MASTER OF SCIENCE
IN
SYSTEMS ENGINEERING

A ROBUST SYMMETRICAL NUMBER SYSTEM WITH GRAY CODE PROPERTIES FOR APPLICATIONS IN SIGNAL PROCESSING

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A new symmetrical number system with applications in parallel signal processing is investigated. The Robust Symmetrical Number System (RSNS) is a modular system in which the integer values within each modulus, when considered together, change one at a time at the next position (Gray code properties). Although the observed dynamic range of the RSNS is somewhat less than the optimum symmetrical number system, the Gray code properties make it particularly attractive for folding analog-to-digital converters. With the RSNS, the encoding errors (due to comparator thresholds not being crossed simultaneously) are eliminated, as is the need for the corresponding interpolation signal processing (reduced complexity). Computer generated data is used to help determine the properties of the RSNS. These properties include the largest dynamic range (number of distinct consecutive vectors), and the position of the largest dynamic range within the system. The position of the maximum unambiguous dynamic range is also quantified. Least squares analysis of 2 and 3 moduli systems is used to formulate closed-form expressions for the dynamic range. To compare the advantages of the RSNS with previously published results, the transfer function of a 3-channel RSNS folding analog-to-digital converter architecture *($m_1 = 3$, $m_2 = 4$,* and *$m_3 = 5$)* is numerically evaluated using SPICE.

A COMPARATIVE ANALYSIS OF COMMERCIAL-OFF-THE-SHELF SOFTWARE FOR USE IN TRANSMITTING SENSITIVE BUT UNCLASSIFIED DATA

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Transmission of electronic data across the national information infrastructure (NII) makes such data vulnerable to interception and modification. Cryptography is the method of choice for protecting data integrity and preventing unauthorized disclosure. An effective and inexpensive method of protecting electronic transfer of sensitive but unclassified (SBU) data across the NII is required. This research develops a procedure to evaluate and compare the performance of Commercial-Off-The-Shelf (COTS) cryptography software products. This procedure is used to recommend cryptography products suitable for use with the Navy's IT-21 initiative. A set of minimum criteria for the software to be evaluated was developed to verify the general suitability for its use by the Navy in the transfer of SBU information. A search was conducted to determine which COTS products met the minimum criteria. Systematic and detailed evaluation procedures were developed. Products were tested using these procedures and scored using a system adaptable to a variety of potential users. Two products were identified which may be suitable for use with the IT-21 initiative.

UNCLASSIFIED FEASIBILITY OF REPLACING OR SUPPLEMENTING THE EA-6B SUPPORT JAMMING SYSTEM USING UAV BASED JAMMER(U)

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(U) There are increasing demands by theater CINCS for EA-6B Electronic Attack aircraft to provide Stand-Off-Jamming support during peace operations, as well as to protect aircraft which have missions near and within hostile countries. To reduce some of the demands for the EA-6B, large-payload Unmanned Aerial Vehicles (UAVs) containing stand-off Electronic Attack packages are now feasible. This study analyzes the feasibility of replacing or supplementing the EA-6B support jamming system using a UAV based jammer. The Global Hawk UAV with the ALQ-99 Electronic Attack system are the base systems for this study. This added support along with Global Hawks increased connectivity, higher survivability, and long on station time would give the EA-6B added flexibility in its employment against advanced radar and SAM systems. Global Hawk would still perform its primary mission of collecting airborne imagery, when not required to support the Suppression of Enemy Air Defenses. In order to determine the appropriate Concept of Operations for Global Hawk as a Stand-Off-Jammer, this study includes a threat analysis, and a determination of required airframe and electrical modifications.

A HIGH POWER MICROWAVE APPLICATION FOR INFORMATION OPERATIONS (U)

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(U) This thesis documents the requirement, concept, and validation process for the feasibility demonstration of a high power microwave application for Information Operations. Information Warfare (IW) and Information Operations (IO) are about providing the commander or decision-maker with options. Information Attack provides new courses-of-action for the commander when pursuing his mission objectives and gives him unique capabilities to attack the adversary in previously unimaginable ways. In order to procure any new weapons system, there must be a valid requirement for the system. In some cases, if the technology already exists, or if the system under consideration is an extension of an existing requirement, the new system concept may be validated by a feasibility demonstration. Supporting documents to this thesis provide summaries of testing conducted to demonstrate and quantify the potential effectiveness of the application.

STRATEGIC IMPACT OF IRANIAN DATA COMMUNICATIONS UPGRADES (U)
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Information Warfare goals include assessing an objective from a broad perspective, including the entire system of which the target in question is impacted by. This paper performs a case study against new, modern telecommunications systems and their impact on national strategies. Specific areas which effect the decisions of the top government officials are studied and reviewed. The impact of culture and how it prejudices a decision-maker is integrated with geographic and climate concerns. Other concerns, such as demographics and the impact this has on new installations is then added to the mix. These issues are then represented as a background to the more technical aspects of the telecommunications upgrades being experienced. Specifically, the digitization of all areas of the radio frequency spectrum and the innovation in switching technologies are included as part of this technological explosion and advance. Finally, the impacts the decisions (regarding the technological upgrades) have on national strategies, national policies, and how they impact the United States are addressed.

THE APPLICATIONS IN MILITARY COMMUNICATIONS OF LOW AND MEDIUM EARTH ORBIT COMMERCIAL SATELLITE SYSTEMS
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At the dawn of the 21st century several Low and Medium Earth Orbit Commercial Satellite constellations will be operational and they will be able to provide high bandwidth Global Communications in voice, data, and multimedia services for mobile consumers and also "users in the move." This research evolves as a continuation of previous studies (on Iridium, Globalstar, Teledesic, and Odyssey) and considers the ICO as well as the Teledesic and Global Broadcasting Services (GBS) systems in an effort to provide comprehensive model architecture. This model is desired to accommodate the narrowband, wideband, and broadcast requirements, respectively, of the U.S. MILSATCOM in addition to the communication needs of a model UN peacekeeping mission. The application of these systems to U.S. MILSATCOM coincides perfectly with the U.S. defense doctrine of a CONUS-based military with the capability of rapid global power projection to respond to crises throughout the global arena. Instead of investing heavily in new satellite systems, the U.S. military services can use the forthcoming commercial Low Earth Orbit (LEO) and Medium Earth Orbit (MEO) systems to meet the information requirements of tactical commanders.

VIDEO CONFERENCING USING PACKET RADIO TECHNOLOGY
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Information and its effective delivering means are becoming more and more important in today's world. Video-conferencing is a highly effective means to deliver information since it is interactive. This thesis studies the packet-radio-networking technology that can be used to support video-conferencing applications. The popular networking protocols, i.e., the Amateur X.25 (AX.25), the Transport Control Protocol/Internet Protocol (TCP/IP), and other protocols, widely used in packet

radio technology are described. By using the File Transfer Protocol (FTP) of the TCP/IP standard, the average speed and time of various file sizes across a half-duplex radio channel, a full-duplex emulated-radio channel, and a RS-232 link were collected and analyzed. Finally, comparisons were made among channels, including the effects of an additional routing node.

TACTICAL UNMANNED AERIAL VEHICLES USED
AS STAND-IN JAMMING PLATFORMS (U)
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Electronic Attack plays an important role in support of Information Warfare. Electronic attacks on enemy radar systems limits their use of the electromagnetic spectrum for detection of in-coming aircraft, causing them to be incapable of defending their airspace during an attack. By taking advantage of modern technology and supporting military actions, the use of tactical Unmanned Aerial Vehicles (UAVs) as stand-in jammers extend the military's ability to suppress enemy radar systems. UAVs can be used to fly riskier missions than current electronic attack aircraft such as the EA6B because the loss of the vehicle has no potential for loss of human life. UAVs are feasible platforms for conducting stand-in jamming. By comparing various UAVs and decomposing a stand-in jamming mission into its operational and functional parts, the effectiveness of tactical UAVs to perform this mission is demonstrated. Matlab is used in conjunction with IMOM version 3.2 to compute the effectiveness of stand-in jamming against various radar systems.