

MASTER OF SCIENCE IN SYSTEMS ENGINEERING

21ST CENTURY SUBMARINE INFORMATION OPERATIONS (U)

Scott R. Coughlin-Lieutenant, United States Navy

B.S., United States Naval Academy, 1992

Master of Science in Systems Engineering-September 1998

Advisor: Vicente C. Garcia, Jr., National Security Agency Cryptologic Chair

Second Reader: CAPT James R. Powell, Information Warfare Academic Group

The United States Submarine Force has a long and distinguished history of providing national decision makers with Intelligence, Surveillance, and Reconnaissance services allowed by the unique access granted by the submarine's attribute of stealth. To maximize the effectiveness of our submarine fleet to continue to perform tomorrow's Information Operations (IO) missions requires evolution. This thesis will explore how to best prepare our submarine fleet to perform Information Operations.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Command, Control and Communications, Conventional Weapons, Electronic Warfare, Surface/Under Surface Vehicles – Ships and Watercraft, Sensors, Directed Energy Weapons, Air Vehicles, Space Vehicles, Computing and Software

KEYWORDS: Submarine, Information Operations, Information Warfare, Intelligence, Reconnaissance, Surveillance

AN ASSESSMENT OF WIRELESS LOCAL AREA NETWORKS: VULNERABILITIES AND POTENTIAL MILITARY IMPLEMENTATION (U)

Cynthia M. Fulmer-Lieutenant Junior Grade, United States Navy

B.S., United States Naval Academy, 1995

Master of Science in Systems Engineering-September 1998

Advisors: CAPT James R. Powell, Information Warfare Academic Group

Vicente Garcia, National Security Agency Cryptologic Chair

Wireless network technology provides improved services such as flexibility and high data rates at the promise of full mobility. The emergence of wireless local area networks (WLANs) has changed the role of wired communications in the face of this lower-cost, easy to implement, flexible technology. Wireless networks have mainly been implemented for civilian use. However, there is tremendous potential for WLANs in the military, from everyday administrative to operational shipboard implementation, to use by the Marine Corps during amphibious assaults and other ground maneuvers. The widespread use of WLANs, however, has occurred without certain key issues such as the security and vulnerabilities of WLANs being addressed. The objective of this thesis is to provide the Department of Defense with critical information on WLANs, a tutorial on how WLANs work, and to address the issue of vulnerabilities. This thesis provides a background of WLANs, looking at wireless communication, wired LANs, and the IEEE 802.11 standard for WLANs. It discusses vulnerabilities of WLANs and provides an initial vulnerability assessment and provides an overview of how WLANs have been implemented in the military, its potential for future use, and the security issues involved with military implementation.

MASTER OF SCIENCE IN SYSTEMS ENGINEERING

DoD KEY TECHNOLOGY AREAS: Command, Control, and Communications, Computing and Software

KEYWORDS: Wireless Local Area Networks, Local Area Networks, Wireless Communication, IEEE 802.11, Wireless Security

COMPUTER MODELING OF CAPTIVE-CARRY MISSILE SIMULATOR EXPERIMENTS

Wagner A. de Lima Goncalves-Lieutenant, Brazilian Navy

B.S., Escola Naval (Brazilian Naval Academy), 1986

Master of Science in Systems Engineering-September 1998

Advisor: Phillip E. Pace, Department of Electrical and Computer Engineering

Second Reader: Robert G. Hutchins, Department of Electrical and Computer Engineering

The increasing number, diversity and sophistication of the anti-ship cruise missiles around the world in the past thirty years have led to sophisticated countermeasures. The Naval Research Laboratory has developed hardware-in-the-loop (HIL) missile simulator technology to assess the effectiveness of electronic attack (EA) countermeasures. These simulators appear in two basic configurations: the closed-loop in an anechoic chamber and the open-loop captive-carry on board a P-3 aircraft.

The objective of this thesis was to develop a comprehensive Simulink© model representing the two HIL missile simulator configurations. These models were then used to study the influence of each parameter on EA effectiveness, as measured by missile miss distance.

The development of this model now makes it possible to compare the seeker responses of the two configurations as well as to have an inexpensive way to test new approaches to combine the closed-loop missile dynamics with the open-loop environment information to obtain more accurate EA effectiveness measurements.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Anti-Ship Cruise Missiles, Electronic Attack (EA), Hardware-in-the-Loop, Missile, Simulations, ASCM Digital Model, EA Effectiveness, Miss Distance

AN AGENT-BASED APPROACH TO ANALYZING INFORMATION AND COORDINATION IN COMBAT

Richard B. Hencke-Lieutenant, United States Navy

B.S., California State Polytechnic University, Pomona, 1990

Master of Science in Systems Engineering-September 1998

Advisors: Donald P. Gaver, Department of Operations Research

Carl R. Jones, Information Systems Academic Group

The quality and quantity of information flows is a critical factor in the command and control of forces in battle. Many current simulations do not adequately show the interactive effects of information on the battlefield. Agent-based simulation is a promising technique that can provide insight into these effects.

The purpose of this thesis is to develop an agent-based simulation to analyze the relationship between information and command structure. (SinBaD) Simulation of Information in Battlefield Decisions is the agent-based simulation developed specifically for this thesis. Although SInBad is only an abstract model of combat, it is believed that this approach can provide much insight into the mechanisms that affect the effectiveness of information in battle.

Several combat scenarios are simulated using different control rules. These simulations suggest that there exists scenarios where information is essential to mission success and some cases where its role is less instrumental or even detrimental.

MASTER OF SCIENCE IN SYSTEMS ENGINEERING

Other insights generated from this research suggest that agent-based simulation may help define metrics useful in aiding decision-makers during the planning and execution of a large and complex campaign.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Agent-Based Simulation, Complexity Theory, Complex Adaptive Systems

COMMUNICATIONS VULNERABILITY ANALYSIS OF FINANCIAL TELECOMMUNICATIONS

**Eric W. Herbert-Lieutenant, United States Navy
B.A., Pennsylvania State University, 1991**

Master of Science in Systems Engineering-September 1998

Advisor: John McEachen, Department of Electrical and Computer Engineering

Second Reader: Vicente Garcia, National Security Agency Cryptologic Chair

The American defense forces, national intelligence, and law enforcement agencies are challenged with meeting high operational demands with a finite set of resources. This thesis proposes a new Information Operations tool that focuses upon using computer network analysis. Using the OPNET Modeling and Simulation software, developed, by MIL3, Inc. to demonstrate how nation states and non-governmental organizations who condone and support the sale of illegal narcotics use computers and electronic media to communicate, an Information Operations/Warfare plan can be developed to defeat its use. Furthermore, this thesis' centers its research on how to remove the incentive, money, from drug dealer's coffers; thus, making the cultivation and sale of illegal narcotics a zero sum game.

This thesis concentrates on one nation in particular, country X, to create a baseline model of its electronic financial transactions. Once a model of a nation, who sponsors criminals and terrorist to operate within its borders, is created then this model can be tailored to fit any other nation. The strategy behind this research centers on country X's critical communications nodes and how to manipulate the nodes to serve our purpose vice their original intent.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Electronics, Electronic Warfare, Modeling and Simulation

KEYWORDS: Telecommunications, OPNET, Money Laundering

WINDOWS NT 4.0 SECURITY FOR IT-21

**Kevin S. Hinton-Lieutenant, United States Navy
B.S., United States Naval Academy, 1991**

Master of Science in Systems Engineering-September 1998

Advisors: CAPT James R. Powell, Information Warfare Academic Group

Vicente C. Garcia, National Security Agency Cryptologic Chair

The Navy is jumping into the information technology revolution by procuring commercial off-the-shelf computer networking hardware and software. This strategy is termed IT-21 and revolves around minimum standards set in January 1997. These standards designate Microsoft Windows NT 4.0 as the computer network operating system for tactical and administrative networks. Windows NT is inexpensive and easy to install and maintain, but it is a young operating system and has proved to be full of vulnerabilities. This may make the Navy's exchange of administrative and tactical information highly vulnerable to a determined and technical foe as well as the teenage hacker. There are methods to reduce the risk, however. Windows NT can be configured and implemented to significantly reduce the number of vulnerabilities.

MASTER OF SCIENCE IN SYSTEMS ENGINEERING

There are also a number of commercial security products that monitor the configuration of Windows NT, scan for security vulnerabilities, and detect near real time intrusions into Windows NT networks. The application of a combination of these techniques can drastically improve the security of our information exchange systems in the 21st Century.

INTEGRATING DIGITAL SIGNAL COLLECTION AND PROCESSING INTO THE EP-3E AND P-3C NAVAL AIR RECONNAISSANCE PLATFORMS (U)

John C. Kelleher-Lieutenant Commander, United States Navy

B.S., University of Arizona, 1984

Master of Science in Systems Engineering-September 1998

and

Gregory S. Kirkwood-Lieutenant, United States Navy

B.S., Southwest Missouri State University, 1988

Master of Science in Space Systems Operations-June 1998

Advisors: Vicente C. Garcia, Jr., National Security Agency Cryptologic Chair

Herschel L. Loomis, Jr., Department of Electrical and Computer Engineering

Abstract is classified

DoD KEY TECHNOLOGY AREAS: Air Vehicles, Space Vehicles, Battlespace Environments, Command, Control and Communications, Computing and Software, Electronics, Electronic Warfare, Human System Interface, Manpower, Personnel, and Training, Sensors, Manufacturing Science and Technology, Modeling and Simulation

KEYWORDS: MARTES, PAT, EP-3E, P-3C, SIGINT, COMINT, ELINT, Digital

COMPARISON OF FLIR TACTICAL DECISION AIDS FOR INTER-SERVICE USE

Daniel E. Machado-Lieutenant Colonel, Venezuelan Army

B.S., Venezuelan Military University, 1990

Master of Science in Systems Engineering-September 1998

Advisors: Alfred W. Cooper, Department of Physics

Kenneth L. Davidson, Department of Meteorology

Electro-Optical Tactical Decision Aids (TDAs) have proven their utility as tools for range performance modeling and mission planning. However, several TDAs are in current use in the United States armed forces. In fact, the services use different TDA codes which differ in the input data files and their sources required, in the operator expertise required, and the hardware required to run the program.

Within the concept of Joint Operations, which has become crucial in the modern battlefield environment, all the services must share procedures, techniques, and often the same technology. This thesis presents a comparison between the Army FLIR TDA, (ACQUIRE), and the infrared module of the Navy/Air Force TDA, WinEOTDA. Differences in the modeling of underlying physical principles, input parameters, and predicted target detection ranges are presented. Despite differences in input and treatment of environmental effects this analysis indicates similar levels of accuracy for the two codes. For two scenarios selected average predictions for three "typical" sensors fall within 20% of published observations. With further analysis and an operational evaluation it may be possible to select one Electro-Optical Tactical Decision Aid for all branches of the military.

MASTER OF SCIENCE IN SYSTEMS ENGINEERING

DoD KEY TECHNOLOGY AREA: Electronic Warfare

KEYWORDS: Tactical Decision Aids, ACQUIRE, WinEOTDA

INFLUENCE MODELING STATE-TERRORISM FOR INFORMATION OPERATIONS (U)

Russell L. Marsh-Lieutenant, United States Navy

B.S., Oregon State University, 1994

Master of Science in Systems Engineering-September 1998

Advisor: CAPT James R. Powell, Information Warfare Academic Group

Second Reader: Gordon McCormick, Special Operations Low Intensity Conflict (SOLIC)

Curriculum Committee

The purpose of this research is to use Situational Influence Assessment (SIAM) Module created by SAIC to model a terrorist organization that is attempting to disrupt negotiations between two state actors. The SIAM model was used to analyze the causal relationships and to look for the various leverage points at which to apply Information Operations (IO) that will minimize the effects of terrorist action, and influence the terrorists decision making process. The actors in a specific scenario were modeled as to how leadership could be influenced. After analysis with SIAM, possible IO options were created, incorporated into the model and tested to see how effective the IO options were at influencing the decision-making process. Once the IO options had been tested, a suggested plan of action results. Both a preventative approach and reactive approach are proposed. The preventative approach is intended to reduce the effectiveness of terrorism and impede the conduct of the terrorist organization. The reactive approach provides options for responding to terrorist activities without alienating the surrounding populace.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: SIAM, Terrorism, Information Operations, Peace Negotiations

AN OPERATIONAL HIGH POWER MICROWAVE APPLICATION FOR INFORMATION OPERATIONS (U)

Daniel J. Miller-Lieutenant, United States Navy

B.S., University of Colorado, 1992

Master of Science in Systems Engineering-September 1998

and

David P. Shewfelt-Captain, United States Marine Corps

B.S., United States Naval Academy, 1991

Master of Science in Systems Engineering-September 1998

Advisor: CAPT James R. Powell, Information Warfare Academic Group

Second Reader: Michael A. Morgan, Department of Electrical and Computer Engineering

This thesis documents the results of a feasibility demonstration of a high power microwave application for Information Operations and recommends future improvements to the system. Success in the Information Operations (IO) and Information Warfare (IW) arena requires advanced capabilities. This thesis describes one such capability that would provide commanders with courses of action previously unavailable.

DoD KEY TECHNOLOGY AREA: Directed Energy Weapons

KEYWORDS: Information Operations, High Power Microwave

MASTER OF SCIENCE IN SYSTEMS ENGINEERING

POLARIZATION EFFECTS ON INFRARED TARGET CONTRAST

Marcos C. Pontes-Captain, Brazil Air Force

B.S., Brazil Air Force Academy, 1984

Aeronautical Engineer, Aeronautical Institute of Technology, Brazil, 1993

Master of Science in Systems Engineering-September 1998

Advisors: Alfred W. Cooper, Department of Physics

David D. Cleary, Department of Physics

An analysis has been carried out of a data base of polarized long wave infrared images of the instrumented Research Vessel Point Sur recorded over a period of two days during the EOPACE measurements series in San Diego Bay in 1996. The measurements were made from a land site on Point Loma with an AGA780 sensor with internally mounted polarization filters. The objectives of the analysis were to determine a possible influence of target aspect angle on the polarization signature, to compare polarization contrast improvement in San Diego Bay with previous measurements in the North Atlantic, and to validate by measurement the estimation of unpolarized signature from vertical and horizontal components. 5508 images representing 70 cases with vertical, horizontal and unpolarized sequences were analyzed. Using a horizontal polarizer, target to background contrast improvement was found with a mean of 1.08 (8%) compared with the 15% found in previous measurements. Estimated unpolarized signatures from vertical and horizontal components agreed with unpolarized measurements with a slope coefficient of .85 to .99. Target signature for major ship facets and for total ship showed no discernable degree of polarization. A total of 37 IDL programs developed for this analysis can be assembled as a package for future data processing.

DoD KEY TECHNOLOGY AREA: Electronic Warfare, Sensors

KEYWORDS: Thermal Imaging, Polarization, Target Contrast, Infrared Radiation

COMPUTER NETWORK ATTACK (U)

David C. Rice-Lieutenant, United States Navy

B.S., United States Naval Academy, 1994

Master of Science in Systems Engineering-September 1998

Advisors: CAPT James R. Powell, Information Warfare Academic Group

Vicente C. Garcia, National Security Agency Cryptologic Chair

The convergence of computing and telecommunications places new and complex demands on U.S. intelligence agencies. Techniques in Computer Network Attack are discussed as a means to cope with the new communications environment.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Command, Control, Communications, Other (Computers and Intelligence)

KEYWORDS: Information Operations, Information Warfare, Computer Network Attack

MASTER OF SCIENCE IN SYSTEMS ENGINEERING

MODELING THE EFFECTS OF INFORMATION OPERATIONS ON AN ADVERSARY DECISION-MAKER (U)

Walter E. Rogers, II-Lieutenant, United States Navy
B.A., Virginia Military Institute, 1991

Master of Science in Systems Engineering-September 1998

Advisor: CAPT James R. Powell, Information Warfare Academic Group
Second Reader: R. Mitchell Brown, Department of National Security Affairs

The potential for crisis and conflict exists in almost every region of the globe in today's unstable world. In this fiscally constrained time, however, the United States cannot afford to expend resources and lives by employing forces in every crisis. This makes the use of Information Operations as an instrument to deter conflict increasingly desirable. Information Operations have the potential to accomplish U.S. strategic goals more effectively, with reduced political risk, and with comparatively less physical risk to our armed forces. Few commanders, however, willingly commit to a course of action before they have a firm grasp of the expected results. Unlike the use of physical means, whose effectiveness can be measured in terms of CEP and PK, the effects of Information Operations on an adversary's decision process cannot be quantified in the same way because the outcome of this process does not display physical phenomena. This thesis applies a software tool entitled Situational Influence Assessment Module (SIAM) to examine how a specific adversary's decision process can be modeled and what effects Information Operations may have on influencing that process.

DoD KEY TECHNOLOGY AREAS: Modeling and Simulation, Other (Information Warfare)

KEYWORDS: IO Modeling and Simulation, SIAM

REFRACTIVE CONDITION IN THE CARIBBEAN SEA AND ITS EFFECT ON RADAR SYSTEMS

Douglas F. Seijas-Lieutenant Colonel, Venezuelan Air Force
Master of Science in Systems Engineering-September 1998

Advisors: Kenneth L. Davidson, Department of Meteorology
David Jenn, Department of Electrical and Computer Engineering

Vertical gradients of pressure, temperature and humidity of the troposphere exert a strong influence over propagation of VHF, UHF, and SHF frequencies. These frequencies are associated with aircraft communications, radars and satellite communications, so it is important in military operations to collect precise and timely data from atmospheric conditions.

In this thesis programs from EREPS were used to assess refractive conditions in the Caribbean Sea against selected radar systems. Data given by SDS from radiosonde stations located in MS 43 and 44 were used as input for COVER and PROPR programs. Outputs from COVER are analyzed to find Optimal Altitude to Avoid Detection (OAAD) for a low-flying target. Outputs from PROPR using climatological data given by SDS and Optimal Altitude to Avoid Detection from COVER was used to verify OAAD against selected land- and ship-mounted radars operating in the Caribbean Sea. Finally, a system under development, TDRAP is introduced in response to requirements for timely and exact data, in order to enhance the tactical data collection process.

DoD KEY TECHNOLOGY AREA: Electronic Warfare

KEYWORDS: Refractive Conditions, Air Defense, Radar Systems

MASTER OF SCIENCE IN SYSTEMS ENGINEERING

IT-21 COMPLIANT CONTROLLED ACCESS TO INTERNET WEB PAGES

Marcia S. Sonon-Lieutenant, United States Navy

B.S., Purdue University, 1993

Master of Science in Systems Engineering-September 1998

Advisor: Gus K. Lott, Department of Electrical and Computer Engineering

Second Reader: Daniel F. Warren, Department of Computer Science

Although numerous resources are available to achieve Internet presence by creating and publishing a web site, security and access control within the site are very limited. The Navy's support of the IT-21 initiative embracing the Microsoft® Windows NT® operating system (OS) provides solutions to not only restrict entry to the site, but also to control access to content on the web page.

Work detailed in this thesis addresses the issue of security by exploring the Windows NT OS and activating its inherent security features to protect the overall system from intrusion and attacks from the Internet. The web pages are published using Microsoft® Internet Information Server 4.0 (IIS) and FrontPage™ 98. Access is controlled by issuing certificates from the resident Microsoft® certificate Server software package or remotely by VeriSign™ OnSite service. Windows NT and IIS permit a certificate to be mapped to a system account to further define the level of access assigned to each user down to the file level.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Electronic Warfare

KEYWORDS: IT-21, Microsoft Windows NT, Microsoft Internet Information Server, Certificates

COMPUTER NETWORK RESEARCH IN THE WINDOWS NT ENVIRONMENT (U)

Bruce G. Ward-Lieutenant, United States Navy

B.S., State University of New York (Albany), 1991

Master of Science in Systems Engineering-September 1998

Advisors: Vicente C. Garcia, National Security Agency Cryptologic Chair

CAPT James R. Powell, Information Warfare Academic Group

The world is witnessing an explosion of computer networking that is quickly changing the way that the United States Armed Forces and Department of Defense (DoD) agencies, such as the National Security Agency (NSA), need to focus their resources. U.S. adversaries and rogue nations as a venue of aggression can easily attain attacks on the United States National Information Infrastructure (NII).

This research documents the development of the Naval Postgraduate School's Computer Network Research Lab and discusses at the classified level different techniques toward educating the warfighters and increasing the technical knowledge base of our military leadership, which will assuredly be required in future conflict and the cyber battle field.

DoD KEY TECHNOLOGY AREA: Computer and Software

KEYWORDS: Computer, Network Research, Windows NT