets our objectives. Investigating past and present MDA exercises that have used SeaVision shows that SEACAT 2018 will be the first time instance in which participants use SeaVision, bringing our thesis goal of designing an exercise plan to bridge the gap between theoretical and practical a reality.

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III. METHODOLOGY

A. VALUE OF EXERCISE PLANNING

The Navy conducts numerous exercises each year and many of those involve partner nations. In 2017, the U.S. Navy's Seventh Fleet (C7F) participated in roughly 160 exercises with other countries, including several with Japan's Maritime Self-Defense Force (Lendon, Cohen, & George, 2017). The amount of time and effort that goes into planning a naval exercise is immense and requires substantial coordination and resources from all involved parties. For example, a carrier strike group costs approximately $6.5 million dollars every day to operate and requires a crew of 6,700 personnel to man the ships and aircraft (Thompson, L., 2016). Not every member on board is directly contributing to the exercise, yet each provides invaluable indirect support to the exercise. The price will increase with each ship or aircraft added to the exercise. The DoD has the largest military budget in the world at $824.6 billion for fiscal year 2018 (Amadeo, 2017). Compare that to Vietnam's military budget of only $5 billion (Yan, 2016) and you can see that these budget discrepancies cause our ASEAN partners to be selective about the exercises in which they participate. Every dollar they allocate toward an exercise must be justified. These countries must carefully consider how and when they can engage in certain exercises with the United States.

The Navy receives a significant portion of America's massive defense budget. However, a large budget does not fix problems that occur in a task-saturated Navy. While our military budget is immense, many commentators claim it is too small for the multitude of missions the military asks its sailors to perform (Lendon et al., 2017). The quest to achieve mission success in a variety of fields has caused operational tempo to increase at an inordinate pace. Admiral John Richardson, the Chief of Naval Operations (CNO) declared in the wake of the loss of service members' lives onboard the USS *Fitzgerald* (DDG-62) and USS *John S. McCain* (DDG-56) that we can no longer have a "can-do culture" (Olson, 2017). The U.S. Navy is requested often to aid in humanitarian disasters or security, but just because funds are available to support these missions does not mean that to do so is a wise investment. Allocating money to build equipment utilized in these

missions rather than in securing freedom of the seas is detrimental to the Navy's mission. It would behoove the Navy to empower partner nation militaries to deal with their own security. To begin this transition, the Navy needs to utilize training opportunities and exercises, and earn buy-in from partner nations. Once foreign nations correlate the benefits from joint exercises they will see that participation, though costly, has an indisputably high return on investment, such as in the ability to secure their EEZs.

For this purpose, countries need to see tangible results, and these results can be simulated or demonstrated with experiments and exercises. The military, in its approach to experimentation, is different compared to academic experiments. Academic experiments are very controlled, longer in duration, allow for variables to be modified, and are peer reviewed. The Navy, on the other hand, has multiple factors, both internal and external, that influence the outcome which makes replication of an exercise difficult without numerous assumptions. These assumptions include the possibilities of different people, ships, experience levels, equipment and weather conditions from one experiment to the next. It is for these reasons that documentation and analysis of all data points are vital to aid in future exercises and decision-making. Multi-national naval exercises are often documented electronically for record-keeping purposes. This increases the ease of sharing of the information, and it aids in the post-exercise analysis for future modifications to the exercise. Moreover, this pushes the military toward a more Network Centric Warfare (NCW) in which each member of the exercise contributes to the overall network. This concept is adaptable to the situation, and form the principles based upon the intent of the objective. In our design, we use NCW based upon the following principles: 1) know the enemy and the environment 2) gain situational awareness 3) iteratively create commander's intent, 4) conduct decentralized execution, and 5) perform self-synchronization (self-synchronization is a made up phrase used to gain attention; it simply means that if a unit achieves the previous four principles, it ought to then collaborate independently with other units of opportunity). These principles build upon one another; you cannot move on to the next principle without the achieving the preceding principle. Therefore, one experiment is not enough and that is why constantly running campaigns of experiments is necessary.

This thesis is part of a multi-year plan. The first year, which has already been completed, focused on a concept of operations. The second year (current year) focuses on developing an exercise plan. The third year will test and adjust the exercise plan as necessary. The fourth and fifth years will analyze objective success as well as incorporate data into other AOR joint exercises. This year, we have relied on *Campaigns of Experimentation: Pathways to Innovation and Transformation* by Dr. David Alberts and Dr. Richard Hayes for creating our plan. They are both experts in the field with numerous accolades. Dr. David Alberts has been a DoD adviser and has enhanced the ideas of NCW and is studied throughout multiple North Atlantic Treaty Organization (NATO) countries. As Albert and Hayes explain, an analogy can be drawn between networks, an experiment and a campaign of experimentation. The lone platform has a relatively small value when compared to a network. Thus, a network is the biggest weapon when establishing your combat power. (Alberts & Hayes, 2005, p. 3). Considerable time, labor, and finances go into planning and executing a multi-national naval experiment. It is logical that every idea, concept and result from ongoing simultaneous experiments are captured to benefit all current and future participants. Communications, information sharing, and design networks are crucial to the success of any exercise or mission, while combined exercises ensure the most effective use of resources.

To effectively use our resources during SEACAT, we want to be as nonintrusive as possible and will be working closely with the coordinator. As SEACAT typically conducts boarding exercises, the exercise plan will correspond to a boarding exercise. Once implemented, our successors will need to determine is the value of this data as well as the experiment hypothesis **"Can a vessel that is not radiating AIS data be found utilizing different software tools during a joint multi-national exercise?"** In this way, the undertaking of the series of MDA theses is both an experiment and experimentation campaign, as the experiment is ongoing with variations in desired outcomes:

> Experiments and experimentation campaigns differ in their analytic goals. Experiments are designed to provide objective testing of a focused set of questions. Therefore, the environment is tailored to provide the best conditions for testing these questions. By contrast, campaigns are designed to provide comprehensive insight across a set of related issues. The various axes of the campaign employ a range of methods to answer the question

> "Are we addressing all of the important aspects of the problem?". (Alberts, Hayes, Leedom, Kirzl, & Maxwell 2002, p. 45)

We want to test that a vessel can be discovered without usual RF signatures utilizing a combination of SeaVision and SPOTR to aid in vessel identification. To demonstrate the worth of this data, this and subsequent data will be analyzed over the course of the campaign of experiments. The eventual goal of this multi-year thesis project will be to complete automation and even apply predictive analytics for VOI within specific maritime operating areas to be utilized at SEACAT 2018 and, eventually, implemented by ASEAN nations in real-world scenarios. Throughout the course of building the experiment, we attempted to mitigate potential problems and distractors.

To design an effective experiment, one must understand the theory involved. After the CONOPS was developed, a formation of the information into an activity (an exercise) was needed. As Alberts and Hayes explain, these campaigns build and enhance interest and capability on a concept. This allows for experiments to eventually join an experimentation campaign, allowing for refinement and support for increased understanding over time (Alberts & Hayes, 2005, p. 22). The information obtained prior to the design of the exercise is immensely useful for integration into large-scale exercises.

In order for the advancement of exercises over time, a review of past exercises is important. Lessons and best practices should be documented so that the exercises can be refined and increased in complexity. For that reason, the design of an exercise is historically based upon previous exercises. Using previous information saves time and resources. These concepts are combined, as Alberts and Hayes explain, into a Code of Best Practices (COBP) these best practices are formed during collaborative efforts between multiple experiments. These events can happen individually, consecutively, or in parallel. Regardless of how the experiments run, the COBP aims to connect individual experiments into a campaign of experiments (Alberts & Hayes, 2005, p. 16). The COBP uses NCW to explore experimentation and present reasons why adherence to principles are important. Additionally, NCW represents an information sharing concept, guiding warfighters in mission effectiveness (Alberts & Hayes, 2005, pp. 2–7). In order to allow for information sharing best practices, procedures are recorded and replicated in accordance with NCW. In

developing our exercise plan, we found referencing Albert and Hayes's COBP diagram useful in moving from the conceptual phase to the process phase, as the process phase is where much of our experiment will be taking place.

See Figure 6 for the flow of experiments from initial concept to experiment design. Time, labor, and finances are all factors considered. The COBP aids in our decision process. There are several timelines that had to be met to both coincide with academic timelines and SEACAT timelines. Labor involves the complexity of experiment design and the repeatability of it. Finances contribute to design consideration as there are limited resources both on the academic side and the SEACAT side. To limit factors research was conducted where it was discovered that not only was data for SEACAT difficult to obtain but overall data for Navy exercises was also difficult to obtain at an unclassified level. The Navy currently does not have the best record keeping practices; this was the conclusion reached by the National Archives and Records Administration (NARA) in its 2016 inspection (NARA, 2016, p. ii).

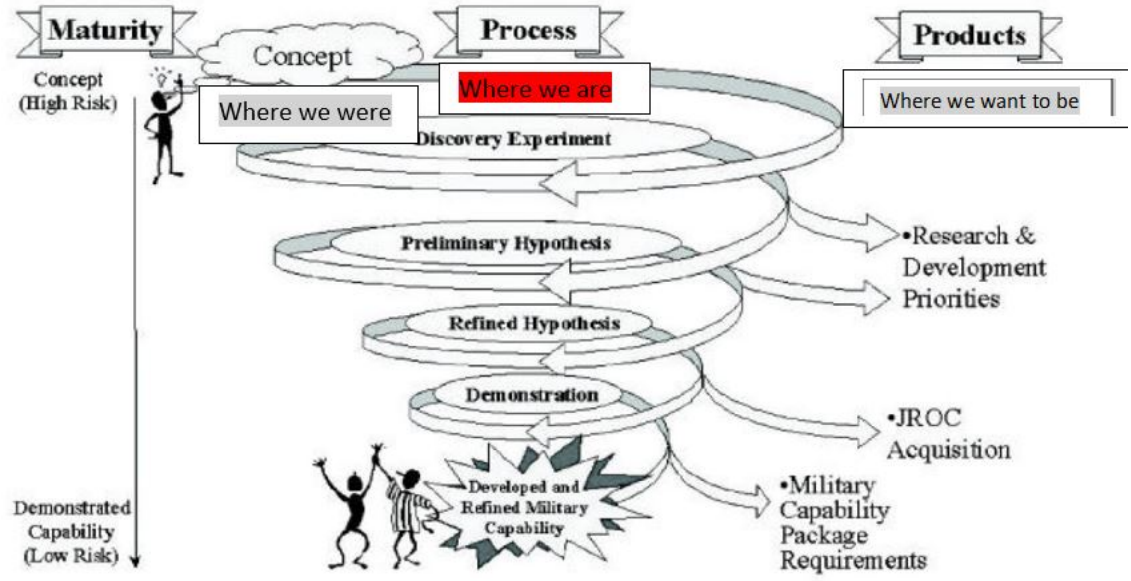

Figure 6. From Theory to Practice. Adapted from Alberts et al. (2002).

Because student-led experiments face restrictions to time and budget, it is unrealistic to travel to multiple areas overseas where exercises are taking place to gather data. For that reason, additional efforts must be made for information gathering. In preparation for designing our experiment, we were able to attend, participate in and gather data from a local 10-day exercise held at San Clemente Island, California. This case study helped lay the foundation for our design. We obtained information there which can be applied, modified, and adjusted for the eventual presentation at the initial planning conference (IPC) for SEACAT 2018 exercise in Singapore. The following section gives a brief description of the exercise and how we adapted sections to aid in forming our exercise plan for the SEACAT 2018 exercise. As explained by Alberts and Hayes, it is not uncommon to work in parallel on the preliminary hypothesis for variables while working on discovery work for a different hypothesis. Demonstrations can also lead to new hypotheses. Concepts of information sharing and collaboration are developed during joint military operations, and are essential attributes in operations (Alberts & Hayes, 2005, pp. 67–75). No matter what the goal of a current exercise is, since exercises build upon one another, it may be possible to relate these findings to another concept in a future experiment.

B. SAN CLEMENTE ISLAND (SCI) MULTI-THREAD EXPERIMENT (MTX)

This exercise consisted of multiple personnel from various organizations including Naval Postgraduate School (NPS) and the Center for Network Innovation and Experimentation (CENETIX) within NPS, various unmanned vessels, special operators, and project managers. The primary goal of MTX according to MTX logistics document 29 OCT 2017, “is to advance autonomy of a collaborative unmanned vehicle (UxV) Network Control System in a multi-domain environment. The system will consist of Scan Eagle (air), SeaFox (surface), Remus 100 (subsurface), Shield AI Quadrotor (air) and Persistent Systems mesh network equipment” (MTX, 2017). This network can reduce the need for personnel in dangerous mission areas, potentially saving operator lives.

Air, surface, and underwater semi-autonomous systems worked together to provide a robust mesh network and situational awareness for special operators. Technical solutions

determined how these UxVs could best support a tactical mission. The scenario required an intelligence brief, research questions, methodology, constraints, and key players. Even though similar experiments had been done before in various places in California, this particular experiment on San Clemente Island utilized certain equipment for the first time. This equipment included software for machine learning and a sharable communication tool called Observers Notepad to increase situational awareness and collaboration. Despite the new tools, there were still limiting factors such as time constraints. Many of the participants involved in this exercise had not received detailed briefs before the start of the exercise and had to learn to use the equipment during the exercise time. We noted several valuable observations as well as some focused areas for improvement.

1. Observations

The students learned about exercise planning and coordination from attending the San Clemente exercise. First, establishing a communication plan from the start is imperative for success during the exercise. The SCI MTX was missing elements of the communication plan and communication in general was unreliable due to the island terrain. This lesson will roll into SEACAT with a defined communication plan set up and tested before the start of the exercise. Many partner nations participating do not have the same communication protocols as the U.S. Navy; without the capability to communicate during the exercise, confusion and frustration occurs. Second, there must be contingency plans that consider uncontrollable factors such as weather or ship maintenance. A capturing of the data or non-data still adds value to the overall process.

2. Value and Areas of Improvement

The participants all had an information technology (IT) background and that aided immensely in troubleshooting the mesh network when it encountered problems. The research questions were well defined in advance and the observers and participants were able to recognize other value-added data points for capture and further analysis. There was a dedicated note-taker who aided in capturing most of the data. Additionally, the exact same scenario was repeated four times with most of the people fulfilling the same roles each day; this provided consistency and equipment familiarization for the operators.

Some of the operators, though diligent with the roles they fulfilled for the exercise, missed exposure and hands-on experience working with different UxVs. Additional factors include the timeline for the scenario and the geography of the island. It took too long to drive from one operating area to another. Dead zones on the island caused radio silence resulting in missed equipment reports. The communication plan and call signs had to be updated due to last-minute participants joining or switching roles, leaving communication gaps.

Weather also was a factor in the experiment. There were days when the unmanned aerial vehicles (UAV) could not fly because the cloud ceiling was too low; when the unmanned underwater vehicles (UUV) could not deploy because there was too much sea kelp in the area; when the unmanned surface vehicles (USV) could not deploy because of high waves. The last day of the experiment every UxV was able to fully deploy on schedule. Weather is unpredictable and proves that modifications to the original plan may be needed to produce results. This shows that, despite planning, unexpected variables can disrupt the exercise. Flexibility is necessary to make the best use of time and resources when participants are gathered for the experiment.

Participants were debriefed by the program manager immediately following the completion of the exercise. Key notes and data points were captured for future use in next year's SCI exercise. Additionally, NPS participants attended a round-table discussion going over data points they may not have mentioned during the first debrief. This gave an opportunity for additional reflection and to update the notes.

This information was categorized for a reiteration of the experiment next year. It is likely that since many of the participants were active duty service members that they will not take part in next year's exercise due to rotation dates. Therefore, the written findings will be very valuable to the team who is coordinating the exercise next year. The lessons learned from the SCI MTX helped in creating the exercise plan for SEACAT 2018.

C. TECHNIQUE SELECTION

The SCI MTX was a field exercise where many valuable lessons were learned and applied to our design. This year will be the first year NPS students will attend SEACAT,

and it is also the year that SeaVision will be used for the first time. A well-designed product, that not only meets the U.S. Navy goals but can also benefit ASEAN partners, must be presented. Due to time constraints and availability of vessels, we must conduct two processes simultaneously while not interfering with the other goals of SEACAT.

SEACAT is a multi-national exercise spanning two weeks. Different partner nations have different goals and expectations for the value of the exercise. As students participating in the exercise, our role is to educate and present our concept and experiment, highlighting the value of SeaVision with other experiments of the exercise.[1] Working with the coordinator for SEACAT 2018, we obtained the AAR for SEACAT 2016 and 2017. By analyzing these we learned that communications were a problem in last year's exercise (CTF 73, 2017, p. 5). At times the participants had to resort to using unofficial communications such as the text application WhatsApp and personal email (CTF 73, 2017, p. 6). These options are not ideal for naval exercises, and we recommend that the communication plan details official methods of correspondence.

The template for the standard operation procedure (SOP) we designed fits all of these metrics. We determined during year-one that adding imagery to the software could aid participants when looking for a VOI. The goal of this exercise plan is to find a vessel that has had its transponder turned off due to mechanical malfunction or nefarious interference, limiting its ability to be tracked, and effectively turning it into a "dark" vessel (Schwegmann, 2014, p. 14). The purpose is to be able to track the dark vessel with the use of SeaVision. Once the partner nations see this value they can utilize it in areas outside of an exercise environment, and it can aid them in securing their EEZs giving them control with assistance from the United States.

D. CONCEPTUAL MODEL

The first iteration of these MDA theses developed a conceptual model. A conceptual model is one that develops a theory or set of ideas. It conveys a general

[1] We were under the impression that the IPC was originally scheduled for February 2018, however, this date has since moved to April 2018. We will therefore not be able to present the experiment at the conference. Follow-on students will present at the IPC.

understanding and desire for a goal or product. The data is then collected, adjusted, and disseminated as required in a feedback loop. Best practices and areas of improvement are validated, and the process is then documented, and the loop continues adapting to new requirements as necessary.

The approach we took in developing our conceptual model was to take the foundation from the initial development of the CONOPS MDA thesis. We modified and adjusted the theory portion to include the concept of integrating SeaVision with SPOTR into SEACAT 2018. We related the SEACAT exercise to a business, because although it is not "for profit" there is still an exchange of goods in the form of training, skill development and refinement. The technology utilized to develop the CONOPS was very labor and resource-intensive. Since then there have been dramatic developments in SeaVision software as well as a better understanding of the capabilities, leading to enhanced usability by the researchers. The features include near full automation and customizable filters for the end users. We were able to expound upon a CONOPS depicting usage of a software utility to integrating the participants within a real naval exercise.

Each one of these sections (depicted as a rectangle in the following two images) could be expanded even more, giving an in-depth description of the tasks for the individual participant or utility. However, that work will be done by the following group. To that end, we want to provide a template that is customizable for future iterations of the exercise. The roles of participants can be changed, the tools adapted, and work flow modified. Theoretically, as long as the premise of the workflow is repeatable it aligns with the end goal of this thesis. As Sokolowski and Banks show in Figure 7, the process of modeling is essentially unfinished. The same school of thought is applicable to our model. We refer to it as a living document, able to be modified as necessary and tailored to the individual viewpoint. The advances in software capabilities for our chosen products, SeaVision and SPOTR have grown significantly in the past year and they will continue to advance by the time SEACAT 2018 occurs. In fact, SeaVision plans on doing quarterly updates; in that regard, it is expected that the capabilities will change every three months, thus emphasizing the need for a customizable model.

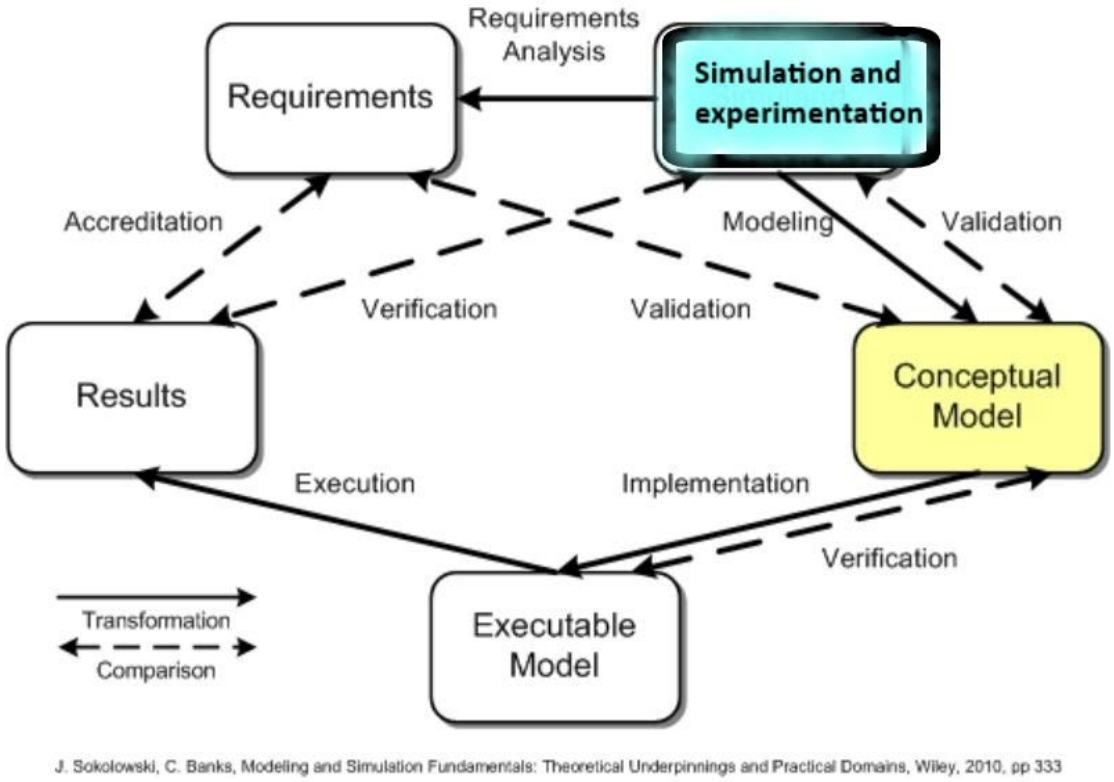

Figure 7. Model for experiment design. Adapted from Sokolowski and Banks (2010).

Our model includes the participants as well as the tools they will use; it is modifiable according to who is using it. Additionally, each of the sections can be executed by a different participant in the exercise. For example, the program manager can define the requirements for the exercise, but a specific ship's Captain can define the requirements for his/her crews' role in the exercise, then he/she can analyze those results. Though the initial conceptual model section has been completed for our experiment, conceptual ideas from this can later be applied to future Naval exercises. Our flow chart is similar to the business process of Event-Driven Process Chains (EPC).

We adapted the EPC model toward our method. This type of model does not have a direct causation pattern. Instead, many events can happen in sequence, in parallel or have a casual if/then effect. Hommes describes EPCs as chains of events and functions which typically they involve "and," "or," or "and/or" splits. (Hommes, 2004, p. 138) These type

of EPCs are usually too complex for an average user to comprehend, so results or best paths are modeled with software such as Savvion. One just needs to understand the if/then concept. One could look at our model and determine that once there is a program manager's intent, then there will be resource allocation and mission execution. On the other hand, no amount of program manager's intent can compensate for a natural disaster, such as a tsunami. In such an instance, if there is intent and a natural disaster occurs, then there will not be an exercise. Again, the model is situation dependent. On the right side of Figure 8 is the managerial component. This section could be a commander's intent, it could be the SEACAT program manager, it could be a delegated role, and then the roles can be further delegated to other members. After the intent is determined, the mission is executed. The mission is accomplished by a crew. The crew can consist of United States and foreign partners as well as the tools they use. In our diagram, we use the software SPOTR and SeaVision as the primary tools of the exercise. The data is then collected, adjusted, and disseminated as required in a feedback loop. Best practices and areas of improvement are validated, and the process is then documented, and the loop continues adapting to new requirements as necessary.

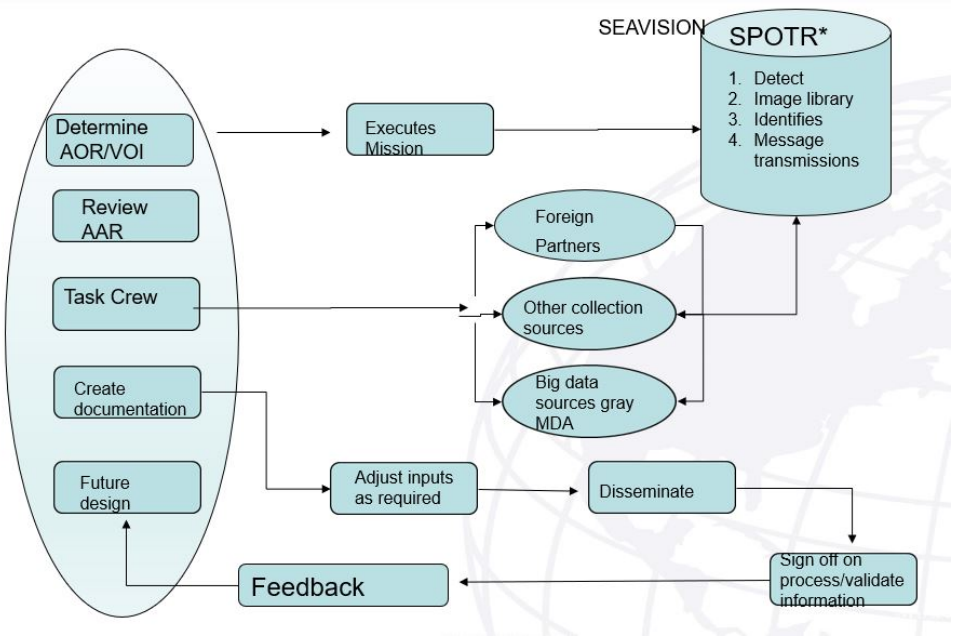

Figure 8. Event Driven Process flow chart for SEACAT 2018.

E. THE VALUE ADDED

The scientific method describes experiments in three general categories. They are laboratory experiments, field experiments, and natural experiments. When developing our methodology, we were immediately able to discard the laboratory and natural experiment types. These two types were impractical for our goals. The experiment did not need measurements at a granular level; instead, overviews and generalizations were determined to be incredibly useful measurements. The end result of the multi-year thesis is to demonstrate the usefulness of MDA tools by their integration in future naval exercises and real-world scenarios. As Figure 9 shows, there are numerous benefits to field experiments such as increased external validity, realistic settings and volume of participants (Thompson, K., 2016). It is beneficial to align with this annual exercise in order to begin the process of tracking data for future modifications and analysis. The results obtained will be analyzed and, provided the results are favorable, may eventually become SOP for SEACAT and other naval exercises.

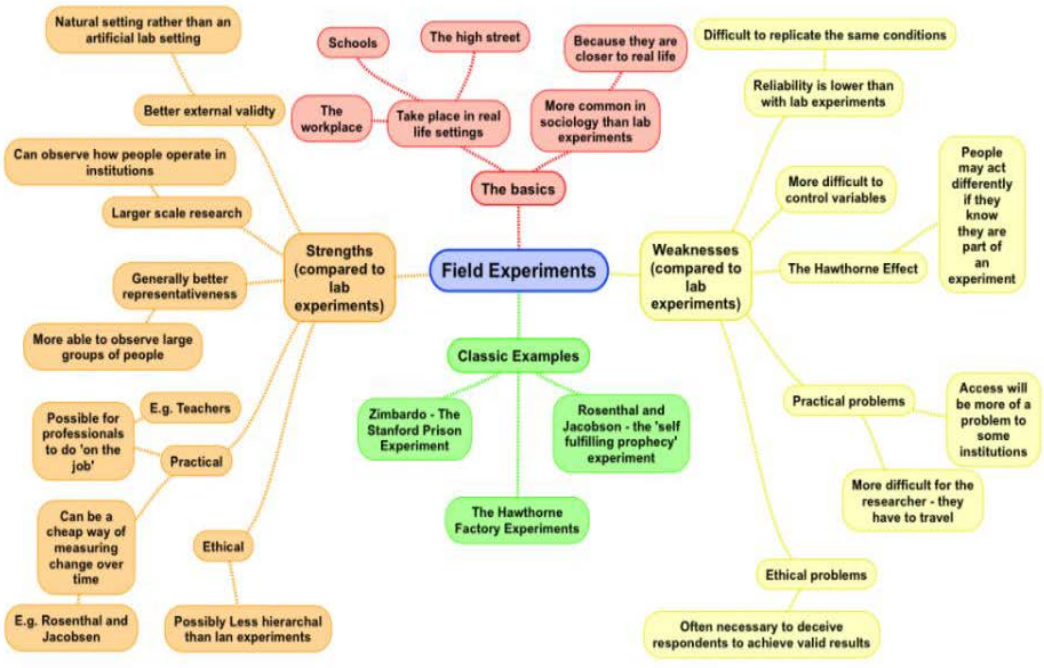

Figure 9. Comparison of field to laboratory experiments. Source: K. Thompson (2016).

Because results will be used in future exercises, it is important to ask the questions: **Why should SeaVision be used? What value does running our SeaVision exercise plan at SEACAT 2018 in parallel provide?** It is likely that the results will lead to a better refinement of the experiment process for future iterations. Additionally, the tools will aid decision makers, not only for future maritime exercises, but also in an advancement in maritime strategy.

Accordingly, each contributing factor needs to be described to demonstrate its value. However, as previously discussed with the San Clemente Island MTX experiment, a field exercise has many contributors along with a litany of manmade and natural variables which make obtaining specific measurements difficult. In order to assist in the mitigation of these known issues, and to make our experiment more valuable, we turned to Berry and Hart who have been experts in the field of human-software interactions. Their book, *Expert Systems: Human Issues*, includes a specification of the method for certain users, organizational context, and specific tasks and tools (Berry & Hart, 1990, p. 123). Their text was developed when the integration of software tools was still under development and these tools were not well accepted in the work force nor adopted in everyday functions. Yet, the principle basis of their research is still applicable today. Historically, people are slow to adopt new technologies, but a shift has occurred due to the increased availability of computers to younger people. However, there is still widespread disparity between those who have access and those who do not. Our multi-national partners in the SEACAT exercise may not be as familiar with or have as much accessibility to the same technology as U.S. Sailors. Berry and Hart further elaborate, "criteria applied to the method includes acceptability (how willing users are), usability (how able the users are to perform the task) and utility (the extent to which use of the method is cost effective)" (Berry & Hart, 1990, p. 125). Berry and Hart go onto state that "the method can easily be up-dated [facilitating] both the incorporation into the method of future knowledge as it emerges-[…] and incremental development of the method" (Berry & Hart, 1990, p. 129). These key factors are the driving force behind our design. The desire is for this foundational design to grow and adapt with future exercises as needed by the participants.

Though it may be difficult to quantify the results, the value of the scheme can be determined if any or all of these factors are met. Analysis of the AAR revealed issues with communication tools but did not elaborate on specific people or specific problems. We can expect that a common communication tool, such as a chat function embedded into SeaVision, would increase the value of the design as it addresses a known obstacle. If any or one of the partner nations is able to find the dark vessel(s) during SEACAT 2018 then there is value added. If the mission planners of SEACAT 2019 read the AAR for SEACAT 2018 and determine that SeaVision helped in the exercise, then there is value added. The metrics for this type of value can be seen simply by the usage of the program. Value can be exponential if this structure leads to a naval proof of concept and is used by ASEAN partners to address their socio-economic issues. The follow-on researchers for the third-year iteration of the CONOPS can assign values to the metrics as they see fit based upon the AAR or correspondence with exercise participants.

If one assumes that a campaign of experimentation continues indefinitely, then longer term measures of effectiveness might include number of piracy events in the SCS, number of fishermen taking captive, number of incidents over island building in the SCS, and finally, health of the fish population.

F. CONTEXT

People will understand an objective if you give context behind the desired goal. It is standard practice for there to be a narrative with background data, history, and objectives when conducting a Naval exercise. Upon receiving the AAR from SEACAT 2017, we have determined that there are two areas of critical concern. These areas include a general lack of effective communication where nations had to rely on the civilian phone application WhatsApp and personal cell phones hampering C2 (CTF 73, 2017, p. 6). The other issue plaguing SEACAT 2017 was the unreliability of their Information Fusion Center (IFC) portal, resulting in malfunctioning accounts from the start of the exercise and the Navy losing administrative controls of the portal (CTF 73, 2017, p. 6). The IFC portal is similar to the Navy's SharePoint portal goal for "all commands to collaborate and manage their data" (DoN, 2018).

Upon reviewing the issues, we predict that a chat function within SeaVision would mitigate communication issues between various units. Secondly, the ability for participants to upload their own layers within SeaVision will allow hands-on training to be used without disruption of real world collection; this function will be available in the upcoming months. Additionally, testing of a secure and reliable portal will be critical for mission success. Finally, granting access to other nations before and after the exercise can help streamline the start of the exercise and help relay lessons learned for future exercises.

To develop a functional exercise plan, a methodology is used to address these disparities. We have constructed a scenario that not only applies in an exercise setting but conceivably to real world proposals as well. Functionally, the participants in SEACAT will all benefit from using the recommended tools; benefits are not bounded to a project, manager, or exercise lead. Each of the individual crewmembers of the exercise will experience the value. Conversely, in a real-world scenario, an intelligence officer or mission planner will find the tool instrumental when looking for a VOI.

The following intelligence brief can be applied to SEACAT 2018 as this year they are focused on information sharing and boarding operations. The below assumptions must be made:

1) SeaVision is able to integrate a rudimentary chat function in the software (or an alternative chat function can be employed).

2) SeaVision is able to create an exercise layer.

3) Key members of the exercise will have access to an unclassified SharePoint type portal before the start of the SEACAT 18 where they will be able to add and edit documents as needed, and all other participants will have read capability.

4) The new features will be usable in the exercise and practiced before the Intelligence brief occurs.

G. SEAVISION

In the last year, SeaVision increased their product update frequency, as seen by the release of SeaVision 2.0 in October 2017 (SeaVision, October 24, 2017). As a result,

SeaVision users will now also have the ability to ingest Keyhole Markup Language (KML) files. An extra benefit to SeaVision will be the inclusion of a chat function among users. According to personal communication on January 30, 2018, with Olithia Strom-Rhea, SeaVision's Program Manager, SeaVision will roll out a chat function within the next few months and will be operational by the opening events of SEACAT 2018. However, SeaVision's chat is not yet operational and in its earliest stages may not address all of SEACAT's needs. To fill the gaps in SeaVision's chat function, we recommend using the complementary online website All Partners Access Network (APAN). The following sections describe the process of obtaining accounts for both SeaVision and APAN for use during the exercise. We recommend that the following steps are integrated into future SOPs. See Appendix A for how to use SeaVision and APAN.

H. ALL PARTNERS ACCESS NETWORK (APAN)

Until SeaVision's chat function is operational and robust, we recommend that all members involved with SEACAT utilize the All Partners Access Network (APAN) social networking website. APAN is free and available over the internet to "individuals and organizations who do not have access to traditional DoD systems and networks [so they] can participate in information sharing and collaborative events" (APAN, 2018a). APAN is already used in other naval exercises involving the 7th Fleet, such as Rim of the Pacific Exercise (RIMPAC), and is the Unclassified Information Sharing Service (UISS) of the DoD (APAN, 2017b). Operators of APAN can create their own groups and control privacy options to share information amongst each other.

APAN offers users a chat function. APAN has three different ways to chat including: Instant Message (Peer to Peer) (IM), Group Chat (chat.apan.org) and via third-party clients (APAN, 2018c). Additionally, APAN has the ability to translate webpages, text and documents in 18 different languages, including multiple Asian languages, with three different providers, including Google, SYSTRAN, and Language Weaver (APAN, 2018d). Although many of the languages of the SEACAT participants are not currently included in APAN, according to personal communication on February 6, 2018, with Donovan Nakama, a support member of APAN, additional languages for translation

purposes may be added in the future. APAN is currently in the process of transitioning to an Amazon Web Services (AWS) cloud infrastructure with a completion time of June 2018 (Giles, 2018).

Additional information sharing capabilities include audio and video conferencing with Adobe Connect. The Adobe Connect solution will allow users to share documents with members of the group (APAN, 2018e). Lastly, APAN allows the importing of KML and JavaScript Object Notation (JSON) geographic data files to "visually collaborate and share with your group by geotagging content and creating custom, interactive maps" (APAN, 2018f). SeaVision, APAN and the Intelligence brief are essential components of our design plan. All of them working in cohesion will provide the best anticipated results. This intelligence brief was designed with collaboration from Steve Mullins, research associate at NPS. (S. Mullins, personal communication, January 24, 2018). The goal of year three's thesis experiment is the use of SeaVision in SEACAT 2018. We have laid the foundation for this to be successfully executed. Our intelligence brief is one that aligns with a goal of SEACAT for boarding missions. We have written it to include the search for a dark vessel(s); this search will be done with SeaVision. The participants will locate the vessel then carry out their mission of a boarding operation.

We have constructed the intelligence brief to correspond not only with current affairs in the area, but also the socio-economic issues plaguing the region. The intelligence brief gives a story line to the participants so that they can see the value and the reasons they are conducting the exercise. This is much more effective than multiple exercise participants providing both context and purpose. The intelligence brief gives a scenario and aligns with the objectives of the exercise, therefore providing all participants and observers with a frame of reference which will not only be utilized in exercises but in also in real world scenarios. We previously discussed the principles of NCW and how they fit into our design plan. The intelligence brief defines our first two NCW concepts of know the enemy and shared situational awareness. While this may not be the exact scenario used in SEACAT'18, it gives an example by which to design the experiment.

I. THE INTELLIGENCE BRIEF

1. Background

Friendly forces and allies consist of U.S. naval forces on stations in international waters off shore Country Orange, a country in the SCS, at the request of its government. Allies consist of U.K. naval assets conducting typical maritime surveillance. The U.S. Navy currently conducts train, advise, and assist (TAA) missions with Country Orange naval forces to build up their ability to conduct local sea control and MDA. As part of this mission, United States forces are performing remote advise and assist (RAA) support wherein U.S. forces do not accompany Country Orange maritime forces during vessel boardings or other direct actions. The U.S. force was deployed to that location some weeks ago at the request of the government of Country Orange, whose geographic position causes it to maintain heightened security due to an increase in piracy and nautical crimes like EEZ violations and poaching. Increasing encroachment by Country Red in the SCS waters appears to be shifting the political climate.

Country Red's waters suffer from endemic weapons, human, and drug trafficking. Their government has been working diplomatic channels with the U.S. government seeking more direct participation from the United States to better patrol their waters and to help Orange resolve the possible presence of chemical materials of concern. Threat forces include rebel groups known as the maritime militia (MM), known to operate in these waters. Additionally, threats of piracy have been on the rise. Multiple ships have reported instances of fuel, rations, and even kidnapping off the ships. The rebel groups are believed to be receiving incentives from Country Red. Because of the increase in attacks, several nearby countries have started heavily arming their fishing and patrol boats.

The MM appear to be benefitting from Country Red, who seeks greater influence in the region in what appears to be turning into a proxy war. Country Red has been smuggling small arms and reportedly also shoulder fired surface-to-air missiles (SAM) to the rebels in the vast under-policed littoral areas. There is unconfirmed image intelligence (IMINT) that they are also helping the rebels by mining the waters off the east of the

archipelago's main island. This mining is causing civil disturbances among local fishermen in the coastal communities due to the risk their fishing boats are facing in the area.

The intelligence assessment of the rebel force is incomplete, but the following was received from a known, credible source. The MM is spread among several of the islands and is believed to number approximately 3,000 mostly male members armed with light weapons.

a. Phase 0: Initial Planning Brief

This phase occurs to brief all participants with the Intelligence Brief. Orders are relayed and any questions on procedure are answered in this time frame. Planners can generate a possible course of action (COA), based upon geographic locations where rebels have been operating recently. Web-based programs such as SeaVision and SPOTR will be crucial to identifying the VOI. In addition, the U.S. command wants to maintain low visibility and involve as few U.S. military assets as possible, therefore empowering local nations. Participants leave and move on to Phase 1.

b. Phase 1: All Participants Arrive and Set Up at their Predetermined Areas of Operation

(1) Note: Phase I begins when exercise assets have been positioned at their start points, and the communications have been confirmed operational.

(2) Note: Phase I ends when adequate coverage has been achieved and conditions are met to support insertion and boarding operations.

c. Phase 2: Participants Execute Objectives and then Return to Headquarters for Debrief

2. Intelligence Brief and flow chart integration

The intelligence brief is a vital resource to both our design and real-world missions. The participants in the exercise or the crew embarking on a mission need all the information available. This lets commanders plan and react accordingly. This leads us to our third principle of commander's intent. A commander may tread more cautiously if he/she does not have full situational awareness. On the other hand, if given the option and they know there is little chance of retaliation they will take advantage of the opportunity to strike. The

crew needs to be prepared to execute the commander's intent and that is why it is essential that the intent is clear. Time is usually of the essence in these situations and undefined intent can lead to costly mistakes. We can see how the self-synchronization principle comes into play here because self-synchronizations deviate from the typical hierarchical command and control structure and that is what we want to eventually happen for our ASEAN partners. The desired outcome would be for them to police their own waters and handle the situation accordingly without referring to the U.S. In the exercise plan, we empower the individual ships' commanding officers so that they can react accordingly to illegal activities in their waters. The steps of the exercise, based upon NCW principals, build upon each other to improve real-world situations. We have given the participants SeaVision and APAN procedures to accomplish this.

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IV. CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY OF RESULTS

As stated previously, the goal of this thesis is to build upon the CONOPS developed in year one in order to create an exercise plan that will then be used in SEACAT 2018. The overall goal of the multi-year thesis project focuses on designing, implementing, and analyzing an experiment at SEACAT that can be applied to real-world scenarios. This thesis is the result of comprehensive research into socio-economic issues plaguing the SCS, programs that can assist with MDA operations in the SCS and the applicability of these programs to SEACAT 2018.

B. PROCESS IMPROVEMENTS

This experiment is still at a theoretical stage but will be tested at SEACAT 2018. The next steps will be critical in moving from the theoretical into the practical. This research will produce an experiment, but it must be cultivated with the input of Commander, Task Force (CTF) 73 and our partner nations at CTF 73 to maximize its effectiveness. Some of the difficulties and restrictions encountered in developing our exercise plan were eventually mitigated and these methods should be used in the future when confirming the exercise plan. Because we encountered difficulties in determining the right person to speak to for specific products we recommend that POCs at CTF 73 be identified early. Again, a common information sharing portal would elevate this issue.

A key recommendation would be to obtain a list of personnel and their nationalities, and what languages will be present at the pre-planning conference for SEACAT 2018 to be held in April 2018. Once this information is acquired, determination of their account access to SeaVision or APAN is revealed and they can go through the setup process if needed. If their respective countries do not currently have an agreement with SeaVision, then participants can be shown the benefits and the usefulness of SeaVision. If the attendees of the pre-planning SEACAT 2018 conference speak a language that is not already loaded into APAN, then requests to the support team of APAN can be made.

One more update to the process involves the procurement of the specific areas of operations that the VOI will use during SEACAT 2018. Having this information will be crucial to utilize SeaVision to its full potential. As Wreski and Lavoie noted in their thesis, having additional imagery of the VOI will improve "SPOTR's classification and identification processes" (Wreski & Lavoie, 2017, p. 90). Without an appropriate amount of images of the VOI, SPOTR's ability to detect, identify and categorize the VOI is dramatically reduced. Currently, the process involves bidding and the VOI are not released until right before the exercise. We suggest that the bidding process occurs earlier in the planning stages so that the VOI are identified at least two months before the exercise to allow for proper software updates through SPOTR and SeaVision.

C. RECOMMENDATIONS FOR FUTURE RESEARCH

1. Import Imagery Data into SeaVision

We have learned through personal communication with SeaVision developers that SeaVision's ability to assist its users is dependent on the amount of data sources that are fed into the program. Currently, SeaVision obtains imagery from the Marine Traffic website. Registered users on MarineTraffic are able to upload photos, and are "included in the MarineTraffic Photo Directory" (MarineTraffic, 2018). As mentioned earlier with the MDA service Equasis, the validity of the imagery is questionable due to MarineTraffic not validating its authenticity before displaying it on the website. Therefore, it is pertinent that SeaVision ensure that the source of its imagery and other supporting data can be verified and trusted.

2. Transition to Future Capabilities

With the growing advances in technology, one can only estimate that the capabilities for MDA will also continue to grow. Two areas of interest include grey MDA networks and big data databases. In grey networks, atypical features are focused on, such as crew size, crewmember names, and port visits. Grey MDA information can be gathered through a variety of sources, including social networking sites, government- and non-government entities. The information can assist law enforcement (LE) by providing them with known criminal names in order to arrest or confiscate ships involved in illegal activity.

Big data databases are constantly updated and users can run queries based on their specific needs. The information gathered from big data databases can be immensely useful, providing LE officials another tool to help navigate their AOR. This data alone would save money and reduce unnecessary patrols.

Secondly, we believe that UxVs and artificial intelligence (AI) will help in MDA. UxVs and AI can collectively work together to patrol vast maritime regions and gather a litany of data that can be gathered and processed in near real-time. Maintaining a proper schedule of UxVs and AI operations will reduce the risk to personnel patrolling the sea and redirect their focus on other critical issues. Another aspect of AI that can be leveraged are tools that support pattern of life understanding. Such understanding can help MDA analysts understand when nonstandard, anomalous behavior is occurring, which can be a tipper to nefarious intent.

D. CONCLUSION

Our research has shown the growing importance of the SCS to the region, our country and the world. Without a stable SCS where countries abide by international law, illicit activities including overfishing, piracy, and energy usage will continue to accelerate with far-reaching consequences.

The theme the CONOPS focused on was awareness. In the past year, we, as academics, have moved past just being aware to taking action. We have determined through extensive research that the oceans, though vast, are very fragile. They are the lifeline of many societies' economies from a simple fisherman to global shipping companies. It is not only our duty to try to mitigate effects caused through collateral damage from everyday operations, but also to raise MDA for everyone who frequents these waters. When the facts and metrics are laid out, we can see that billions of dollars are being extorted through these waters. The reality is that competition in these areas will only continue to grow as these finite resources become less available. In an effort to take preemptive action, we want to educate, while giving resource tools to the nations that are situated near these waters.

We have developed a detailed proposal on how to gain acceptance of our methodology, as well as proven the utility of our proposal. It is our intention that this

exercise plan be used during SEACAT 2018. Once implemented, this will be valuable to the U.S. Navy by transferring some of the policing responsibility to our allies in the region who will be able to allocate LE personnel to these critical areas. The functions of SeaVision will continue to adapt and APAN, along with the eventual merger of SPOTR, will increase functionality, making users more comfortable. The dark vessels will therefore become more easily identifiable and it will become easier to thwart illicit activities. The crimes discussed throughout this thesis will eventually decrease, bringing stability to this volatile region.

APPENDIX. USER INSTRUCTIONS FOR SEAVISION AND APAN

A. HOW TO REQUEST AN ACCOUNT FOR SEAVISION

SeaVision is the MDA program that will be used during SEACAT 2018. The prerequisite for individual users to access SeaVision is that their respective county must have an agreement with SeaVision to provide their vessel's AIS data so all members of SeaVision can use the data for MDA. Once that relationship is established, the individual user uses the link https://seavision.volpe.dot.gov/login and agrees to SeaVision's terms and conditions. Figure 10 shows the SeaVision home screen.

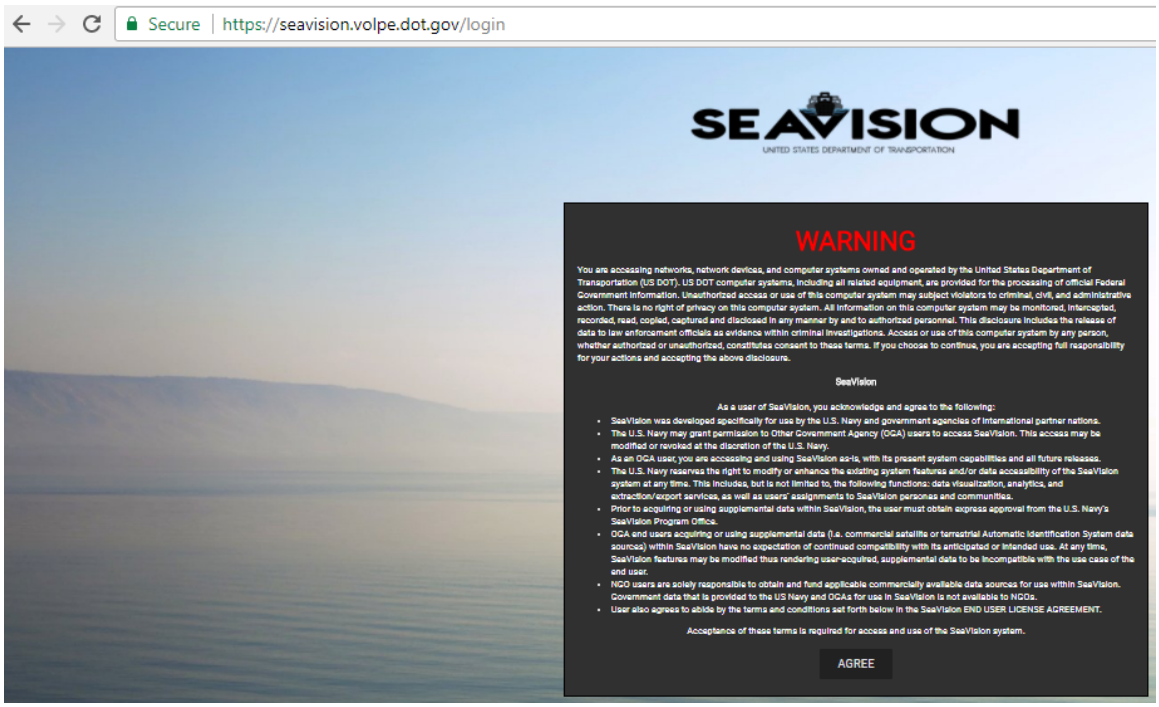


Figure 10. SeaVision home page. Source: SeaVision (2018).

Afterwards you will click on the "Request New Account" link. One you have a SeaVision account this is where you will insert your e-mail address/username and password that you provided during your registration. This page also has a "Forgot Password" and a "Get Help" link to assist the user. Figure 11 is a screenshot of the request new account page.

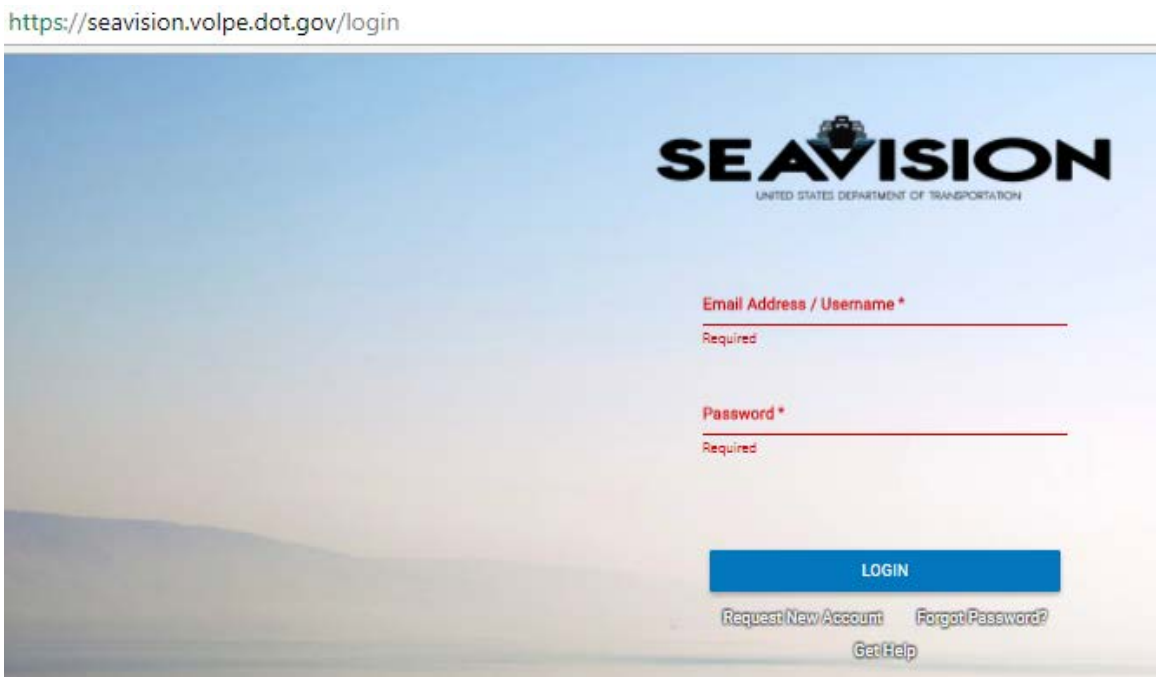


Figure 11. Request New Account Portion. Source: SeaVision (2018).

Figure 12 shows where you will insert your e-mail address. Afterwards you will click the "register" box. You will then receive an e-mail from SeaVision to continue the registration process.

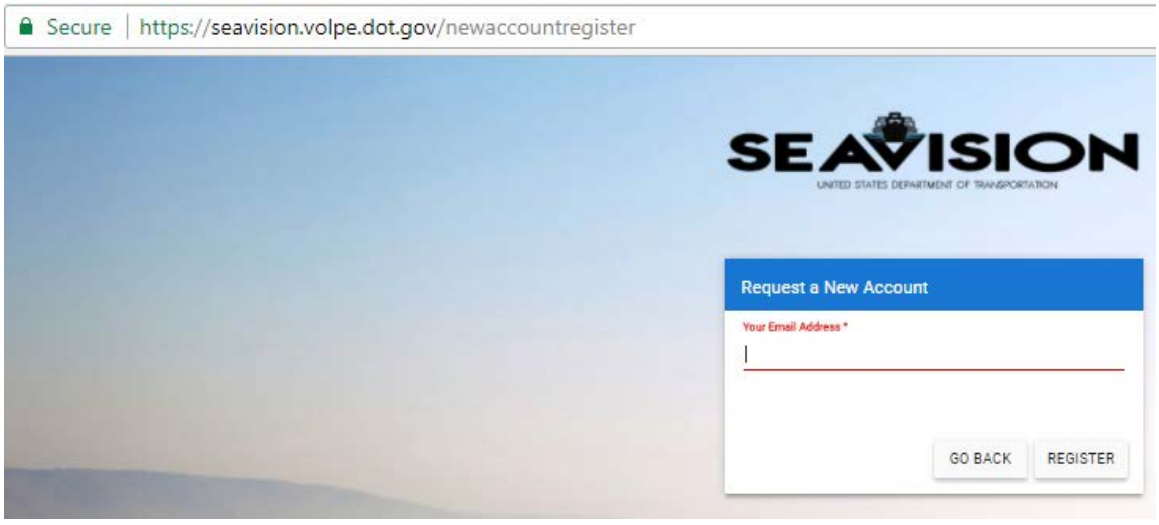


Figure 12. Request a New Account. Source: SeaVision (2018).

The e-mail will ask the user to click the "Validate Email" box or click on the provided link to complete the new account creation process as seen in Figure 13.

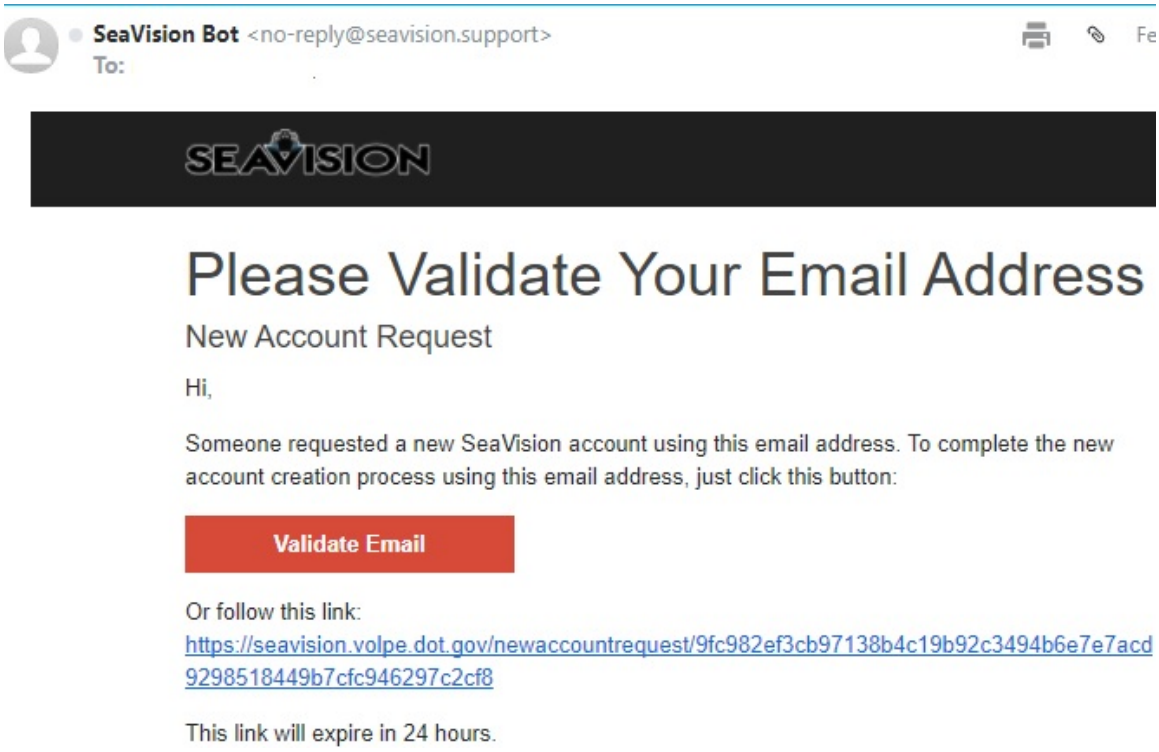


Figure 13. New account request e-mail. Source: SeaVision (2018).

Next you will arrive at the New Account Request page. You will fill out the profile information, login information, tell us about yourself section, and select a community to join. The community you join will depend on your mission. SEACAT members should select the Pacific community to join as it deals primarily with the Pacific Fleet and ASEAN member nations. Upon completion, you will click the send request button and wait for SeaVision to grant you access. Figure 14 displays the various fields requiring data. Due to screen limitations, the new account request page has been cut into thirds and placed side-by-side, rather than vertically.

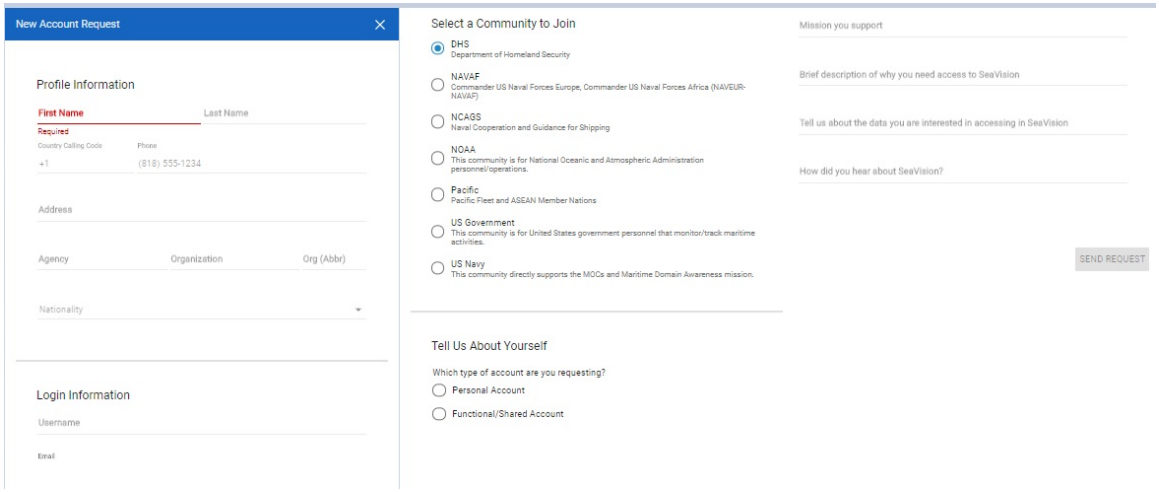


Figure 14. New account request page. Source: SeaVision (2018).

B. HOW TO REQUEST AN ACCOUNT FOR APAN

Requesting an account for APAN is relatively easy and requires little time. Figure 15 is a guide on how to join APAN

How do I join APAN?

1. Go to the APAN homepage: https://apan.org, and click ***Create Account*** on the top, right.
2. Complete the *registration page*.
3. Check your email, a ***validate your email*** message was sent.
4. Click the link in your email to complete your registration process.
5. Once your email is validated, finish the ***Join*** APAN form and select your password and security image.
6. Click ***Create Account,*** a system generated username will be provided to you.
7. Log into your account.

Figure 15. How to join APAN. Source: APAN (2018).

C. HOW TO SET UP GROUPS IN APAN

A key benefit of APAN is for users to establish groups with other APAN users. Members of a group can share information, chat, or access documents that will not be available to non-group members. Any user can create a group. A corollary benefit of this

feature is that the user creating the group does not have to be the "owner." Figure 16 is a step-by-step guide on how to create a group in APAN.

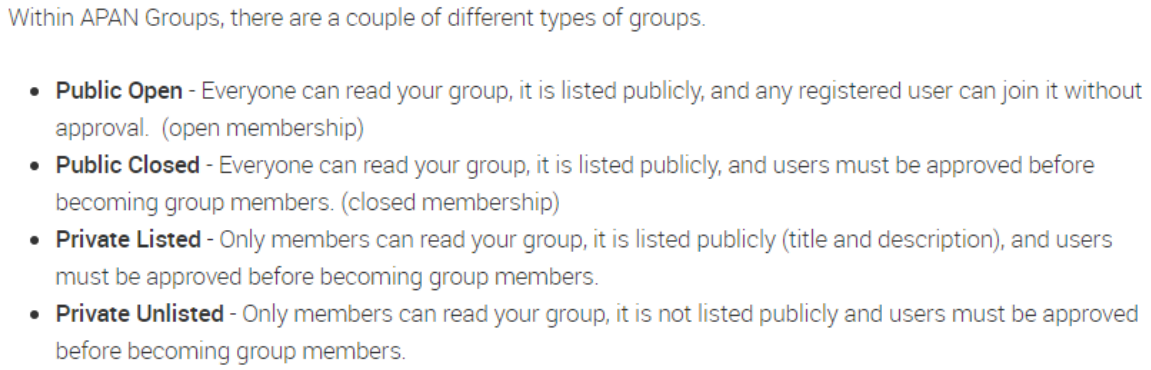
1. **Submit a Support Ticket** (https://community.apan.org/support/p/contact) The APAN staff will review your request and send you an email with a link to the APAN Community Requirements Form.
2. **Complete and Submit the Community Requirements Form** APAN requires one form for each community requested. Include as much information as possible. Once the APAN staff receives your requirements form, they will contact you to further discuss your information sharing & collaboration objectives.
3. **Get Approval** Once your requirements are fully captured and understood, the request is sent to APAN Application Service Provider(ASP) for review and approval. Requested Communities usually need to meet the following criteria for approval:
   a. Have a need to share unclassified information between the DOD and non-DOD entities (Non-Governmental Organizations, International Organizations, Foreign Nationals, other government agencies)
   b. Community participants who do not have access to the traditional DOD networks
   c. Originate from a U.S. DOD entity or have a U.S. DOD sponsor
4. **Community Owner Information Assurance Training and Agreement Form** A short training document will be sent to all new community owners that covers Information Assurance issues applicable to APAN. All new community owners are required to review this training document and sign the accompanying Agreement Form. The signed form must be returned to the APAN staff before you can be granted control of your community.
5. **Customize the Community** If your community is approved, an APAN staff member will build the basic shell of your group and contact you when it is ready. They will send you an email with the URL of your new community and some online resources for community owners. From there, it is the community owner's responsibility to:
   a. Customize the layout and brand the community
   b. Provide and monitor community content
   c. Manage the community's membership
6. **Attend Training** The APAN staff provides live online training weekly for community owners. There are also other community resources to assist users and owners with using APAN including the APAN Knowledge Base, Community Owner's blog, and the Ask APAN Forum.
   https://community.apan.org/support/default.aspx

Figure 16. How to create a group in APAN. Source: APAN (2018).

1. Group Types in APAN

APAN has multiple options for users to establish a group based on their personal preference. Groups consist of four variants: public open, public closed, private listed, and private unlisted. The public open option is the most accessible to other users while the accessibility is limited in the other types of groups. The two public options allow anyone

to be able to read your groups while only members can read your group in the private groups. Figure 17 outlines the various groups.


Within APAN Groups, there are a couple of different types of groups.

- **Public Open** - Everyone can read your group, it is listed publicly, and any registered user can join it without approval. (open membership)
- **Public Closed** - Everyone can read your group, it is listed publicly, and users must be approved before becoming group members. (closed membership)
- **Private Listed** - Only members can read your group, it is listed publicly (title and description), and users must be approved before becoming group members.
- **Private Unlisted** - Only members can read your group, it is not listed publicly and users must be approved before becoming group members.

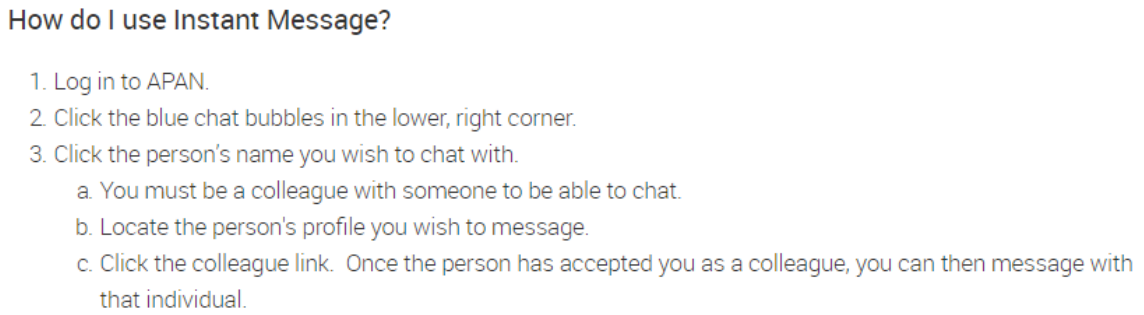
Figure 17. Group types in APAN. Source: APAN (2018).

D. HOW TO CHAT IN APAN

Communication issues abounded among participants in SEACAT 2017 based on the AAR. APAN uses three chat options, consisting of Instant Message (IM), Group, and via a third-party application.

1. Instant Message

During SEACAT, users may need to only communicate with a single user. IM would be the preferred method in this instance. IM will allow an APAN user to have real-time conversations with another APAN user. Figure 18 is a guide on how to use IM.

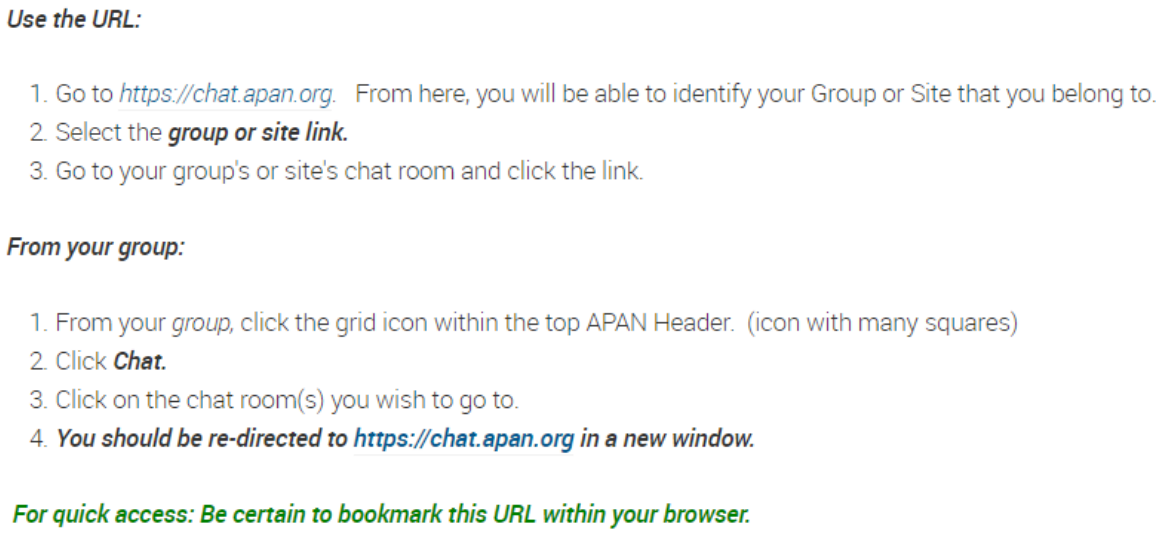

How do I use Instant Message?

1. Log in to APAN.
2. Click the blue chat bubbles in the lower, right corner.
3. Click the person's name you wish to chat with.
   a. You must be a colleague with someone to be able to chat.
   b. Locate the person's profile you wish to message.
   c. Click the colleague link. Once the person has accepted you as a colleague, you can then message with that individual.

Figure 18. How to use Instant Message in APAN. Source: APAN (2018)

2. Group Chat

SEACAT members may require to speak to all members of a specific group. For this occasion, the Group Chat option is available. Users can access Group Chat via the uniform resource locator (URL) or from your group. Figure 19 is a guide on how to use Group Chat from the URL of your group.



Use the URL:

1. Go to *https://chat.apan.org*. From here, you will be able to identify your Group or Site that you belong to.
2. Select the ***group or site link.***
3. Go to your group's or site's chat room and click the link.

From your group:

1. From your *group*, click the grid icon within the top APAN Header. (icon with many squares)
2. Click ***Chat.***
3. Click on the chat room(s) you wish to go to.
4. ***You should be re-directed to https://chat.apan.org in a new window.***

For quick access: Be certain to bookmark this URL within your browser.

Figure 19. How to use Group Chat. Source: APAN (2018).

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