MASTER OF SCIENCE
IN
SYSTEMS TECHNOLOGY

GLOBAL BROADCAST SYSTEM REACH BACK VIA ULTRA HIGH FREQUENCY DEMAND ASSIGNED MULTIPLE ACCESS SATELLITE COMMUNICATIONS

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The U.S. military requires a reliable, high-speed, multimedia capable system to disseminate information that cannot be efficiently distributed over existing low data rate channels. The Global Broadcast System (GBS) is being developed to meet this requirement. The cornerstones of the GBS simplex broadcast are the premises of smart push and user pull. An integral part of the user pull is the reach back channel. The reach back channel allows users to specify the information they need broadcast and tailor the information to meet their mission needs. Ultra high frequency (UHF) demand assigned multiple access (DAMA) satellite communications are the most widely available long haul communication systems available to members of the armed services and as such are a prime candidate to provide a reach back path for GBS. In order to fully utilize UHF DAMA as a reach back channel for data communications a number of interface requirements must be met. The problems of using UHF DAMA are discussed and recommendations are made for the GBS Phase Two systems so they might support the use of UHF DAMA as a reach back channel. This thesis shows that UHF DAMA is a viable reach back channel, however there are factors which could improve the efficiency.

DoD KEY TECHNOLOGY AREA: Command, Control, and Communications

KEYWORDS: Global Broadcast System, Reach Back, Ultra High Frequency Demand Assigned Multiple Access

CONDUCT AND ASSESSMENT OF A2C2 EXPERIMENT 3 AND GUIDELINES FOR FUTURE EXPERIMENTATION

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The Adaptive Architectures for Command and Control (A2C2) project is sponsored by the Office of Naval Research (ONR) and is focused on analysis of joint decision-making at the operational level and adaptation of joint command and control architectures. To accomplish this objective, the A2C2 project team has conducted a series of human-in-the-loop experiments at the Naval Postgraduate School (NPS). The third experiment of the series was conducted during November 1997. This experiment differed from previous A2C2 experiments in that it focused on how organizations adapt their structure to maximize their effectiveness under changing events. This thesis reports on the planning and conduct of Experiment 3 with a focus on the contributions made by author and the Lead Team of officer-students and the analysis of their hypotheses. The author examines data collected during Experiment 3 in support of these hypotheses. A detailed statistical analysis is per-

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formed and results discussed. Finally, a discussion of lessons learned from the author's perspective pertaining to the experiment is given along with recommendations for conducting future experiments at NPS.

DoD KEY TECHNOLOGY AREAS: Command, Control, and Communications, Modeling and Simulation

KEYWORDS:. Adaptive Architectures for Command and Control (A2C2), Statistical Analysis of Measures of Effectiveness, Human-in-the-Loop Experimentation at NPS

AN ANALYSIS OF BANDWIDTH REQUIREMENTS FOR COLLABORATIVE PLANNING

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Any military operation, no matter how large or small requires some level of planning. Planning has become more complicated, requiring more interactions across geographical, functional, and organizational boundaries in a more compressed command and control decision cycle. For ships at sea, conducting planning with other units, at sea or on shore, is constrained by the availability of communications bandwidth and limitations of the tools used for real-time interactions. Emerging tools such as audio and video conferencing and shared whiteboard, enable real-time collaboration among dispersed forces, however, these tools are bandwidth "greedy," requiring more than is currently available on many ships. In an effort to determine what amount of bandwidth a ship needs, this thesis used simulation and modeling to experiment with combinations of bandwidth, collaboration tools, the number of planners, and the network delivery method used. In general, a bandwidth of 128 kbps enables two ships to conduct a video and audio session. Using multicast network delivery, *256* kbps enables a ship to collaborate with five other sites, and at 384 kbps, a ship can conduct a whiteboard with video and audio with up to eight other sites.

DoD KEY TECHNOLOGY AREAS: Command, Control, and Communications; Modeling and Simulation

KEYWORDS: Collaborative Planning

ADAPTING THE MARINE AIR GROUND FORCE TACTICAL WARTIME SIMULATOR FOR USE WITH THE A2C2 EXPERIMENT

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The goals of the Office of Naval Research sponsored Adaptive Architectures for Command and Control (A2C2) research project are to study current and future joint command and control (C2) issues and develop theories about adaptive C2 architectures. The project includes three tiers of model-based human-in-the-loop experiments ranging from ones using simple, highly abstract computer-based simulations (Tier I), through more complex, realistic simulations (Tier II), to involvement in wargames and operational experiments (Tier III). Three Tier I experiments have been conducted to date, and a fourth is in planning. All have employed the Distributed Dynamic Decision Making III Simulation, developed for this type of experiment, and all have involved variants of the same amphibious scenario. The purpose of this thesis is to help the A2C2 research team prepare for Tier II experiments. The target platform for Tier II is the Marine Air Ground Task Force (MAGIF) Tactical Warfare Simulator (MTWS), a detailed and highly realistic stochastic simulation designed to train deci-

sion-makers. The author investigated the degree to which Tier I techniques and procedures can be transitioned to Tier II! MTWS by adapting the A2C2 scenario to the MTWS environment. This thesis also discusses extracting experimental data from MTWS.

DoD KEY TECHNOLOGY AREA: Command, Control, and Communications, Modeling and Simulation

KEYWORDS: A2C2, MTWS, Command and Control, Architectures, Simulation

DECISION AIDS IN AIRBORNE COMMAND AND CONTROL PLATFORMS

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As a result of dramatic growth in the capabilities of C41 systems, commanders have an immense amount of information available to them. Increased bandwidths and improved speeds in our communications systems can overload our commanders with data. One solution is improved methods of presenting information to the commander.

The same advances that threaten to overload the commander with data provide a solution. Improved technology now allows us to present the information in an easily assimilated graphical, 3D or "picture" form. These new types of displays can present the information in an intuitive style that eases the commander's cognitive workload and speeds comprehension. Recent studies comparing different types of displays support this theory.

Because commanders in airborne command and control platforms require a detailed understanding of a three dimensional environment, they should adopt some type of 3D display. Perspective or 2ΩD displays are not perfect for absolutely every situation the commander will face; but the added understanding of the action, tactics and intentions of friendly and enemy forces demand its adoption.

DoD TECHNOLOGY AREAS: Battlespace Environments, Command, Control and Communications, Computing and Software, Human Systems Interface

KEYWORDS: Decision Aids, Command and Control (C2), Display, E-2C Hawkeye, Three Dimensional Displays

ANALYZING COMMUNICATION ARCHITECTURES USING COMMERCIAL-OFF-THE-SHELF (COTS) MODELING AND SIMULATION TOOLS

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There are many initiatives focused towards the pursuit of information systems capabilities—hardware, software, and architecture—and other technologies that will markedly enhance the command and control (C2) function. The overarching purpose of this thesis is to provide joint task force communication planners with the tools for planning and managing the increasing communications demand. To this end, this project had two goals, to compare the performance of two computer-aided modeling and simulation tools representing both ends of the cost and complexity spectrum, and to provide a subjective evaluation. Four computer models were developed to simulate Information Technology for the 21st Century (IT-21) and Joint Tactical Information Distribution System (JTIDS) networks using OPNET Modeler/Radio, by MIL3, and EXTEND by Imagine That, Inc. Although assumptions were made to simplify the models, simulation runs demonstrated that the network models developed using OPNET and EXTEND produced very similar and believable results. The JTIDS

models results for data rate and message latency agreed within 3.5%. Similarly, IT-21 system models detected changes and trends caused by different system loads. The results indicate that low cost, commercial off-the-shelf modeling tools can be used to describe various networks used in joint operations.

DoD KEY TECHNOLOGY AREAS: Command, Control, and Communications, Modeling and Simulation

KEYWORDS: JTIDS, Link-16, IT-21, EXTEND, OPNET, Modeling and Simulation, Command and Control, Architectures, Simulation

CLASSIFIED TITLE
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Infrared remote sensors often detect thermal signatures on surfaces of naval ships induced by heating from internal sources Once thermal signatures are identified, temperature differences between various surface features can provide indication of these units' operational intentions.

This thesis demonstrates how a specific infrared remote sensing platform can be used to exploit signatures of specific military unites for intelligence Indications and Warning. Through the use of the Multisource Automatic Target Recognition with Interactive Exploitation (MATRIX) software, 18 infrared images were exploited and analyzed for temperatures. Temperature differentials were obtained between various areas along the hull and compared with departure times. A positive correlation was shown between temperature values over 60 C and departure of the selected units (U).

DoD KEY TECHNOLOGY AREAS: Space Vehicles, Other (Intelligence, Indications and Warnings (I&W))

KEYWORDS: Imagery Intelligence, Remote Sensing, Infrared, China, Naval

COMMAND IN THE 21ST CENTURY: AN INTRODUCTION TO CIVIL-MILITARY RELATIONS
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This thesis serves as an introduction to civil-military relations and the just war tradition for Joint Command, Control, Communications, Computers, and Intelligence (C41) students taking CC3000 or an equivalent course. The goal of this thesis is to provide the student with a broad understanding of these subjects. The author intends this thesis to be used as a supplementary reading in CC3000.

This thesis addresses the following: professionalism and its relationship to the study of civil-military relations, the roles of the military in society, civilian control and the various schools of thought associated with it, historical and legal precedents for the American civil-military relationship, the just war tradition, various issues affecting current and future civil-military relations in the United States, the impact of military operations other than war (MOOTW) on civil-military relations and the military ethos, and, finally, the applicability of the just war tradition to the MOOTW environment.

DoD KEY TECHNOLOGY AREA: Command, Control, and Communications

KEYWORDS: Command, Civil-Military Relations, Just War Tradition

MANAGEMENT SYSTEM FOR HETEROGENEOUS NETWORKS SECURITY SERVICES

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Military C41 facilities form an enormous network of distributed, heterogeneous computers. Operating these computers such that commanders can exploit their computing power effectively requires a resource management system. Management System for Heterogeneous Networks (MSHN) is a program under development specifically designed to address this need. Security for distributed computing systems is of particular importance to the Department of Defense. Previously developed resource management systems have largely neglected the issue of security. This thesis proposes a security architecture through which MSHN can achieve its goal of providing optimal usage of compute resources while simultaneously providing security commensurate with the software and data processed. A demonstration of the security framework was created using Intel Corporation's Common Data Security Architecture (CDSA). CDSA provided the cryptographic mechanisms required to build the security framework.

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

KEYWORDS: MSHN, Distributed Computing, Security Mechanisms, Common Data Security Architecture, Virtual Heterogeneous Machine