Technical Document 2899
June 1996

Command History

Calendar Year 1995

Preface

The Naval Command, Control and Ocean Surveillance Center, RDT&E Division, or NRaD, Command History for calendar year (CY) 95 is submitted in conformance with OPNAVINST 5750.12E. The history provides a permanent record of CY 95 activities at NRaD. Although the history covers one calendar year, most information was available on only a fiscal year (FY) basis and is so noted in the text.

The history is divided into two main sections. The first section gives an introduction to NRaD and describes developments in finance, organization, personnel, and facilities. The second section documents technical programs underway during 1995.

Because the results of scientific work often develop out of many years' effort, programs are not always documented annually. Previous command histories provide extensive background articles on many major programs. When possible, background articles are prepared for new or previously untreated programs. By consulting command histories written over a period of several years, a reader can follow the broad thrusts of Division research and development.

Appendices to the history provide supplementary information to the main text. Appendix A lists achievement awards given in CY 95. Appendix B lists patents awarded in FY 95. Appendices C and D provide lists of distinguished visitors hosted by NRaD and major conferences and meetings at NRaD, respectively. Appendix E lists additional program information (project name, number(s), role, point of contact, principal/supporting sites, and leadership area). A descriptive list of technical facilities is provided in appendix F.

Every attempt was made to identify acronyms and abbreviations—an impossible task. Most acronyms and abbreviations are defined when first used in the text; a glossary is included for reference.

Foreword

We live in a world that has changed significantly in a short amount of time. Political and economic changes will continue to shift many resources from defense to other areas. To meet the military requirements of the future while remaining competitive in today's market requires a new approach to how the Navy does business. Of primary interest will be the design of systems that are compatible and interoperable. Top-level requirements have been defined and architectural options have been initiated to ensure that individual systems will provide an integrated capability in support of joint, theater, force, and unit levels. To facilitate this integration, on 2 January 1992, the Navy established four major warfare centers, one of which is the Naval Command, Control and Ocean Surveillance Center (NCCOSC). Part of the NCCOSC command is the RDT&E Division (formerly the Naval Ocean Systems Center). Informally, we are referred to as NRaD.

Contents

Introduction and Administrative Developments 1

Introduction to NCCOSC RDT&E Division (NRaD) 3

NRaD's Mission and Leadership Areas 4

NRaD Technical Programs 4

Facilities 7

Finance 10

Organization 13

Personnel 14

Technical Developments 15

Command and Control 17

Advanced Combat Direction System (ACDS) 17

Command and Control Processor (C2P) 19

E-2C Airborne Tactical Data System Software Support 19

High-performance Computing (HPC) 20

Human Computer Interface (HCI) 21

Joint Maritime Command Information System (JMCIS) 21

Joint Tactical Information Distribution System (JTIDS) 22

Multifunction Information Distribution System (MIDS) 23

Range Naval Tactical Data System (NTDS) Upgrade 23

Communications 24

Electromagnetics 24

INFOSEC 27

Mobile Communications 28

Networks 31

Submarine Communications 33

Communications Support 37

Ocean Surveillance 39

Acoustic Sources 39

Advanced (COMINT) Voice Processing ATD 39

Advanced Deployable System (ADS) 40

Advanced Sensor Applications Program (ASAP) 40

Autonomous Sensor Concepts Project 40

Bottom Limited Active Classification (BLAC) 41

CERCIS 41
Common Aperture Multi-band Radar (CAMBR) 41
Common Integrated Platform 42
dbMASTER 42
Distributed Surveillance Technology 42
Electromagnetic Field 43
Fixed Distributed System (FDS) 43
Hayfield Multi-Chip Module 44
High-frequency Surface Wave Radar (HFSWR) ATD 44
IUSS Surveillance Direction System (SDS) Shore Systems Engineering 45
Marine Mammal Acoustic Tracking System (MMATS) 45
LEO SPO Support 46
Man Transportable Socrates (MTS) 46
Mine-Laying Surveillance 47
Mobile Undersea Warfare System, System Upgrade (MIUW-SU) 47
Multi-Mission Advanced Tactical Terminal (MATT) 47
Multistatic Active Project 47
Non-Acoustic Distributed Systems Components (NDSC) 48
Project Spinnaker: Iceshelf-95 48
Radiant Jade Demonstrations 48
Rapid Imagery Transmission (RIT) 49
Relocatable Over-the-Horizon Radar (ROTHR) 49
Shallow-Water Environmental Cell Experiment-4 (SWELLEX-4) 50
Shallow-Water Sensor System (SWSS) 51
Shipboard Infrared Search and Track 51
SITE 7800 51
Spatial Processing for Deployables/Robust Environmentally-Based Adaptive Broadband Beamforming/Automated Track-Before-Detect Processing 51
Standard TRE Display 95 (STRED 95) 52
SURTASS and Low-frequency Active (LFA) 53
Surveillance All-Optical Towed Array (SAOTA) Program 53
Tactical Aircraft Mission Planning System (TAMPS) 53
Tactical Cryptological Systems/Information Warfare Exploit 53
Theater Acoustic Warfare (ThAW)/Data Fusion 54
Tomahawk In-flight Position Reporting System (TIPRS) 54
TRAP Data Dissemination System (TDDS) 55
Vertical Launch ASROC (VLA) Missile Program 55

Virtual Lab 56
An Integrated Hybrid Neural Network and Hidden Markov Model Algorithm for Classification Applications 56
Command, Control, and Communication Modeling and Analysis 57
C3 Simulation and Technology 57
MAGTF Tactical Warfare Simulation (MTWS) System 57
Research, Evaluation, and Systems Analysis (RESA) 59
Ocean Engineering 60
Air-Mobile Ground Security and Surveillance System (AMGSSS) 60
Flying Plug 60
Marine Materials 61
Mine Neutralization System (MNS) 61
Mobile Detection, Assessment, and Response System (MDARS) 62
Test and Evaluation 62
Unmanned Undersea Systems 62
USS *Dolphin* 63
Navigation 64
Air Navigation 64
Global Positioning System (GPS) 64
Navigation Sensor System Interface (NAVSSI) 66
Navigation Technology Programs 66
Ocean Survey Program (OSP) 67
Ring Laser Gyro Navigation (RLGN) 68
Marine Mammals 69
Marine Mammal Systems (MMS) 69
Integration of Space Communication and Surveillance Systems 71
AN/USQ-101(V) TADIXS B/TRE 71
Electronic Sciences and Technology 72
Analog Photonic Link Dynamic Range 72
Infrared Focal Plane Array (IRFPA) 72
Low-power Electronics 73
Memory Chip 73
PINC Wavelength Division Multiplexing (WDM) 73
Silicon-on-Sapphire (SOS) 74
Stochastic Resonance (SR) 74
Tri-Service Support 75
Trident Missile 75

Environmental Assessment 77
Marine Environmental Support Office (MESO) 77
Site Characterization and Analysis Penetrometer System (SCAPS) 78
Marine Sciences and Technology 80
Waterside Security System (WSS) 80
Independent Research (IR) 81
Independent Research Program 81

Appendices

A Awards—1995 . . . . . A-1
B Patent Awards—CY95 . . . . . B-1

D Meetings—1995 . . . . . D-1
E Program Information E-1
F FY95 NRaD Facilities F-1

Figures

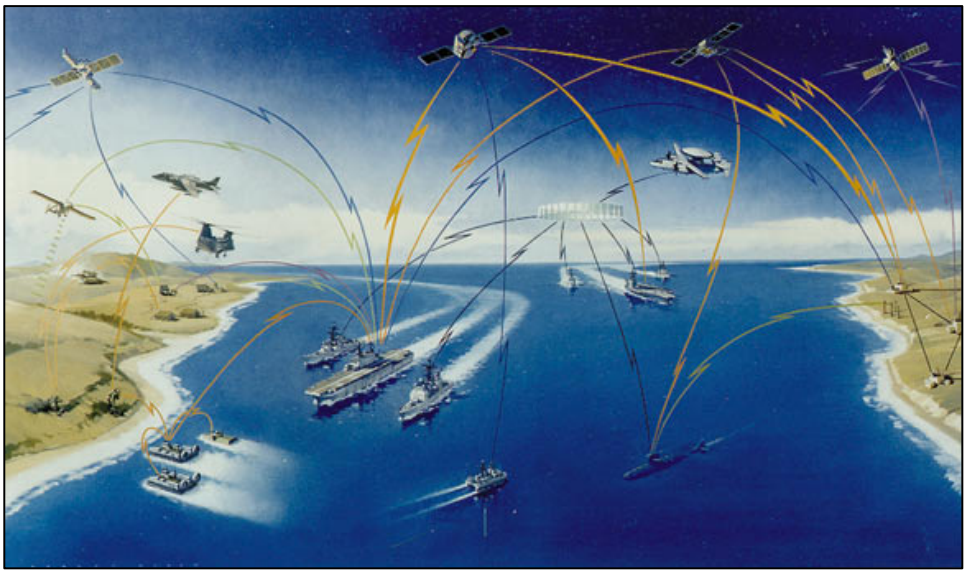
Global Positioning System (GPS) 6
Point Loma Penninsula 7
Advanced Combat Direction System 17
E2C Airborne Tactical Data System (ATDS) Integration 20
Full-Spectrum Communications 24
SHF SATCOM Facility 30
Undersea Surveillance 39
Relocatable Over-the-Horizon Radar (ROTHR) 50
MAGTF Tactical Warfare Simulation (MTWS) System 58
TRANSDEC Facility at Night 61
USS Dolphin enroute to NRaD, Bayside 63
USS Dolphin and crew arriving at NRaD, Bayside 63
NAVSTAR GPS program segments 65
Ocean Survey Program 67
Dolphin with trainer 69
Dolphins at NRaD 70
NRaD Microelectronics Laboratory. (LRO 2034-8-87) 72
Cone Penetrometer Fiber-Optic Fluorometer (Double Fiber System) 78

Table

1. FY 95 NRaD property resources. 10

Introduction and Administrative Developments

Introduction to NCCOSC RDT&E Division (NRaD)



The Naval Command, Control and Ocean Surveillance Center (NCCOSC) RDT&E Division (or NRaD) is a full-spectrum RDT&E laboratory serving the Navy, Marine Corps, and other Department of Defense and national sponsors within its mission, leadership assignments, and prescribed functions. NCCOSC is one of the Navy's four major warfare centers and reports directly to the Commander, Space and Naval Warfare Systems Command (SPAWAR) in Washington, DC. At NRaD, we provide solutions to Navy, joint service, and national problems by generating and applying science and technology. We provide innovative alternatives to tomorrow's decision makers, enabling them to pursue new or expanded missions and capabilities.

We work closely with NCCOSC In-Service Engineering (NISE) Divisions to provide Fleet, joint, and national users and customers with complete life-cycle support. This support spans efforts that range from generating science and applying technology to creating new system concepts and upgrading older systems to perform previously unforeseen roles. We also work with SPAWAR, other Navy system commands, the Fleet, the Office of Naval Research, defense and national agencies, academia, and industry to produce quality products and services. Our roles include providing leadership for developing systems and solutions and functioning as a "smart buyer" to ensure that the government purchases quality products in an increasingly complex and technological marketplace.

At NRaD, we are strongly committed to our customers. We maintain close contact with them to ensure that our efforts remain relevant and meet the needs and threats of tomorrow; our goal is to ensure that Navy, joint commands, and

defense and national agencies—the ultimate users and customers of our products—retain technological and operational superiority. We are also uniquely capable of serving operational users during national crises. Specifically, we support systems that we have helped introduce into today's forces by providing technical expertise and laboratory and test facilities not available to operational commands.

We continue to serve our sponsors in roles for which we have demonstrated expertise: creation and demonstration of technology, program formulation and initiation, Technical Direction Agent, Acquisition Executive Agent, Software Support Agent, system and subsystem prototyping, and the support of test and evaluation. We also actively license technology and support the transition of technology to industry.

NRaD's Mission and Leadership Areas

NRaD's mission is to be the Navy's research, development, test and evaluation center for command, control and communication systems and ocean surveillance and the integration of those systems which overarch multiplatforms. NRaD's leadership areas include the following:

- Command, control, and communications systems
- Command, control, and communications systems countermeasures
- Ocean surveillance systems
- Command, control, and communication modeling and analysis
- Ocean engineering
- Navigation systems and techniques
- Marine mammals
- Integration of space communication and surveillance systems

NRaD Technical Programs

NRaD provides full-spectrum research, development, test, and evaluation within its assigned mission and leadership areas.

Command and Control

In command and control (C^2), NRaD pursues an aggressive technology-based program that includes distributed C^2 technologies, information management, human systems interaction, modeling and simulation, advanced computing technologies, and Marine Corps technology applications. As an active participant in the Joint Directors of Laboratories Technology Panels for command, control, and communications; computer science; and human factors, NRaD leverages our Navy technology with those developments in the Army and Air Force. Transition of our technology base to evolutionary systems is our enduring goal.

NRaD's current C^2 systems development includes the Advanced Combat Direction System for command ships, the Joint Tactical Information Distribution

System, the C^2 Processor, and the Joint Maritime Command Information System (JMCIS). JMCIS is a new architectural initiative that encompasses the Navy Tactical Command System-Afloat and the Operations Support System. JMCIS is an operational C^2 system that provides an integrated decision support capability for all levels of command, both ashore and afloat.

Communications

Communications of all types (e.g., wire, fiber optics, line-of-sight, satellite, ATM) are the foundation for all components in the C^4I infrastructure. NRaD provides communications support for entire integrated systems as well as system architecture development. NRaD's leading role in the development and deployment of interoperable advanced communications for the joint warfighter on all platforms includes Lead Laboratory responsibilities for the Joint Maritime Communications Strategy (JMCOMS). NRaD also leads the Navy in extending the National Information Infrastructure and Global Grid to the theater through a high-data-rate wireless mobile network that optimizes the mix of commercial and military assets to ensure successful Expeditionary Force operations.

Surveillance

NRaD is charged with developing systems and technologies for the surveillance of air, surface, and undersea objects in and around ocean areas of operational interest, and with fusing multisensor information into an integrated theater and regional surveillance picture. Technologies and sensors include radar; microwave; millimeter wave; optical; electric and magnetic field; and passive and active acoustics and associated processing.

Ocean Engineering, Marine Mammals, and Marine Environmental Quality Assessment and Remediation

NRaD provides ocean engineering expertise in the areas of undersea search, work, and reconnaissance systems. NRaD is also pursuing innovative research in robotics, materials, optical and acoustic undersea communications, and electro-optical and electromagnetic propagation.

NRaD's RDT&E work with marine mammals has demonstrated that marine mammals can perform tasks related to object detection, location, marking, and recovery. Four operational marine mammal systems have been delivered to the Navy. Such work has also resulted in improved diagnostic and treatment techniques for marine mammals and a much improved understanding of their capabilities. Work has started to determine impacts of fleet activities on marine mammals in the wild.

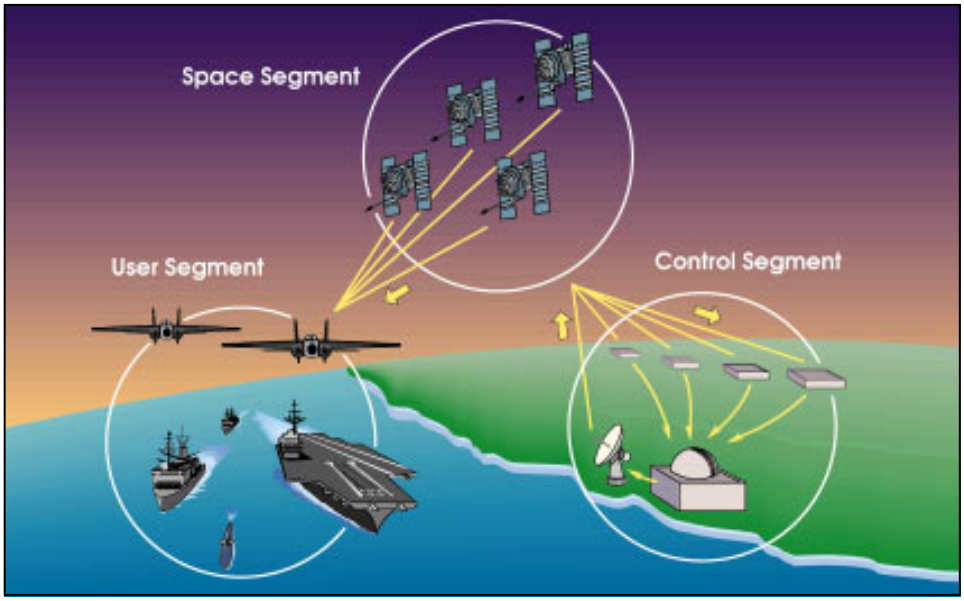
NRaD also develops marine environmental risk assessment and remediation technology, and, through its Marine Environmental Support Office, provides direct support for aquatic environmental issues to the Fleet and to Navy shore facilities.

Engineering and Integration of Overarching Multiplatform Systems

NRaD provides full-spectrum C^4I/Surveillance (C^4I/S) RDT&E capabilities-from theater-level systems architecture through specific systems design, development, test, and evaluation to evolutionary program support. These capabilities are provided to Navy, Marine Corps, Joint, and Allied customers.

Navigation

NRaD is the Navy's lead Navigation Center—developing and integrating navigation sensors and systems for all types of Navy platforms, including aircraft, ships, and submarines. Product lines include internal reference systems such as inertial, gravity, and absolute velocity; and external reference systems such as the Global Positioning System (GPS). NRaD is the GPS Program's Central Engineering Activity for GPS user equipment. In addition, under the Multimission Survey Program, NRaD implements this navigation technology to develop and maintain systems that produce ocean-bottom contour charts for use by the Fleet.



Global Positioning System (GPS).

Independent Research

New and innovative ideas proposed by NRaD scientists and engineers are supported by the Executive Director through the use of discretionary funding provided by Independent Research (IR) programs. These programs support initial research in many areas of interest to the Navy, including command, control, communications, ocean surveillance, and navigation.

FY 95 program developments are discussed in the Technical Developments section of this document. Appendix E lists additional program information (Project Numbers, Role, POC, Principal Site, Supporting Sites, and Leadership Area).

Facilities

Point Loma Peninsula.

NRaD occupies more than 500 acres on the Point Loma peninsula, approximately 7 miles from downtown San Diego. NRaD's resources include superb facilities for conducting RDT&E in command, control, communications, intelligence (C^3I), and surveillance. NRaD's laboratories offer worldwide networking capabilities plus the ability to participate in major joint exercises. NRaD also has the waterfront access and berthing capabilities vital to its activities in ocean surveillance, ocean engineering, and marine sciences. The NRaD detachment in Warminster, PA, provides facilities for navigation and airborne communication systems.

Building 33 and surrounding area, Topside.

Building 600, Seaside.

Berthing Pier 160 and marine mammal cages, Bayside.

In San Diego, facilities are concentrated in three major areas: Topside, Bayside, and Seaside. NRaD Topside, located on the ridge of Point Loma, includes the principal administrative and support sections, as well as facilities for communications, environmental testing, electronic materials, advanced electronics, laser technology, and ocean surveillance. NRaD Bayside faces San Diego Bay, which provides waterfront access and berthing capabilities. NRaD Seaside, located on the west slope of Point Loma, offers a protected, electromagnetically shielded site essential to RDT&E in C^3I and ocean surveillance.

Distributed Test Beds

Command, control, communications, computers, and intelligence (C^4I) and surveillance systems must link ship, aircraft, submarine, land, and theater, joint, allied, and coalition forces into an information network that supports the

warriors in the execution of their assigned mission. The overarching nature of these systems requires test beds that support the integrated testing of multiple configurations that involve components on a global scale. Connectivity for these distributed test beds is provided by Integrated Virtual Networks using both military and commercial communications systems. Distributed test beds facilitating system development, integration, and evolution include Link-16, SATCOM, Tactical Receive Equipment/TRE-related Applications (TRE/TRAP), Global Grid, and the Submarine Communications Integrated Test Facility.

From modeling and simulation to Fleet exercises, at-sea testing, and global exercises, NRaD continues to develop integrated test beds for multiplatform systems. NRaD has put in place the communications connectivity to allow most of the Navy's C^4I and surveillance systems to be interconnected to support developmental testing as well as to participate in live operations with Fleet units.

High-Performance Computing

NRaD is a leader in Department of Defense (DoD) high-performance computing (HPC). The most recent addition to this capability is the Intel computer Paragon, which is a scalable parallel system that provides DoD employees with classified operation support in solving the next generation of grand application problems. Command-wide facility connectivity of optical and Synchronous Optical Network (SONET) data rates is provided to enhance and enable global connectivity for state-of-the-art advances in HPC, networking, and information integration.

Information Transfer Management Structure

The enabling part of NRaD's total capability is the Information Transfer Management Structure developed by the Communications Department to provide for and manage rapid reconfiguration of our significant C^4I and surveillance capabilities and to provide national and international connectivity using commercial and military capabilities in support of primary mission areas.

NRaD's surveillance resources include field sites for electromagnetic, electro-optic, and acoustic experimentation off Point Loma and nearby locations, and in-house facilities such as the Tactical Surveillance Laboratory, the Surveillance Test and Integration Center, and the Parallel Processing Applications Laboratory. Access to operational data links combined with a close working relationship with air, surface, and submarine units provide a complete systems analysis, engineering, integration, and test capability.

NRaD Detachment, Warminster, is located at the Naval Air Warfare Center, Aircraft Division, Warminster, PA. As a full-spectrum Navy laboratory, it provides engineering services to DoD for developing military navigation and airborne communications systems. The Inertial Navigation Facility, located in Warminster, provides a uniquely quiet environment that isolates noise and vibration, allowing extremely high stability and long-term inertial sensor measurements.

NRaD property resources as of 30 September 1995 are given in table 1.

Appendix F gives additional facilities information.

Table 1. FY 95 NRaD property resources.

	Land (Acres)		Buildings (sq. ft. in thousands)				Acquisition Cost			
	Owned	Leased	RDT&E	Admin	Other Operational	Other	Real Prop (Class I/II) ($M)	Equipment (Class III/IV) ($M)	New Cap Equipment ($M)	New S&E Equipment ($M)
La Posta	1108	0	0.0	0.0	0.0	7.0	1	0	0	0
Morris Dam	0	660	22.0	2.0	4.6	3.7	3	1	0	0
San Clemente IS, CA	0	0	23.3	0.1	3.9	14.0	0	2	0	0
San Diego, CA	508	0	1406.5	276.5	167.6	22.7	102	68	3	0
Sentinel, AZ	47	0	0.0	0.0	0.0	0.0	0	0	0	0
Warminster, PA	0	0	94.4	13.6	4.3	0.0	0	7	0	0
NRaD Total	1663	660	1546.2	292.2	180.4	47.4	106	78	3	0

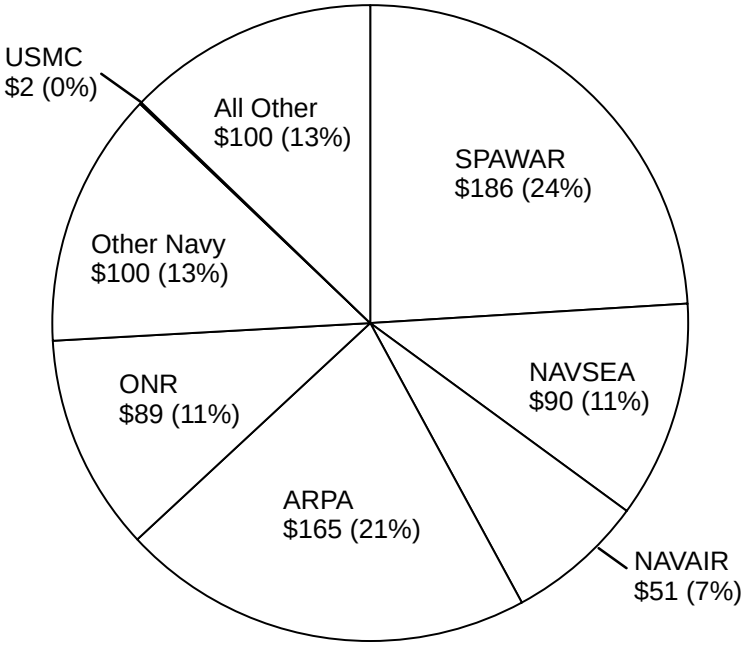
Finance

NRaD receives funding from sponsors that include SPAWAR, the Naval Sea Systems Command (NAVSEA), the Naval Air Systems Command (NAVAIR), the Office of Naval Research (ONR), the Advanced Research Projects Agency (ARPA), and the U.S. Marine Corps. The accompanying charts show FY 95 funding.

NOTE: ARPA's name changed to the Defense Advanced Research Projects Agency (DARPA) in March 1996.

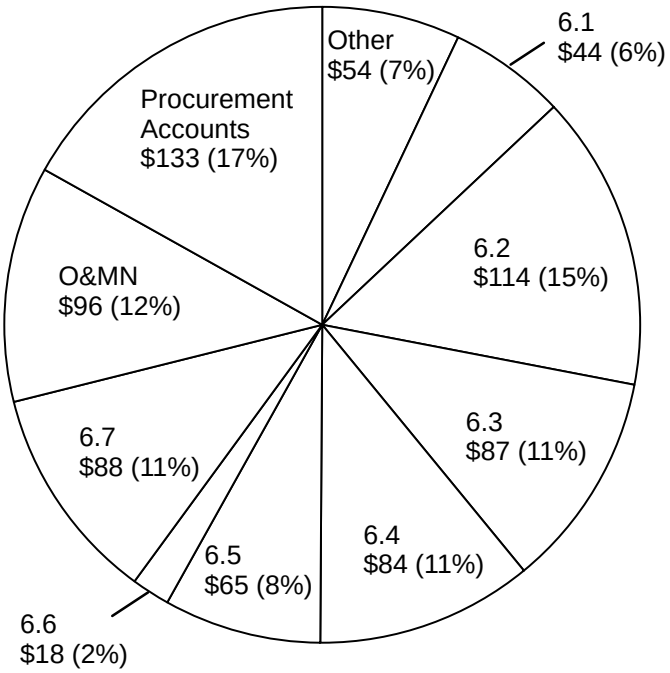
Funding by Sponsor – FY 1995

Actual $783 Million



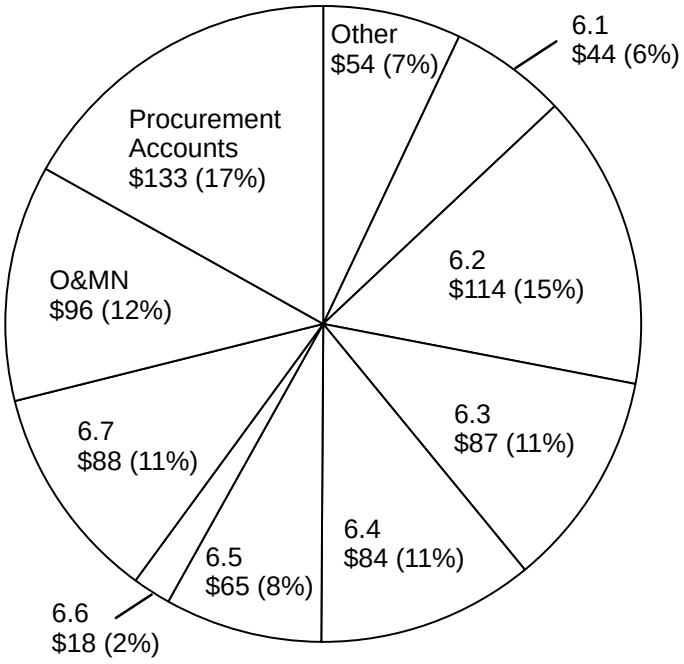
Funding by Appropriation – FY 1995

Actual $783 Million
(Includes Direct Cites $265 Million)



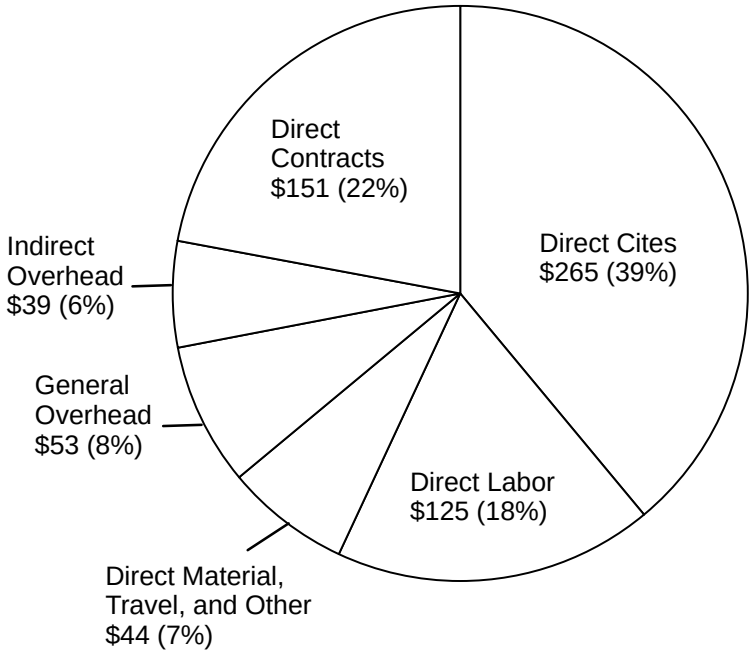
Funding by Appropriation – FY 1995

Actual $783 Million
(Includes Direct Cites $265 Million)



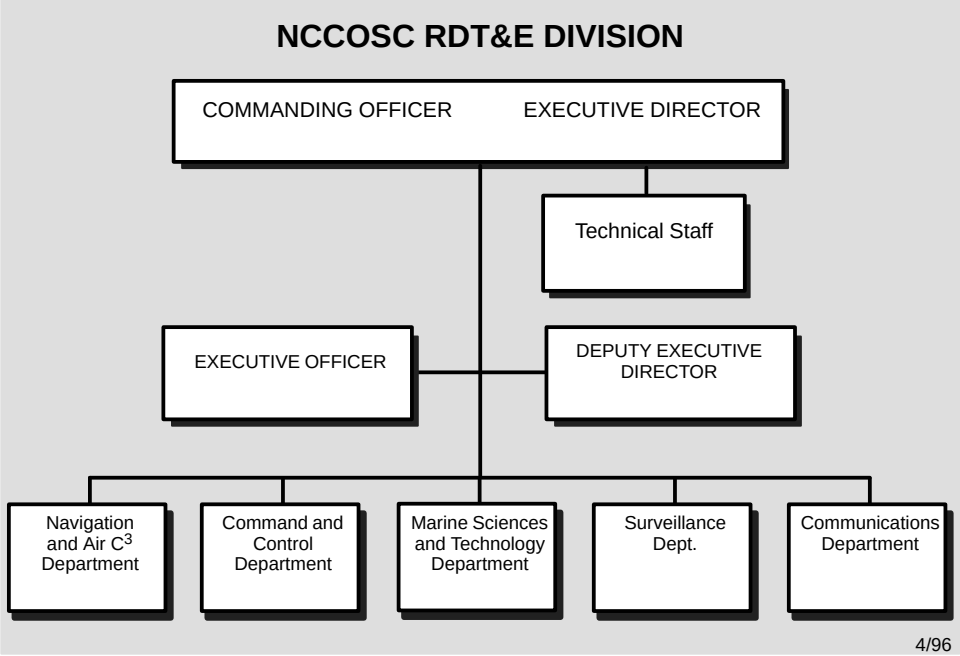
Distribution of Funds – FY 1995

Actual $677 Million



Organization

NRaD is organized into five technical departments and several staff codes. The five technical departments include Navigation and Air C^3, Command and Control, Marine Sciences and Technology, Surveillance, and Communications. The following chart shows NRaD organization as of 30 September 1995.



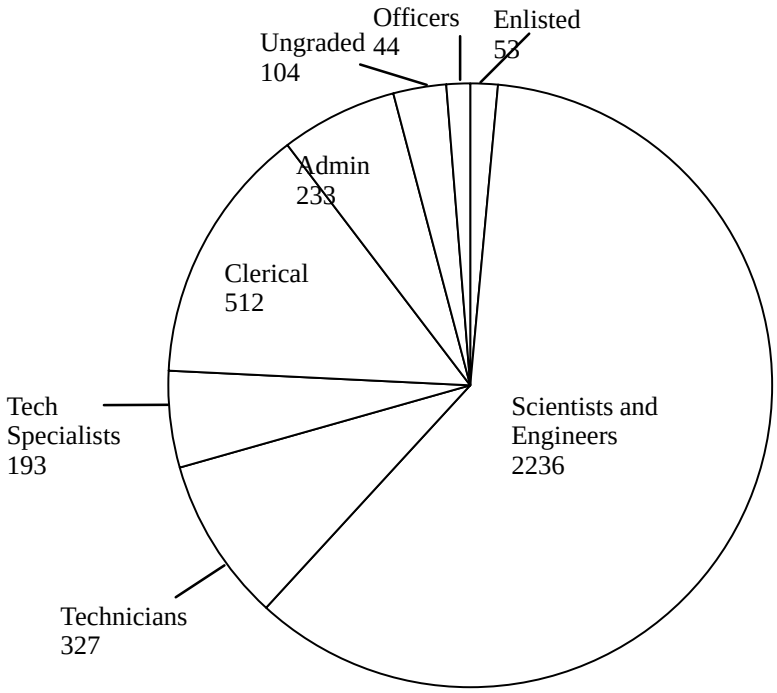
BRAC 95

Relocation of the Space and Naval Warfare Systems Command "from leased space to Government-owned space within the National Capital Region (NCR) ..." was one of the original recommendations of the BRAC 93 Commission. However, the Defense Base Closure and Realignment Commission 1995 Report to the President (July 1995) modified the direction to "relocate...from leased space to Government-owned space in San Diego, California, to allow consolidation (with) the Naval Command, Control and Ocean Surveillance Center...." Other BRAC 95 recommendations included disestablishment of the Naval Management Systems Support Office (NAVMASSO) and relocation as a detachment of NRaD; disestablishment of NISE West and consolidation with NRaD; and closure of the NRaD Warminster Detachment. All recommendations were scheduled for October 1997 completion. However, NAVMASSO was expected to merge with NCCOSC in January 1996; the NISE West/NRaD merger was expected to occur in March 1996; and the closure of the NRaD Warminster detachment was expected to be complete by the end of September 1996.

Personnel

Total NRaD personnel as of 31 December 1995 was 3702, including 97 military and 3605 civilians. Further personnel data are given in the following chart.

NRaD PERSONNEL, 31 DECEMBER 1995
(TOTAL 3702)



Technical Developments

Command and Control

Advanced Combat Direction System (ACDS)

Advanced Combat Direction System.

The Advanced Combat Direction System (ACDS) is a major development program that will upgrade the current Navy Tactical Data System (NTDS) on aircraft carriers, LHDs, and selected cruisers. ACDS is being developed in two phases designated as Block 0 and Block 1. ACDS Block 0 is intended to provide for the installation of upgraded Navy-standard computers, displays, and peripheral hardware, and the rehosting and enhancement of existing Model 4 NTDS software to operate on this hardware. ACDS Block 1 is intended to provide a major software upgrade to Model 5 NTDS by using the same hardware as installed for Block 0. In addition to the Model 5 capability, principal software enhancements provided by the Block 1 computer program include increased surveillance ranges and capacities, automation of the track management process, integration of electronic surveillance measures (ESM) and nonorganic surveillance assets, enhanced ability to identify system tracks based on contributing sensor sources, improved multiship gridlock achieved in concert with Joint Tactical Information Distribution System (JTIDS), and system adaptability through operator-defined doctrine processes.

ACDS Block 0

The ACDS Block 0 program is the initial step in the upgrade of the NTDS as implemented on CV/CVN, LHD, and LHA platforms. ACDS Block 0

development is a phased approach via levels (or versions). As one level is being deployed to the Fleet, another level is in the testing phase, and a third level is in the development phase.

NRaD's ACDS Block 0 program develops and maintains combat direction system computer programs, other support programs, and related documentation. NRaD provides lead laboratory management, direction, system engineering, and program development to the ACDS Block 0 software program . This effort will define, engineer, test, and certify new version releases that correct reported problems, improve system performance, or accomplish equipment changes.

FY 95 accomplishments included the following: Delivered Level 9 LHD R9.13 program version to the Integrated Combat Systems Test Facility for the start of LHD Combat Systems Integration Test (CSIT) retest; delivered a CV Level 9 R9.13 version for use in preparation for dual-net/multifrequency link tests ; installed Level 9 program at Fleet Combat Training Center, Pacific (FCTCPAC); installed Level 9 program version R9.16 onboard USS *Kitty Hawk* (CV 63); installed Level 9 Engineering Development Model program onboard USS *America* (CV 66); installed Level 9 program version R9.16 onboard USS *Boxer* (LHD 4);completed ACDS Block 0 Level 9 combined CV/CVN/LHD Fleet Delivery Readiness Review process and authorized for Fleet release; installed Level 10 program at LHD 5 Combat Systems Assembly and Checkout Facility (CSACF) in Pascagoula, MS; successfully completed Level 9 Navy and Joint Link-11 Certifications conducted by the Navy Center for Tactical System Interoperability (NCTSI).

ACDS Block 1

ACDS Block 1 is a replacement and upgrade for NTDS that will provide a significant enhancements in the areas of sensor management, tactical data exchange, warfare area coordination, and system reliability. NRaD provides Lead Laboratory management and direction. NRaD is developing ACDS Block l and performing planning and system engineering leading to development of Block 1 versions for designated combatants and amphibious ships.

FY 95 accomplishments included the following:

ACDS Block 1 Level 1

Completed Level 1 Program Acceptance Test (PAT) and delivered Level 1 computer program upgrade to Integrated Combat Systems Test Facility for Combat System Integration Testing (CSIT); conducted initial data link testing; applied results of PAT, CSIT, and data link testing development of Level 2 computer program; completed development of training materials required for Level 1 operator training.

ACDS Block 1 Level 2

Completed Preliminary Design Review and Critical Design Review of Level 2 computer program and associated hardware; installed Level 2 test beds at NRaD and the Fleet Combat Training Center, Atlantic (FCTCLANT); continued development of Level 2 computer program for delivery into PAT and CSIT during the first quarter of FY 96; specified all changes to Level 1 training materials required for Level 2 operator training; and completed analysis and design of Level 2 Interactive Courseware to support Level 2 operator training.

Command and Control Processor (C^2P)

The addition of the Joint Tactical Information Distribution System (JTIDS) on ships will provide the first major upgrade of tactical digital infromation link (TADIL) communications to C^2 ships since the introduction of the Naval Tactical Data System (NTDS). It is anticipated that there will be follow-on improvements/additions to ship's TADIL communications, such as an improved Link-11 and EHF SATCOM link. The Command and Control Processor (C^2P) will provide for the control and management of these diverse TADIL communications assets in a multithreat environment. The primary objective of the C^2P is to provide real-time interoperability between widely dispersed C^2 ships by efficient use of all of each ship's TADIL communications equipment/systems.

The program provides for the development, test, independent verification and validation (IV&V), and evaluation of a C^2P system intended for the management and control of TADIL communications aboard major surface ships. The C^2P will provide an isolation and buffering function between ownship's C^2 systems and data link transmission and reception protocols.

The C^2P is being developed in two configurations. One of the configurations, termed "(V0)," is intended to allow the introduction of the JTIDS/ Link-16 into ships with "Model 4" combat direction systems (CDSs). The second version of C^2P, termed "(V1)," is intended to provide full TADIL J/Link-16 service on the ships scheduled to receive the new "Model 5" ACDS Block 1 CDS.

NRaD is the Technical Direction Agent (TDA) for the C^2P and is leading the government acceptance test and product validation effort. NRaD is also the designated Software Support Activity (SSA) for the system.

FY 95 accomplishments in FY 95 included the following:

C^2P OPEVAL — Participated in the successful JTIDS/C^2P Operational Evaluation (OPEVAL).

C^2P Deliveries — Delivered C^2P Model 4 to USS *California* (CGN 36), USS *Arkansas* (CGN 41), USS *Nimitz* (CVN 68), USS *George Washington* (CVN 73), USS *Callaghan* (DDG 994), USS *Anzio* (CG 68), USS *Cape St. George* (CG 71), USS *Enterprise* (CVN 65), USS *Port Royal* (CG 73), and USS *Shilo* (CG 67). Following a 1-day installation, *Shilo* was underway within 24 hours and demonstrated full operational capability in less than 48 hours.

C^2P Rehost — Successfully tested the exchange of Link-11 messages in both directions. Rehost Model 4 was scheduled for delivery in March/April 1996 and Model 5 in March/April 1997. The C^2P is being rehosted from the UYK-43 to the TAC-4. USQ-69 C^2P human-machine interface (HMI) screens have been ported to X-Windows. With the exception of recoding the HMI and the input/output in "C" language, the C^2P software programs will be maintained in their original CMS-2 language in the TAC-4.

E-2C Airborne Tactical Data System Software Support

The objectives of the E-2C Airborne Tactical Data System Software Support program are to plan, design, construct, test, and deliver E-2C Airborne Tactical Data Systems (ATDS) computer programs to the Fleet; correct, update, modify,

and distribute operational programs in accordance with evolving Fleet requirements; provide ancillary computer programs to support life-cycle maintenance; provide technical assistance to shore sites; provide tactical, diagnostic, and support software of the highest quality; and rapidly respond to Fleet requirements.

E2C Airborne Tactical Data System (ATDS) Integration.

FY 95 accomplishments include the following: Updated and delivered software version J5 (Group II) in response to urgent requirement from VAW-117; software version J5 (Group II) passed Navy Interoperability Certification Testing for Link-16 performed by the Navy Center for Tactical Systems Interoperability (NCTSI); software version J5 (Group II) participated in Joint Interoperability Certification Testing for Link-16: Developmental Certification Test (DCT-002); software version P9 (Group 0) underwent final Software Trouble Report (STR) correction and preparation for Navy and Joint Link-11 Certification Testing and subsequent delivery to the Fleet.

High-performance Computing (HPC)

The High-Performance Computing (HPC) program conducts HPC in support of all mission areas and technical endeavors in the Laboratory. Center-wide coordination facilitates and supports acquisition of state-of-the-art systems for local and shared high-performance computing with focus on C^2 and embedded signal/image processing, as well as defense-wide network access to HPC systems throughout the DoD R&D laboratory community.

FY 95 accomplishments included the following: Implemented major upgrades to both NRaD HPC systems that form the core of the San Diego DoD HPC Distributed Center–Convex Exemplar SPP-1000 (4X increase in processors with 8-GB memory and 160-GB disk storage) and Intel Paragon XP/S-25 (increase memory 2X to 14 GB and disk to 128 GB, addition of archival storage system). Presented computational science and HPC applications work for both NRaD and

the DoD HPC program at Supercomputing '95. This year's NRaD demonstrations included the following: digital libraries research implemented on distributed, parallel processors; scaleable, parallel test bed for radar imaging, featuring Khoros and MPI; application of signal detection algorithms to radar returns in sea clutter; Scaleable Programming Environment, a software development environment for scaleable dataflow applications; SmartNet, the Supercomputing '94 award-winning scheduler for heterogeneous distributed computing; and Visualization models–contaminant transport with fuel spill, ship antenna electromagnetic fields, and turbulent flow control. DoD demonstrations spanned the R&D HPC work in all the Services. NRaD also received initial funding to begin participation in a new defense scaleable software development initiative, totaling $2.45M annually in three of the DoD-designated computational technology areas: Computational Electromagnetics and Acoustics, Signal/Image Processing and Forces Modeling, and Simulation/C^4I.

Human Computer Interface (HCI)

The Advanced Research Projects Agency (ARPA) Human Computer Interface (HCI) program is leading the development of advanced human–computer interface concepts for C^2 and distributed simulation systems. The program will integrate concepts into advanced C^4I and simulation applications.

NRaD will support the ARPA Software and Intelligent Systems Projects Office (ARPA SISTO) effort to develop advanced HCI technology applicable to the Joint Services community and to transfer the technology to warfighters. NRaD will demonstrate how the Services' need to interact with the next generation of complex systems can be met by high-risk HCI technologies.

ARPA and NRaD have recognized that technology demonstration programs must put a priority on providing increased capability, usability, and utility into the hands of our nations' warriors. Additionally, demands for joint operations will require interoperability from C^2 systems that is currently lacking. Advanced HCI technology, including distributed collaboration techniques for planning, rehearsal and execution, intelligent associates, and computer interactive speech and gestering, are useful in supporting interoperability for joint operations. Investment in these and related techniques must result in capability that demonstrates improved planning/action and that paves the way for improved and least-costly system acquisition methods.

FY 95 accomplishments included the following: Completed a script and filming for a video depicting C^4I in the 21st Century using advanced HCI interfaces. A prior edition was incorporated into the NRaD Command Center of the Future and presented to many Center visitors. The Command Center was upgraded with improved displays, computer-based presentation capabilities, and demonstrations of advanced ARPA HCI products.

Joint Maritime Command Information System (JMCIS)

The Joint Maritime Command Information System (JMCIS) will provide the primary C^4I system for the U.S. Navy and Joint Task Force Commander. JMCIS

is an integrated hardware and software product consisting of the core Unified Build (UB) segment and those segments developed by numerous agencies to meet specific operational requirements. NRaD provides systems engineering and integration and is the Software Support Activity.

JMCIS is a class of command, control, communications, and intelligence (C^3I) software variants and hardware architectures that are fielded to operational sites using non-developmental item (NDI) commercial hardware and a common operating environment (COE). The JMCIS Superset is composed of segments made up of computer software configuration items (CSCIs). Two key segments are the Environment and the UB. The UB segment provides the core services (communications, display manager, track database, etc.) that applications use.

FY 95 accomplishments included the following:

JMCIS 2.1

Continued to provide system engineering and installation support of JMCIS 2.1 systems on a worldwide basis. Work sites included C7F/ USS Blue Ridge (LCC 19) in Japan; the Fleet Ocean Surveillance Information Facility in Rota, Spain; and the Commander United States Naval Center (COMUSNAVCENT) in Bahrain. Installed the JMCIS 2.1 Central Data Base Server (CDBS) at Naval Surface Warfare Center Dahlgren Division (NSWCDD) for Joint Service Imagery Processing System–Navy (JSIPS–N) land-based testing; also installed JMCIS 2.1 at the Navy Marine Corps Intelligence Training Center (NMITC) to support General Intelligence and Imagery Training. Began the first allied 2.1 installation at the Canadian Maritime headquarters in Halifax, Nova Scotia.

Global Command and Control System (GCCS)

Provided engineering, database tailoring, software installation, and on-site support for a GCCS demonstration at the Joint Demonstration and Evaluation Facility (JDEF), Arlington, VA. The demonstration concentrated on GCCS Intelligence applications (JMCIS-based); demonstration software was an initial version of GCCS 2.0.

Joint Tactical Information Distribution System (JTIDS)

JTIDS is an integrated communications-navigation-identification system featuring multichannel, multinet, high-data-rate communications and relative navigation capabilities for tactical operations.

Operating across the C and D bands, in the TACAN frequency region, the JTIDS system uses spread-spectrum, anti-jam techniques to achieve its performance requirements while interoperating with the TACAN. In 1986, SECNAV decided to embrace the Air Force's TDMA terminal development effort. The terminal contractor was then placed under contract to develop a block of terminals to satisfy unique Navy operational needs. PMA/PMW-159 has since conducted a number of design and progress reviews with GEC Marconi and awarded a contract for the development of Block 2 terminals. Block 2 terminals have been successfully tested in the System Integration Facility (SIF) and installed in the USS *Carl Vinson* Battle Group. Block 2 terminals are installed at NRaD and on USS *Arkansas* (CGN 41), USS *Anietam* (CG 54), and USS *Carl Vinson* (CVN 70). Full-rate production was authorized for additional U.S. Navy JTIDS terminals for 10 battlegroups.

NRaD performs the following tasks:

- Provide system engineering support to PEO SCS (PMW-159) in support of the JTIDS Program.

- Perform ship integration engineering and installation test support. Continue development of the JTIDS shipboard.
- Perform test and evaluation planning for terminal and platform integration testing.
- Maintain, operate, and continue development of the SIF. Conduct validation and certification testing of Navy and Marine Corps JTIDS terminals.
- Validate JTIDS integration aboard F-14, E-2C, and other Navy platforms.

FY 95 accomplishments included the following:

JTIDS/C^2P

Completed JTIDS/C^2P Operational Evaluation (OPEVAL) during USS *Carl Vinson* (CVN 70) Battle Group deployment in the Persian Gulf and while transiting the Pacific and Indian Oceans. NRaD was a key player in the Technical Evaluation (TECHEVAL) events leading up to this very successful step in the deployment of JTIDS and C^2P. The Commander, Operational Test and Evaluation Force (COMOPTEVFOR) Link-16 OPEVAL report of 19 October 1994 stated that all Critical Operational Issues (COIs) were satisfied and that both JTIDS and C^2P would be recommended for Fleet introduction.

Tactical Data Link (TADIL) Gateway

Accepted for joint testing. As a result of the Joint Interoperability Test Command's (JITC's) successful use of the TADIL Gateway in Developmental Certification Test (DCT) -001 of the E-2C and F-14D, JITC released official correspondence stating that the NRaD TADIL Gateway "approach to TADIL J testing represents a significant reduction in JTIDS terminal requirements for those services and agencies with their own RF network."

Multifunction Information Distribution System (MIDS)

Built with more recent hardware, Multifunction Information Distribution System (MIDS) terminals provide JTIDS functionality with lower weight and cost. NRaD is the primary U.S. Navy systems engineer supporting both the MIDS terminal development within the international community and its application in the U.S. lead platform, the F/A 18.

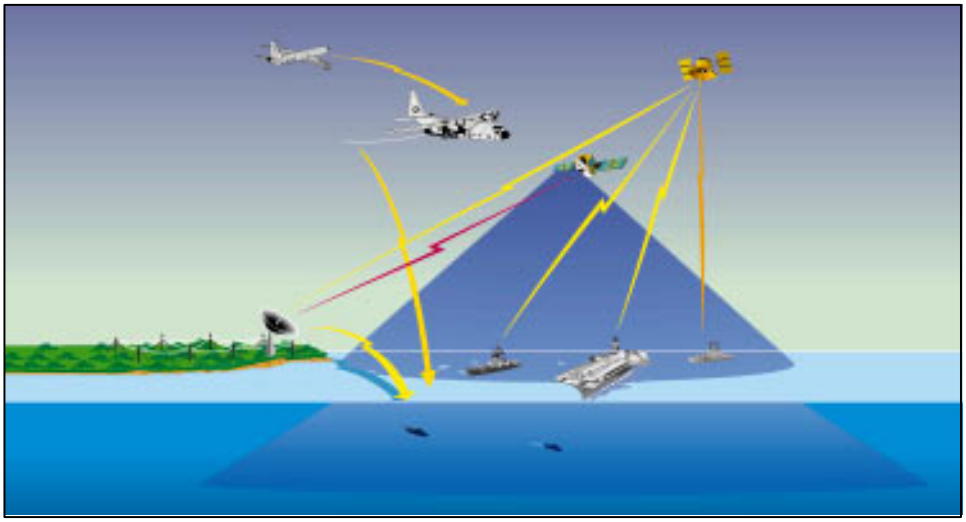
NRaD initiated the MIDS effort in FY 95. Start up included modification of the JTIDS Systems Integration Facility (SIF) to support F/A-18 integration and MIDS DT II testing.

Range Naval Tactical Data System (NTDS) Upgrade

The Range Naval Tactical Data System (NTDS) upgraded the existing NTDS systems at the Atlantic Fleet Weapons Training Facility (AFWTF), Puerto Rico, and the Pacific Missile Range Facility (PMRF), Hawaii, to current Fleet standards. NRaD provides life-cycle support of the Range NTDS Upgrade System (RNUS) installed at these facilities.

The NTDS upgrade achieved Intitial Operational Capability (IOC) at AFWTF in December 1994 and at PMRF in June 1995. Also during FY 95, NRaD transitioned to the role of Cognizant Field Activity (CFA) for life-cycle support of the RNUS system.

Communications



Full-Spectrum Communications.

Electromagnetics

Antenna Design and Modeling

The Antenna Design and Modeling program designs and develops advanced antenna concepts and systems for DoD platforms and systems. This work includes designing, developing prototypes, and testing at NRaD facilities and on ships, systems, etc. Antennas include Multifunction Electromagnetic Radiating System (MERS), spiral, Near Vertical Incidence Skywave (NVIS), current probe, loaded wideband, and other antennas.

FY 95 accomplishments included the following:

MERS

Developed the Multifunction Electromagnetic Radiating Systems (MERS) concept. Under the ONR exploratory development program, a MERS concept has been developed in which the RF transmission and antenna requirements of four different radiating systems will be merged into a single transmission and antenna structure. An advanced technology demonstration (ATD) based on this MERS concept has been proposed and will start in FY 97. The proposed MERS ATD will demonstrate, at sea, a merged, low-cost antenna system that will restore full combat system performance for multiple systems, reduce sensor signature, meet the demands of a real shipboard environment, and decrease topside weight, moment, and volume.

SINCGAR

LSD 41 and LHD 1 requirements call for installations of VHF signal-hopping radios called Single Channel Ground/Air Radio Systems (SINCGARs). The new shipboard systems required an integrated analysis to meet shipboard performance criteria and operational requirements. NRaD has built Numerical Electronic Code Models and run computer EM databases to design and determine performance criteria.

Modeling and Simulation

The Modeling and Simulation program provides verification testing and data population support for the Naval Simulation System; planning development simulation support for JTMD; Functional Process Improvement (FPI) IDEF modeling in support of the Joint Maritime Operations (JMO) architecture project; and development of computational electromagnetic models to support electromagnetic engineering analysis.

During FY 95, NRaD performed IDEF modeling to analyze Navy Theater Ballistic Missile Defense (TBMD) information architectures and evaluated data requirements for architecture functional activities. Models that had been developed for characterizing current Navy antiair warfare (AAW) operations were adapted for this effort. Analyses included allocating processes to systems and determining adequacy of systems/platform connectivities to meet the data requirements for the processes. Several technical papers were prepared describing "as is" and "to be" physical architectures and their relationships to information transfer and processing requirements.

Signal Processing

The Signal Processing program provides system design, analysis, research, and computing for advanced high-data-rate (HDR) communication links, electro optical, and Synthetic Aperture Radar (SAR) projects including TOPSIGHT (a project to develop parallel processing algorithms on the Paragon parallel processing computer), WARBREAKER (a project to implement foliage penetration SAR image formation algorithms and automatic target recognition on Paragon and Sun Workstations), and Stochastic Target Detection and Recognition (STD/R).

FY 95 accomplishments included the following:

Super Chip — Prepared a Draft High Systems Requirements for the Communications Super Chip.

Soldier 911 Program — Under ARPA sponsorship, this project started the Soldier 911 Program to support the Seventh Army's border patrols along the Macedonia-Serbia border. During FY 95, the system became operational in Macedonia. In January 1995, after the downed helicopter incident in Korea in late 1994, a Phase I version of the Korea Soldier 911 system was deployed; it was demonstrated in February 1995. ARPA integrated a PRC 112 radio, radio interface, communication network, and ARPA GPS receiver chip into a single handheld package.

GPS Guidance Package (GGP) — Designed, developed, fabricated, tested, and demonstrated a tightly coupled, miniature, integrated navigation package including solid-state rotation sensors and accelerometers to perform low-cost, high-performance vehicle navigation (strike weapons, high-performance aircraft, and unmanned vehicles ([UMVs]).

Analytical Solutions — Demonstrated the significant gains that can be achieved with spatial temporal processing of multichannel receivers in a fading multipath environment. A paper describing the results received the award for the Best Unclassified Technical Paper at the 1995 IEEE Military Communications Conference (MILCOM-95) in November.

Nonlinear Quasi-Phase Matched (QPM) — Designed and fabricated devices consisting of diffusion-bonded stacks of alternating layers of indium phosphide. Transmission losses of ~1-percent per interface were achieved.

Hyperspectral Mine Detection

Successfully completed several field experiments to establish the phenomenology of Hyperspectral Mine Detection at Falon NAS, the Nevada Test Site, in Hawaii, and at Ft. Huachuca. Lawrence Livermore National Laboratory fielded their Livermore Imaging Fourier Transform Infrared Spectrometer for the desert experiments. Design work for a new miniature, ruggedized airborne spectrometer was begun. Algorithm development for data processing/reduction continued. Contracts were awarded to the University of Hawaii, Technical Research Associates, Space Computer Corporation, Sensor Concepts Applications, and Space Applications Corporation.

STD/R Project

Developed adaptive filtering techniques using two-dimensional least mean square (LMS) noise-canceling to exploit the differences in signatures between the natural background and man-made objects. A field experiment was conducted at NRaD using the Specially Modulated Imagining Fourier Transform Spectrometer (SMIFTS) hyperspectral infrared sensor to obtain vehicle target signatures.

High-Data-Rate Communications

The High-Data-Rate Communications program develops high-data-rate (HDR) communications concepts and hardware, including HDR line-of-sight (LOS) UHF communications and HDR laser communications systems. During FY 95, NRaD developed a simulation capability to determine channel capacity under various operational conditions. Initial results were reported at the MILCOM-95 conference in November. The performance of narrowband adaptive interference suppression filters initially reported for one class of filters is being extended to a broader class of filters with modifications to include the effects of mobile transmitters and receivers.

FY 95 was the beginning of research on performance evaluation of adaptive equalization algorithms for digital communications. A paper entitled “Multichannel Adaptive Equalization for LOS Digital Communication Corrupted by Interference” was presented at ICASSP-95 in May 1995 in Detroit. A paper entitled “Performance Analysis of a Multichannel Adaptive Equalizer for Line-of-sight Digital Radio” was presented at MILCOM-95. The paper was awarded best technical paper at the conference.

Electromagnetics Technologies

The Electromagnetics Technologies program develops communications and related technologies such as SOLDIER 911, a system that provides border alert warning for aviators; and the Universal Radar Moving Target Transponder (URMTT), which generates over-the-air radar targets for most radars, including frequency-hopping radars.

FY 95 accomplishments included the following:

Laser Technology

Transitioned the temperature-insensitive, diode-pumped, solid-state laser technology developed under the Applied Physics ONR Program to NAVAIR PMA 264 for their ATD-111 Program. This new technology allows diode-pumped, solid-state lasers to be efficiently used in military environments.

SATCOM Tests with the Predator UAV

Conducted and coordinated tests to access UHF Fleet Satellite assets. Alternative communication links were proposed for the Hunter unmanned airborne

vehicle (UAV) to use the Light Airborne Multi Purpose Systems (LAMPS) or Common High-Bandwidth Data Link systems. Improved shipboard C^3 integration to the Joint Maritime Command Information System for the Pioneer UAV was proposed. A communication relay development for the Hunter UAV was supported. Planning was conducted for a UAV/cruise missile demonstration using SHF SATCOM to provide imagery to an afloat platform.

Aegis APC

FY 95 efforts supporting Aegis Advance Planning Cell (APC) activities included participating in numerous APC and Aegis planning meetings; coordinating NRaD presentations to the APC; participating with the planning and execution of the OSD/Aegis Defense Information Infrastructure (DII) Symposium; and providing technical evaluation and recommendations to Aegis-related manufacturing technology proposals.

Sensor Fusion Experiment

Operated and successfully conducted experiment at the Innovative Science and Technology Experimentation Facility (ISTEF) involving microwave radar, several passive optical sensors in the 3- to 5-micron region, and laser radar. Simultaneous data from these various sensors were recorded using free-falling targets containing GPS.

6X8 Si-ADP Detector Array

Designed, built, and tested the first 6X8 Si-ADP detector array. Single photon detection was accomplished with Geiger-mode ADP, 7-cm range resolution. A design was completed and fabrication started on a short-pulse (2 nsec) transmitter.

ARPA MIMIC Technology

Completed the transition of ARPA millimeter/microwave integrated circuit (MIMIC) technology into highly advanced processes and materials under the CEC T/R Module ManTech program that achieved a cost reduction of 33 percent of the major cost drivers for communications and radar phased arrays. A start-up contract for ManTech process development of Common All Optical Towed Arrays was awarded. This ManTech project directly impacts three major SPAWAR and NAVSEA antisubmarine warfare (ASW) systems by transitioning new surveillance technology in parallel with technical base developments in addition to significant cost reduction of the acquisition program to follow.

INFOSEC

Information Security Systems/Architecture

The Information Security Systems/Architecture program integrates information security (INFOSEC) capabilities into naval C^4I systems and architectures and serves as liaison between SPAWAR, the end users, and supporting contractors to maintain present capabilities and respond to present and future INFOSEC needs.

FY 95 accomplishments included the following: Planned and executed the transfer of software support responsibility and capability for the AN/USC-43(V) digital voice terminal to NRaD; tested and delivered upgraded software and support documentation for the Navy Automated COMSEC Reporting System to more than 1100 Navy, Marine Corps, and Coast Guard customers; established a “Help Desk” to assist Fleet users and system operators with responsive software assistance; transferred software support responsibility and capability for the Navy Key Management System to NRaD and established software

development and test environments; and stood-up defect control and configuration management systems.

Mobile Communications

Multiple Platform Links

The Multiple Platform Links program provides system engineering, system development, and system testing of advancements in multiple platform communication links to ships and aircraft. This includes the application of HF for high-speed data service and automation of HF radio operation and circuit establishment.

During FY 95, NRaD supported the HF Defense Communications System (DCS) entry upgrade for the Defense Information Systems Agency (DISA) and prepared a draft procedure for the Communications Exercise (CONEX) document. This draft procedure was tested during a full-up, over-the-air test between an AN/TSC-120 HF communications shelter at Camp Pendleton, CA, and McClellan AFB, CA. Test messages were sent directly into the Automated Digital Information Network (AUTODIN) system.

Satellite Communications Systems

The Satellite Communications Systems program provides system engineering, system design, and development to the joint services in UHF, SHF, and EHF satellite communications. This includes development of interoperability standards and protocols, terminals, and control systems for existing and developing systems.

The objective of the UHF SATCOM program is to enhance the existing UHF SATCOM system to provide low-cost, over-the-horizon, joint services interoperable communications for a variety of users, including ground forces, ships, submarines, aircraft, and fixed-plant facilities.

The Defense Satellite Communications System (DSCS) SHF satellites are currently used for robust, anti-jam (AJ) communications, command, and control with Fleet commanders on carriers and command ships. In addition to current uses, plans call for introduction of SHF demand-assigned multiple-access (DAMA) communications, SHF Fleet broadcast, and direct communications that are interoperable with Ground Mobile Forces (GMF) for an increased tactical support role. Development of Jam Resistant Communications using the Universal Modem and Surveillance Towed Array Sensor System (SURTASS) anti-jam capabilities are also being addressed. These new capabilities are planned to be introduced in three phases. Phase I is a near-term effort to add existing SHF SATCOM capability to all carriers. Phase II will be a transition phase, upgrading capabilities on selected Navy platforms with an SHF DAMA capability. Phase III will incorporate all requirements.

NRaD will provide technical expertise to establish the new systems architecture for SHF SATCOM. The new SHF architecture will address the large, planned increase in the quantities of afloat SHF terminals and emerging requirements from the new MILSATCOM, Copernicus, and Communications Support System (CSS) architectures. NRaD will provide technical support for the

development of the procurement package for the AN/WSC-6 (V)XX follow-on satellite terminals. Included are the development of specifications and other pertinent acquisition documents and participation in the Technical Evaluation Board (TEB). NRaD will continue to provide updates to the Navy Future Phase III SHF SATCOM.

The Navy EHF SATCOM Program (NESP) evolved from the CLARINET OMEN 8/9 experiment, which demonstrated the technology base for EHF satellite communications. The NESP effort will develop a similar capability for submarine, shore, and surface ships to support Minimum Essential Communication (MEC). CLARINET OMEN specifically addresses the sub-surface ballistic nuclear (SSBN) requirements for MEC. The close coordination of these two programs was directed by CNO in order to develop an affordable system. The Navy chose Raytheon Corporation to build the AN/USC-38 NESP terminal, and NRaD is supporting test and evaluation of this terminal design. Toward this end, NRaD has developed a Land-Based Test Facility (LBTF) to support terminal testing and has been active in developmental testing of the terminal.

FY 95 accomplishments included the following:

UHF SATCOM

Provided technical information and participated in the development of the field change kit for the TD-1271s so DAMA UHF SATCOM channels may operate in the automatic mode. This was the lead technical IPT in developing system requirements and the performance specification. The project also provided support to JWID-95 from the Navy UHF System Test Facility. Directed the development of the mini-DAMA and DAMA-SAC systems for future installation in the Fleet.

SHF SATCOM

Updated the SHF portion of the System Specification; conducted 7-foot antenna mounting stiffness requirements study; and developed 7-foot antenna mounting and flexure papers. The team also completed an AN/WSC-6(V)XX proposal evaluation and participated in specification and statement-of-work efforts. The team updated the "Future PH-III Navy SHF SATCOM System functional description. Testing was completed to provide DISA certification testing by the SHF SATCOM Test Facility.

EHF SATCOM

Provided system engineering support to SPAWAR and provided support for JWID-95 from the NESP LBTF.

SHF SATCOM Facility.

Terrestrial Communications Links

The Terrestrial Communications Links program supports planning, designing, developing, implementing, and testing of terrestrial radio frequency communication links using existing and new technology.

FY 95 accomplishments included the following: Performed developmental testing of both low-rate-data and high-rate data high-frequency radio telemetry and control circuits for the Remote Minehunter System. Sufficient hardware to outfit a prototype minehunter vehicle was provided and spares were purchased. An over-the-air test demonstrated 56 kbps over HF over a distance of 65 miles. Candidate antenna systems were considered and full-scale impedance measurements were completed. HF e-mail software was revised to increase overall system speed. New interface cards were designed, tested, and fabricated for full RS-232 interface operation. A live over-the-air demonstration was conducted in the Pentagon (Aug '95).

Advanced Concepts in Communications

The Advanced Concepts in Communications program investigates advanced concepts in satellite communication systems. Issues of design improvements, vulnerabilities, and exploitation are researched and tested.

FY 95 accomplishments included the following: The GOFR system was installed and accepted for operation at the Naval Space Command where it is used to monitor interference on the UHF SATCOM system. The POWER Geolocation subsystem was delivered to U.S. Space Command and was installed in the POWERR workstation. DAMA vulnerability simulations and experiments were completed and delivered to SPAWAR. Geolocation simulations were completed and delivered with test for inclusion in the Phase I report.

Communication Architectures

The Communication Architectures program provides technical expertise and advisor support to OPNAV and SPAWAR in the development of communication architectures, system engineering, and program definition and development.

FY 95 accomplishments included the following: Provided communication system experts to SPAWAR, OPNAV, and Australia; ensured that international Data Exchange Agreements have been properly executed; developed Minimum Essential Interoperability Support document; and commenced preparations for the 35th C3 Board/11th Supervisory Board Meetings.

Mobile Communications Technologies

The Mobile Communications Technologies program investigates, develops, and tests technologies relating to satellite and mobile platform communications. During FY 95, NRaD participated in working groups and planning for GBS development. The groups assessed the applicability of the existing modems and radios to high-data-rate initiatives for UHF and Ku/K/Ka band systems.

Networks

Advanced Digital Networks

The Advanced Digital Networks program develops and implements advanced digital networks to accommodate multimedia user applications, including data, voice, video, and imagery. During FY 95, the program developed an interoperable network system linking the NATO countries.

Local-Area Networks/Wide-Area Networks

The Local-Area Networks/Wide-Area Networks program develops local-area networks (LANs) and wide-area networks (WANs) technology and architecture to provide high-data-rate connectivity between ashore and afloat locations. The program also develops prototypes to standardize and facilitate sharing of information.

WWW Technology

During FY 95, the program developed World Wide Web (WWW) technology implementation strategies and a model home page prototype to standardize and facilitate sharing of information among laboratories. The objectives of this task were to develop WWW technology implementation strategies for the Office of Secretary of Defense, Deputy Director for Research and Engineering (OSD DDR&E), and a model home page prototype to standardize and facilitate the sharing of information among the 81 DoD laboratories. This model home page prototype is an enhancement and add-on to the existing DDR&E LabLink WWW Home Page. As part of this task, NCCOSC will also acquire and produce presentation hardware and software to demonstrate the newly developed interlaboratory WWW communication methods. The initial laboratory Home Page template will be oriented toward fulfilling the yearly lab report requirements.

Switching

The Switching program develops switching systems to interconnect Navy computers and peripherals; defines interface requirements; and fabricates, installs,

integrates, and checks out total systems. During FY 95, the program developed a high-speed data switch (HSDS) to interconnect Navy computers and peripherals in support of the Aegis program at the Naval Surface Weapons Center (NSWC).

Information Systems Engineering

The Information Systems Engineering program provides technical support for integrating systems, including interior communications radio.

Data Multiplex System on the DDG 51

During FY 95, NRaD made design upgrades, including fiber-optic technology, to the Data Multiplex System on the DDG 51, resulting in data transfer improvements. The Navy's DMS program completed OPEVAL in April 1986. This evaluation of the shipboard data multiplexing system demonstrated the feasibility of using shared digital data circuits in lieu of dedicated hardwires in a shipboard environment. NRaD has provided technical support to NAVSEA in integrating DMS with DDG 51 ship class systems, including interior communications, engineering, damage control, and the combat system.

Interior Shipboard Communications

The Interior Shipboard Communications program develops components, data links, standards, specifications, and test procedures for shipboard applications. The program efforts also apply data bussing/networking technology to shipboard information transfer problems, and new techniques to increase flexibility, security, and survivability of communications aboard ships.

The introduction of new and planned complex and distributed weapon systems into the Fleet requires internal data transfer and voice communications capabilities. Necessary qualities include redundancy, flexibility, ease of reconfiguration, and the ability to handle large volumes of traffic. These capabilities should also incorporate standard interfaces. This program will provide the following benefits: (1) the identification and validation of technology to support requirements associated with processor-to-processor data communications and (2) a digital voice system design in which individual elements (e.g., digital intercom subsystem) can be developed as stand-alone units in the near term and also form a compatible, modular element of an integrated Digital Voice Multiplex System in the mid term.

During FY 95, the program incorporated the Interior Communications (IC)2 backbone specification into LPD 17 ship specification, and a multilevel security (MLS) prototype of the backbone was integrated in the NRaD lab.

RF Networks

The RF Networks program plans, performs systems design, develops, and implements the total shipboard communications system. The program also supports development of an implementation approach for introduction of commercial/joint telecommunications standards, hardware, and software to support naval C^4I systems. During FY 95, the program formed the Communication Support System (CSS)/Joint Maritime Command Information System (JMCIS) Action Team to direct development and field initial CSS capability.

Network Technologies

The Network Technologies program plans, designs, develops, and tests communications systems and multimedia technology.

Routing for ATM Networks

During FY 95, the project developed routing metrics to predict the effect of adding new connections to an asynchronous transfer mode (ATM) network. Routing is the process of selecting a sequence of transmission links joining two network users who need to communicate. Routing in an ATM network poses new challenges that are different from those in existing networks. Routes are selected and new connections accepted to ensure an efficient use of network resources while providing an adequate level of quality of service (QOS) to the new and existing connections; therefore, an effective ATM routing algorithm must include a metric that can determine whether the QOSs of all connections can be met if a proposed route is selected to support a new connection. Developing such metrics requires a thorough understanding of the effect of statistically multiplexing heterogeneous connections, and is the main challenge of this project.

The objective of this project is to design effective routing algorithms for ATM networks. Measures of effectiveness for ATM routing will be developed. Routing algorithms that optimize those measures will be formulated. Developing reliable routing metrics that predict the effect of adding new connections to an ATM network will be the key. Effective routing algorithms may be designed once good metrics are formulated. The quality of the algorithms will be evaluated through extensive simulation studies.

Submarine Communications

SUBCOMM Architecture

The SUBCOMM Architecture program supports the design and development of architectures such as the Automated Communications Management System, a satellite communications management program, and the Submarine Communications Support System, whose goal is to eliminate reliance on stovepipe communication systems, provide transparent, assured communication and network management, improve communication through efficient use of channels, and make the submarine indispensable to the Battle Group.

SCSS

NRaD is the system architect and system engineer for the Submarine Communications Support System (SCSS). This effort will support research, design, implementation, and integration of the SCSS/Baseband Switch (BBS) prototype development. NRaD defines the multilevel security (MLS) requirements on this architecture and assists in the integration into the prototype BBS. The Submarine Message Buffer, a subsystem within the SCSS, is developed by NRaD. NRaD supports the research, design, implementation, and test software and hardware necessary for the continued development of current and future software releases. NRaD will provide systems engineering, development, and integration of additional communication systems and a centralized integrated Network Manager to control these resources. NRaD will incrementally demonstrate improved and broadened automatic switching functionality, backup technical control, and message processing.

During FY 95, the SCSS project developed the Architecture Description Document that defined the SCSS goal architecture. The SCSS engineering effort assessed commercial SATCOM products and radio equipments for use in radio rooms. The systems engineering effort also provided support to the new attack

submarine, baseband switch, and SCSS security design for future submarine programs. It also supported the merger of the SCSS into the JMCIS environment.

ACMS

The objective of the Automated Communication Management System (ACMS) program is to provide an integrated planning system for the Milstar EHF SATCOM communication system. Using an open and distributed workstation architecture, ACMS will support the apportionment, allocation, and configuration of satellite payload resources and the definition and distribution of EHF terminal databases.

The ACMS program will follow an "evolutionary/incremental" approach. Build 1 includes all of the Milstar planning capabilities. Build 2 integrates in the UHF Follow-On/E (UFO/E) and advanced EHF planning functions. Build 1 consists of four "incremental" products, the last two of which are released to the users.

NRaD was tasked by the Air Force Space and Missile Command to perform as the prime item developer of the ACMS. This tasking includes system engineering, software requirements analysis, design, and implementation, and software testing for the ACMS. The ACMS program was initiated on 17 January 1995. During FY 95, the ACMS program developed the system-level specification and system architecture. The first of several increments was also delivered to the MILSATCOM Joint Program Office. ACMS was a new start in FY 95. The first increment of Build 1 was completed on 8 July 1995.

Integration of C^4I Systems

The objectives of the Integration of C^4I Systems program are to develop and integrate the Submarine Message Buffer and Navy EHF Communication Controller, Baseband Switch, JMCIS, JTIDS, and Link 11 into the SCSS architecture.

Baseband Switch

The current submarine radio room switching system is manually operated and has no expansion capability as required for future equipment installations. Requirements are to automate the Baseband Switch distribution system, and to integrate it with the CSS environment on the submarine. NRaD's objectives are to procure the hardware and software necessary to implement the submarine version of the Ship Automated Communications Control System (SACCS) and integrate the Baseband Switch distribution system into the automated submarine radio room.

During FY 95, the Baseband Switch project produced the system/segment specification, developed the software, and completed the installation of the Integrated Network Manager and BBS Fleet software, with documentation. This suite also included commercial off-the-shelf (COTS) and government off-the-shelf (GOTS) hardware.

NECC

The Communications Support System (CSS) is a communication architecture that enhances battle force communications connectivity, flexibility, and survivability through multimedia access and media sharing. The Navy EHF Communication Controller (NECC) is the initial implementation of the CSS. NECC is a sophisticated communications server that will be used to transfer information between ships and between ship and shore installations. The NECC uses satellite connectivity to support tactical data exchange system requirements of the Tactical Data Processors (TDPs).

NRaD's objective is to provide the Fleet with the capability to use Navy EHF Satellite Program (NESP) terminals for tactical communications in an automated network environment. In particular, this program is to provide reliable, internetted communication services for the TDP users. Multimedia access, making use of multiple EHF and UHF SATCOM resources, will be supported.

During FY 95, NRaD participated in the CSS demonstration involving the USS *Kitty Hawk* (CV63), USS *Cowpens* (CG 63), and NCTAMS EASTPAC. This demonstration provided sussessful transfer of tactical data via an Internet Protocol (IP) router over multiple media, using the NECC for the EHF portion. The NECC software was also approved for release to the Fleet for operational use.

SMB. During FY 95, NRaD integrated the Submarine Message Buffer (SMB) with the NECC and Baseband Switch projects, a first step toward demonstrating the Submarine Communications Support System future radio room concept.

Submarine Communications Management

The objective of the Submarine Communications Management program is to use existing VLF/LF transmitters to cost-effectively communicate with submarines through implementation of Consolidation of Broadcast Keying Sites, new flexible broadcast modes, and dynamic broadcast management.

NRaD Coverage Prediction Program

During FY 95, NRaD completed the development and testing of the Submarine Communications Assessment Tool Software. It was delivered to operational forces in FY 95.

Strategic Submarine Communications System Engineering

The Strategic Submarine Communications System Engineering program provides technical leadership for the improvement and maintenance of the Strategic Connectivity System (SCS). The newest SCS mode developed greatly reduces Emergency Action Message delivery times without reduction in coverage. In addition, the program supports the Modified Miniature Receive Terminal (MMRT), NONAP, VLF systems development, and TACAMO Message Processing Systems.

FY 95 accomplishments included the following:

Three-Mode Scanning

Developed a three-mode scanning approach for high-data-rate (HIDAR) for implementation in the Enhanced VERDIN system and supported implementation. On-the-air simultaneous operation was successfully demonstrated aboard TACAMO aircraft operating in distant areas.

High-Data-Rate Communications

Updated the high-data-rate communications mode documentation to support the implementation of the system in the MMRT. The program also certified and fielded several upgrades to submarine communications including the following: the Integrated Radio Room (for receiving submarine launched ballistic missile retargeting messages), integration of ELF, upgrading the IRR message processor, and effecting crossover to KG-84s.

System Engineering

Provided system engineering covering a wide range of systems including: the TRIDENT SCSS variant, HIDAR for TRIDENT, post shakedown availability for SSBN, and UHF power amplifier failure. This effort also required software changes and engineering and document upgrades for MILSTAR Message Processing System.

TMPS

NRaD has been tasked to provide life-cycle support of software for the current TACAMO Message Processing System (TMPS) and develop new software for the Block upgrade. TMPS is installed on naval aircraft and is a message store and forward system that provides input to and receives input from the VERDIN and EVS VLF/LF submarine communication systems. For the past 16 years, NRaD has been responsible for maintenance of software for VERDIN/ISABPS and related interfaces with SSIXS and TMPS. Maintenance of the current software and development of the Block II upgrade Ada software in support of TMPS is directly related to the ongoing effort.

NRaD developed software updates in anticipation of a January 1996 baseline. NRaD made and installed several software changes to the system following NAVAIR direction that included improvements in the efficiency for the Enhanced VERDIN System to the TMPS interface and incorporating new message formats.

Upgrade Existing SUBCOMM Assets

The objective of the SUBCOMM Assets program is to lead in the upgrade of shore-based FVLF and HF systems, including those on hull, operations systems, ship-to-shore communications, and NATO and bilateral communications.

FY 95 accomplishments included the following:

ISABPS Update

Early in 1973, it was recognized that two major systems, the Submarine Satellite Information Exchange System (SSIXS) and VERDIN, being developed for fixed transmitter submarine broadcast communications, would not realize their full potential when interfaced via the then proposed manual torn-tape operation. The Integrated Submarine Automated Broadcast Processing System (ISABPS) program was initiated by this Center to provide an automated capability to interface SSIXS at the Broadcast Command Authority (BCA) Operational Control Center with VERDIN at fixed VLF/LF broadcast transmitter sites. ISABPS, via its Submarine Broadcast Processor (SBP), provides an automated capability to receive, store, schedule, distribute, and verify FVLF/LF message traffic transmitted via the VERDIN shore subsystems.

NRaD's involvement in the ISABPS program covers a broad range of activities from concept formulation through installation and follow-on life-cycle support. Principal areas include the following: (1) systems design, (2) development of all operational software, (3) logistic activities with training and support documentation, and (4) life-cycle software support.

During FY 95, NRaD deployed ISABPS to 8 of the 10 operation sites. Software and Fleet documentation for several associated systems were also approved, deployed, and installed.

Consolidated Fleet Submarine Broadcast

Updated plan; developed planning documentation for WAN.

VERDIN

VERDIN is a VLF/LF communications system designated the AN/URC-62. It provides one, two, or four channels of encrypted information employing Minimum Shift Keying (MSK) modulation. VERDIN also provides Frequency Shift Keying (FSK) modes. Error detection and correction is used to improve performance. Multiple data rates are used to improve coverage in the presence of interference. Multiple VLF/LF shore sites provide for global submarine broadcast

coverage. Airborne systems aboard TACAMO aircraft provide additional coverage capabilities. To provide NATO Standard Agreement (STANAG) 5030 compatibility, VERDIN developed the NATO Interoperable Submarine Broadcast System (NISBS). This PC-based system intercepts the VERDIN baseband signal and replaces one or all channels with STANAG 5030 compatible channels. NRaD has played a major role in the development and deployment of the VERDIN system beginning with feasibility testing in the early 1960s. The Center's involvement in the VERDIN program covers a broad range of activities from concept formulation through installation and follow-on support. Principal areas include system design, software development, logistics, training, software life-cycle support, technical planning, and system enhancements.

During FY 95, NRaD implemented changes allowing elimination of a requirement for specialized software for the VERDIN transmit terminal as a part of a phased improvement to replace old equipment.

NRaD also completed software and system support for upgrades to the software systems of all platforms. The Enhanced VERDIN system is the VLF/LF receive terminal for the majority of the submarine and associated support platforms, and is the transmit terminal for the airborne relay (TACAMO) platforms.

SLVR

NRaD provides system, hardware, and software engineering to SPAWAR in the development of the Submarine LF/VLF VMEbus Receiver (SLVR), which replaces the Compact VLF/LF (CVLF) Receiving Set canceled in 1994. SLVR will provide continuing survivable communications via the Strategic Communications System and Fleet Submarine Broadcast System networks. During FY 95, NRaD provided requirements analysis and preliminary design phases.

SUBCOMM Software Management Process

The SUBCOMM Software Management Process program supports the development and implementation of a Software Support Activity for the SMB. During FY 95, NRaD successfully established and maintained the new Software Support Activity to support configuration management and quality assurance.

SUBCOMM Technology

The SUBCOMM Technology program develops and improves technologies in areas that advance submarine communications and software engineering. During FY 95, NRaD updated systems and software to provide an avenue to include PC-based receivers as hosts using GOTS standard software.

Communications Support

Communications Software Support Activity

The Communications Software Support Activity serves as the Software Support Activity (SSA) for a variety of naval SATCOM programs. In this capacity, NRaD performs Life-Cycle Support functions that include the following: instituting periodic Configuration Control Boards, providing configuration accounting reports to SATCOM Program Managers, receiving and reviewing user software trouble reports, developing software change proposals in accordance with approved standards, preparing block software upgrades and associated software

documentation packages, and performing software installation upgrades and Fleet training for new system enhancements.

FY 95 accomplishments included the following:

TRE Performed as SSA for Tactical Receive Equipment (TRE). Designed, coded, integrated, and successfully deployed TRE Software Release 10.0 and analyzed, coded, and certified two new releases. Began the analysis and coding of Software Trouble Reports (STRs) for follow-on releases and supported Battle Group IXS.

RN SSIXS Completed development of RN SSIXS, which included test and integration of Screening-On-the-Fly satellite link protocol required for interoperability with U.S. SSIXS.

Satellite Communications Support

The Satellite Communications Support program provides SATCOM support, including general system engineering, Independent Verification and Validation (IV&V), on-site technical support, engineering studies, and network monitoring.

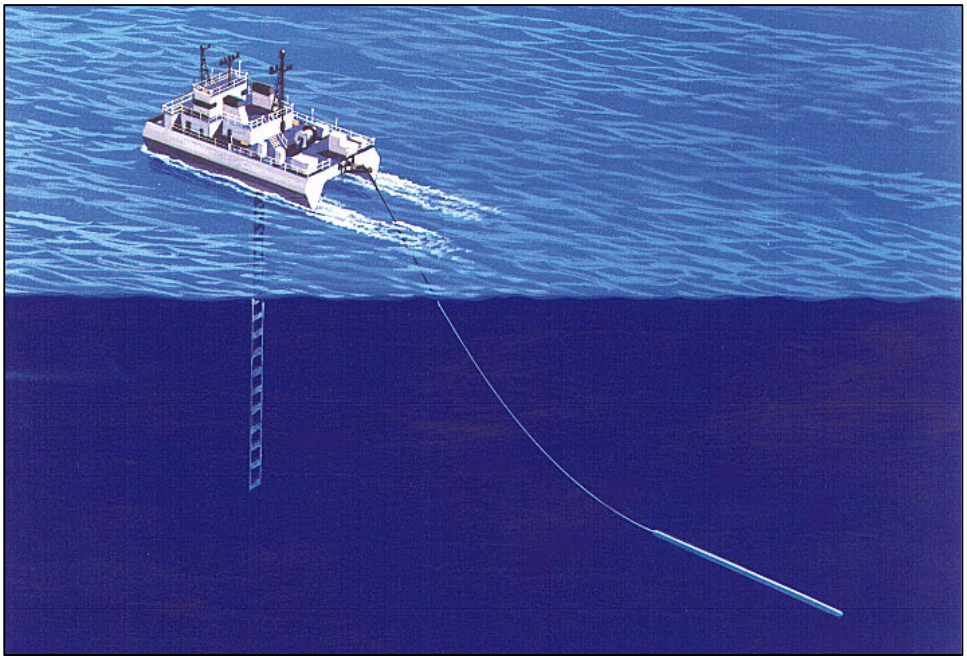
FY 95 accomplishments included the following: Provided software support to SPAWAR and the Fleet; made successful installations of Local Operations Control Center (LOCC) versions 18.3 and 18.31, and Antenna Control Unit (ACU) for 7-foot antenna installations; successfully introduced software that minimized antenna hand-over effects.

Communications Support Technologies

The Communications Support Technologies program develops tools, such as emulators, source analysis tools, software language translators, and data reducers that can be used in standard environments.

FY 95 accomplishments included the following: Provided mechanical engineering design and technical support in the fabrication of automatic test equipment systems and installation support; developed manufacturing technology projects to include Pathways for Continuous Improvement and other industrial base initiatives for joint work with the Army, Air Force, and the Defense Logistics Agency.

Ocean Surveillance



Undersea Surveillance.

Acoustic Sources

The Acoustic Sources program develops new acoustic projector and material technology to reduce the size and weight of low-frequency active surveillance systems.

Thermal Air Gun

The objective of the Thermal Air Gun project is to model, design, fabricate, and evaluate a thermal air gun underwater acoustic projector. The thermal air gun will be designed using ananalytical model for constant volume compression of internal gas. The project will develop a high-power switching scheme to incorporate in a device that can operate with a 100-kJ, 60-kV power supply. During FY 95, NRaD conducted a demonstration of the Thermal Air Gun at Lake Seneca; completed characterization of Third Generation Electrostrictive Ceramic (PMN-PT); evaluated characteristics of High-Strain Phase Change Ceramic (PLSZT); upgraded Hybrid Projector Electronics; and hosted Transducer Technology Workshop.

Advanced (COMINT) Voice Processing ATD

The Advanced (COMINT) Voice Processing ATD program is combining voice processing algorithms for interference rejection, background noise recognition,

automatic speaker and language identification, signal external information correlation, and language translation; the resulting tactical subsystem will automatically sort and analyze intercepted audio communications to find those of potential interest. During FY 95, the program obtained technical information.

Advanced Deployable System (ADS)

The ADS program is developing a rapidly deployable surveillance capability for regional conflict scenarios. ADS will function in shallow as well as deep ocean environments. Design of the architecture will be such that the systems will be modular and components interchangeable to allow rapid configuration to accommodate the environment, life requirement, and scenario as threat situations develop.

FY 95 accomplishments included the following: Completed evaluation of contractor proposals and supported protest review; conducted several major at-sea data collection exercises; developed and implemented several management tools to assist PLO: developed risk-reduction plans to assist hardware developments; participated in all IPTs employed to support and manage ADS Development; and supported the development of AODS.

Advanced Sensor Applications Program (ASAP)

The ASAP is investigating the application of advanced electro-optical sensors for nonacoustic, antisubmarine warfare (NAASW) including target detection, classification, and tracking. Project tasks include sensor development, testing, data processing, and system performance analysis.

FY 95 accomplishments included the following: Established a contract for the development of an airborne light detection and ranging (LIDAR) system; evaluated the application of coherent laser radar (CLR) for periscope detection, identification, and tracking; performed periscope optical signature measurements; and investigated the performance of hyperspectral imaging sensor performance.

Autonomous Sensor Concepts Project

The objective of the Autonomous Sensor Concepts Project is to design and develop sensor and processing technologies for remote in-situ undersea surveillance.

This effort is investigating the application of advanced electro-optical techniques to ASAP program objectives. The specific techniques being assessed include the following: (1) laser detection and ranging (LADAR) systems incorporating a pulsed laser source and a range-gated television receiver, (2) micro-doppler LADAR for non-cooperative target identification, ranging, and tracking, and (3) passive electro-optical techniques that include multispectral imaging systems and bioluminescence.

NRaD will support ASAP research and development, model design, at-sea testing, data acquisition and analysis, and instrumentation design and evaluation

associated with ocean surveillance. An evaluation of airborne passive and active electro-optical sensors will be made for ASW and surveillance. The ability of current technology to address these missions will be analyzed and recommendations made for potential system developments. Emphasis will be placed on multidisciplinary roles for the basic passive and active sensor types involved over the wide range of applications possible in the marine environment.

During FY 95, the Autonomous Sensor Concepts Project wrote a project plan for a new start in FY 96.

Bottom Limited Active Classification (BLAC)

The Bottom Limited Active Classification (BLAC) program develops automated techniques for active sonar target classification to support surveillance and tactical systems in littoral waters.

The undersea threat for limited conflict scenarios is a small diesel-electric submarine operating at slow speed or bottomed in shallow water or marginal seas. As operating areas become increasingly bottom-limited, the number of active sonar contacts presented for classification increases dramatically, necessitating a 100-fold decrease in false-alarm rate to maintain acceptable performance. This program addresses the technical feasibility of a low-frequency active (LFA) search of bottom-limited shallow-water environments. Efforts are focused on developing signal processing algorithms to enhance target detection and classification by exploiting echo characteristics in the cluttered shallow-water environment.

Calendar 1995 accomplishments include the completion of a flexible, modular sonar signal processing test bed in a high-performance computing (HPC) environment, complemented by an extensive array of unique analysis and visualization tools for target detection and echo-structure classification analysis. An active adaptive beamformer was compared in a system context with a SURTASS/LFA baseline and was shown to decrease the false-alarm rate by a factor of approximately one-half when tested against recorded bottom-limited test data.

CERCIS

CERCIS provides the next-generation replacement of signals intelligence (SIGINT) Correlation of Recognized Emitters (SCORE) and SIGINT Universal Recognition Facility (SURF) analyst capabilities currently at operational SIGINT sites. The program designs, develops, and implements all Navy-required capabilities for this theater-level system. CERCIS was initiated in 1991 and is installed at seven sites worldwide. During FY 95, the program provided technical support and system upgrades.

Common Aperture Multi-band Radar (CAMBR)

CAMBR is a multimode/multifunction radar that uses simultaneous multiple microwave bands, multiple wideband channels, and numerous waveforms as the

signal source for the radar. In addition, the radar employs an electronically steered multibeam wideband antenna system. High-data-rate complex signal processing is employed to detect and correlate the received complex signal structure prior to integrating the radar sensor information to the ship self-defense system. CAMBR is designed to improve detection, identification, and track of high-speed, low altitude, and low radar cross-section (RCS) antiship missiles. During FY 95, the program awarded a contract to design and build a proof-of-concept transmitter, receiver, signal processing algorithms, and equipment required to demonstrate CAMBR performance.

Common Integrated Platform

The objective of the Common Integrated Platform program is to create a software environment based on the Common Object Request Broker Architecture to facilitate integration of dissimilar applications that share objects.

FY 95 accomplishments included the following: Performed initial research and development that lead to design of extensions of commercial object request brokers facilitating exchange of high volumes of small objects in real time. Program planning for demonstration of this technology and requirements were established.

dbMASTER

The objectives of the dbMASTER program are to develop, integrate, and maintain dbMASTER, a software application that provides the intelligence analyst with improved methods for sorting, examining, and fusing discrete information from a wide range of intelligence sources. It has been designed to provide intelligence analysts/specialists with tools that significantly enhance their ability to search a variety of intelligence database and reference publications from a single workstation using an intuitive, user-friendly, graphical interface.

FY 95 accomplishments included the following: Distributed a maintenance release of dbMASTER, v1.1 R(2), that included updates to the publications and databases. dbMASTER v1.1 R(2) was integrated into the Air Force Combat Intelligence System (CIS). dbMASTER v2.0 was released. This release contained several major functional enhancements that include integration of the three segments (Facilities, Units and Equipment) of Integrated Data Base (IDB), Defense Mapping Agency (DMA) vector maps, Gazetteer, and the ability to search the ELINT Parameters Limits List (EPL) using only parametric information.

Distributed Surveillance Technology

The objective of Distributed Surveillance Technology program is to evolve shallow-water acoustic and nonacoustic distributed and deployable surveillance concepts through the development, integration, test, and evaluation of preprototype sensor system hardware. The program also demonstrates feasibility, lowers risks and production costs, transitions to industry, and supports other 6.2 and 6.3 developmental programs.

FY 95 accomplishments included the following: Completed operation and recovery of the Shallow-Water Sensor System, which integrated and demonstrated several of the projects developments; demonstrated long-term (6 months) operation of pressure-tolerant telemetry in shallow water; demonstrated maximal use of the "slack-line" analog multiplexing scheme for acoustic sensors; completed the design for a "pop-up" RF communication buoy; completed the design for a high-speed (2.5 Mb/s per channel) RF data link; demonstrated three-channel, bidirectional, fiber-optic multiplexing using low-loss Polarization-Independent Narrow-Channel (PINC) Wavelength Division Multiplexors (WDMs); completed design and parts procurement for an automated fiber-optic manufacturing suite; completed the design of a four-channel PINC WDM Add/Drop Filter; completed acquisition of multifunction Acoustic Data Acquisition System devices to support undersea power source development; demonstrated a 175-nm digital communication relay using a NASA solar-powered UAV flying between 22,000 and 50,000 feet.

Electromagnetic Field

During FY 95, the Electromagnetic Field program completed (with NISE West) at-sea testing of an electro-optically based electromagnetic field (EMF) probe designed and built by NRaD. The design goal of the probe is to detect and identify all on-ship EMF emissions, at frequencies ranging from 2 MHz out to 18 GHz. Testing was carried out on board USS *Chancellorsville* (CG 62), an Aegis class guided missile cruiser, as it sailed from San Francisco to San Diego. Despite high seas, rain, and strong winds, successful testing of the probe was completed without any problems. Among the shipboard systems tested were all the major communications bands, navigational radar, electronic warfare systems, and weapons targeting radar.

Fixed Distributed System (FDS)

The objective of the Fixed Distribution System (FDS) program is to develop a low-frequency, fixed acoustic surveillance system that will serve as the base system for commonality between future surveillance systems such as the Surveillance Direction System (SDS), the Sound Surveillance Underwater System (SOSUS), and the SURTASS upgrades.

FY 95 accomplishments included the following: Completed the FDS-D analysis and disseminated the results; established the framework for the FDS-1; hosted operational concept working group sessions with CUS, Naval Oceanographic Processing Facility (NOPF), and LORAL/Bolt, Beranek and Newman, Inc. (BBN) representatives; published the FDS T&E 7800 CONOPS and Fleet CONOPS; served as Team Leader for FCA/PCA during LORAL's Functional Qualification Testing (FQT)/FAT; developed initial government FCA report; published TECHEVAL Test Plan and TECHEVAL Data Collection and Analysis; researched options for Critical 7800 data recording capability and coordinated development of this Acoustic Recording System with AT&T and Applied Research Laboratory: University of Texas (ARL: UT); coordinated data formats and playback capability with BBN on SMS; worked with Operational Test and

Evaluation Force (OPTEVFOR) and trusted agents to incorporate their operational requirements into the Navy Data Collection Plans, Test Plans and Test Procedures; negotiated Target Services with Commander, Submarine Force, Atlantic Fleet (COMSUBLANT) for FDS System Acceptance Test (SAT); coordinated with PMW-181 in arranging host target services for FDS SAT; developed extensive scenario tracks, and target services requirements that were used to evaluate FDS system performance; and conducted the SAT and published the SAT/IOC Report.

Hayfield Multi-Chip Module

The objective of the Hayfield Multi-Chip Module program is to design a cryptographic chip. With the National Security Agency (NSA), under the sponsorship of the Operational Support Office (OSO), the program will design a "crypto chip." This crypto chip is called the Hayfield Multi-Chip Module (MCM) and has four channels of independently reprogrammable decryption with over-the-air-rekey (OTAR) capability; its size is approximately 2.5 X 2.5 X 0.17 inches. Sandia National Laboratories is manufacturing the MCM from the NRaD/NSA design. The MCM is designed to be compatible with the NSA-mandated Electronic Key Management System (EKMS), to be implemented in the year 2000, and is the planned replacement for the Ricebird crypto chip set that currently provides the KGR-96 decryption function in embedded crypto modules. The Hayfield MCM will emulate other cryptos, e.g., KG-184, KGV-11, as additional algorithms are developed and tested. The Hayfield MCM is planned to be used by the various USN, USAF, USA, and USMC tactical receiver system developers for designing embedded crypto modules.

During FY 95, NRaD completed the Hayfield MCM hardware design and provided it to Sandia National Laboratories for manufacturing of the Hayfield MCM. The first Hayfield MCM was delivered to NRaD on 25 August 1995. The MCM was tested in the Hayfield Development Laboratory, and it successfully decrypted the Tactical Data Dissemination System (TDDS) broadcast data on all four channels.

High-Frequency Surface Wave Radar (HFSWR) ATD

The objective of the High-Frequency Surface Wave Radar (HFSWR) Advanced Technology Demonstration (ATD) is to develop a high-frequency surface wave radar for earlier, over-the-horizon detection of low-flying, low-observable, high-speed, antiship missile threats. This radar will provide increased reaction time for ship defense and hand-over cueing of an engagement radar in range, velocity, and angle.

Increases in the detection and tracking range are essential for successful engagement of existing and future antiship missiles by shipboard weapons systems. Energy radiated in the HF band (3 to 30 Mhz) can propagate beyond the normal microwave radar horizon by virtue of penumbra and shadow region illumination by a surface-attached wave; this type of radar is commonly referred to as a surface wave radar. The capability of HFSWR to detect and track over-the-horizon targets has been demonstrated by four separate systems, all of which have been

installed at shore sites. The radar to be developed and tested in this program will transition the HFSWR to a shipboard system and address the risks of (1) electromagnetic interference by the HFSWR affecting other shipboard systems, (2) radio frequency interference in the HFSWR by other shipboard systems, and (3) the possible degradation of radar performance by the complex shipboard topside environment.

FY 95 accomplishments included the following: Initiated ATD plan; awarded Phase 1 contract to two contractors for study, analysis, and detailed design; and designed and modeled transmit and receive antennas.

IUSS Surveillance Direction System (SDS) Shore Systems Engineering

The Integrated Undersea Surveillance System (IUSS) Surveillance Direction System (SDS) Shore Systems Engineering program supports the development of the IUSS integrated architecture and development of SDS, including system engineering and software test and evaluation.

IUSS is evolving rapidly. What formerly was a single-sensor SOSUS system became a dual-sensor system with the introduction of SURTASS. SURTASS added mobility and satellite communications to the sensor properties but was developed without dealing with many of the system engineering issues. The IUSS is currently developing two new sensors (FDS and LFA) and substantially increased command and control responsibilities (SDS) to support area ASW. Proper systems engineering and testing are required to make use of commonality and integration transitioning opportunities and to reduce acquisition costs, manning levels, and training costs.

The program's objective is to perform the systems engineering, analysis, testing, and prototyping tasks necessary to achieve the highest level of cost-effective performance among the current and future IUSS components.

FY 95 accomplishments included the following: Completed certification testing of the SDS Communications Node Controller (CNC) for the AUTODIN links with the Integrated Communications Subsystem (ICS) and the Replacement ICS (RICS); delivered and installed FDS and SDS Build 4C software at first operational site during fourth quarter of FY 95; FDS/SDS Build 4C underwent Navy Site Acceptance Testing (NSAT) in preparation for FDS TECHEVAL; conducted data analysis of NSAT exercises, using designed Fleet services, at NRaD in the IUSS System Engineering Facility (ISEF); started prototyping efforts to investigate SDS re-engineering using JMCIS functions; continued prototyping of wide-area network (WAN) concept of operations for IUSS sites.

Marine Mammal Acoustic Tracking System (MMATS)

The Marine Mammal Acoustic Tracking System (MMATS) **e**xploits passive acoustic processing techniques to detect, classify, and localize vocalizing marine animals within a designated area of interest.

The Navy has is a long-term requirement to ensure that environmental mitigation measures are employed during sea tests, such as ship shock trails and low-frequency active sonar tests, in order to comply with the terms of several Federal statutes, including the Marine Mammal Protection Act (MMPA), the National Environmental Policy Act (NEPA), and the Endangered Species Act (ESA). Toward this end, SPAWAR PMW-182 sponsored initial NRaD efforts beginning in early 1994 to develop means of passively detecting and localizing calling marine animals to support environmental mitigation efforts during shock trials on the USS *John Paul Jones* (DDG 53). The MMATS evolved from this effort. Work is currently underway investigating the feasibility of adding an active detection capability to use in the case where marine animals are not calling.

During FY 95, NRaD successfully completed the third and final MMATS flight of the ONR "Tracking Humpback Whales with IUSS" exercise. This mission used MMATS to search an area over 400 nautical miles north of Hawaii for a humpback whale that had previously been tagged with an ARGOS satellite tag. MMATS has been used to support a variety of U.S. Navy tests involving the use of explosives and/or the transmission of high-level acoustic signals.

LEO SPO Support

The Low Earth Orbit System Progress Office (LEO SPO) Support program provides technical expertise and systems engineering support for space systems, ground systems, and test systems. The program will conduct engineering validation of ground processing and recommend alternative approaches and conduct a link closure/receiver characterization risk mitigation study, including supporting measurements.

FY 95 accomplishments included the following: Assessed critical algorithms and identified bottlenecks/saturation points; suggested alternative architectures with greater parallelization potential; tested major tactical receivers in the NRaD Joint Space and Tactical System Division's RF lab. Several previously undetected design flaws were identified. Developers have been notified and are working on fixes; technical inputs have been provided to aid specification, development, and testing of future systems.

Man Transportable Socrates (MTS)

The objectives of the MTS program are to define, develop, and integrate the MTS system to operate as a stand-alone or as an adjunct to the Special Operations Forces Intelligence Vehicle (SOF-IV). MTS consists of one or more portable intelligence workstations, a Communications Interface Unit (CIU) and one or more peripheral device units (PDUs) in a modular LAN architecture. MTS must provide Joint Defense Intelligence Support Services (JDISS) or Special Operations Command Research Analysis and Threat Evaluation System (SOCRATES) access via Joint Worldwide Intelligence Communications System (JWICS) connectivity, an Electronics Intelligence (ELINT) capability, and ability to interface with a variety of Special Forces communications systems. During FY 95, the program performed extensive debugging and system integration with the prototype MTS, leading to integration with the SOF-IV prototype for demonstration at JWID '95. (Joint Warrior Interoperability Demonstration).

Mine-Laying Surveillance

During FY 95, the Mine-Laying Surveillance program successfully completed a series of mine drops from a small surface platform off the coast of Camp Pendleton. The experiment obtained data regarding the feasibility of detecting mining operations in a near-shore environment similar to what might be expected within an amphibious operating area. The data will be used for further definition of autonomous sensor systems to support expeditionary and littoral warfare.

Mobile Undersea Warfare System, System Upgrade (MIUW-SU)

The objective of the Mobile Undersea Warfare System, System Upgrade (MIUW-SU) program is to upgrade existing MIUW vans by adding remote sensors, enhanced C^3, upgraded acoustic processing, and electronic support measures (ESM). During FY 95, the program delivered a Mobile Sensor Platform (MSP) to Inshore Undersea Warfare Group 1. This is the second MSP delivered to the Fleet. Van number 1 was integrated and tested. The first article Small Boat Deployment System (SBDS) was built and tested.

Multi-Mission Advanced Tactical Terminal (MATT)

The objective of the Multi-Mission Advanced Tactical Terminal (MATT) program is to maintain the MATT receiver system, which allows the user to simultaneously receive, decrypt, filter, correlate, and distribute the data contained on up to four UHF broadcasts.

MATT has been developed for Special Operations Forces, the U.S. Air Force, and U.S. Navy tactical air platforms as the next-generation tactical intelligence terminal, allowing space- and weight-constrained tactical platforms access to a wide range of intelligence products. MATT significantly downsizes current tactical receive equipment and adds additional radio channels in preparation for the TDDS and the Tactical Information Broadcast Service (TIBS), while retaining considerable capacity for future growth.

During FY 95, NRaD delivered the first full-production MATT unit.

Multistatic Active Project

The Multistatic Active Project develops systems concepts for activation of shallow-water sensors. The project develops algorithms for reverberation suppression techniques that enhance detection performance.

The project will develop technology and conceptual designs to improve multistatic detection in littoral waters against diesel/electric threats using both spatial and temporal bistatic clutter reduction methods and interoperable combinations of towed, air-deployed, and bottomed sources and receivers.

During FY 95, the project conducted a major shallow-water sea test that demonstrated detection performance against a diesel-electric submarine and submitted

three publications documenting advanced adaptive processing for reverberation suppression.

Non-Acoustic Distributed Systems Components (NDSC)

The Non-Acoustic Distributed Systems Components (NDSC) program investigates non-acoustic sensors and signal processing technology to augment acoustic arrays for enhanced detection, tracking, and classification of diesel-electric submarines in shallow water.

FY 95 accomplishments included the following: Demonstrated real-time fire control quality tracking; demonstrated single sensor detection and tracking; demonstrated classification using electromagnetic signals; demonstrated separation of surface ships and submarines in shallow water; extended detection range using transient signals; and participated in major at-sea data collection exercise.

Project Spinnaker: Iceshelf-95

The objectives of the Project Spinnaker program are to develop and deploy lightweight, low-power, low-cost ocean surveillance or sensor array systems. Such technology provides quick, covert, affordable, and rapidly-deployable ocean surveillance/sensor capability. The immediate goal of Project Spinnaker is the deployment of arrays in the Arctic. Project Spinnaker is a joint U.S./Canada program. The U.S. is developing the array, node, and fiber-optic components; Canada is developing autonomous undersea vehicle fiber-optic trunk cable deployment. The Iceshelf series are Spinnaker field tests and experiments.

During FY 95, the program concluded the Iceshelf-95 Arctic field experiment for Project Spinnaker with several major accomplishments. The main focus of Iceshelf-95 was on the Canadian Autonomous Undersea Vehicle (AUV) Theseus, which successfully completed several critical commissioning tests, including remote navigation, system operation, propulsion, communications, and fault handling. On-ice segments of the experiment using NRaD's cutting-edge array technology verified the U.S. segment of the technology.

Radiant Jade Demonstrations

The objectives of the Radiant Jade Demonstrations are to demonstrate Near-Real-Time Electronic Order of Battle (NRT-EOB) updates for operational multi-service users deployed worldwide. In FY 95, NRaD successfully demonstrated NRT-EOB capability for U.S. operational forces deployed to seven sites in the Pacific Area of Responsibility using EOB update information provided by the Joint Intelligence Center Pacific (JICPAC). In March 1995, a similar Radiant Jade II demonstration was conducted to demonstrated this capability to two additional Pacific Area land users plus an operational aircraft carrier. In June 1995, the program initiated planning for Radiant Jade III, which expands this concept to demonstrate the NRT-EOB capability globally to 24 operational

multiservice users in Europe, CONUS, Asia, and at sea using EOB update information provided by JICPAC, STRATJIC, AIC, and JAC Molesworth.

Rapid Imagery Transmission (RIT)

The objective of Rapid Imagery Transmission (RIT) program is to implement standards for rapid reporting of intelligence derived from imagery via near-real-time communications paths like TDDS. In FY 95, the program completed Phase 1 of RIT to modify the MATRIX system to facilitate imagery analyst generation of contact reporting. The program also completed Phase 2 planning, which refines TDDS reporting formats and develops tactical receiver software and concept of operations.

Relocatable Over-the-Horizon Radar (ROTHR)

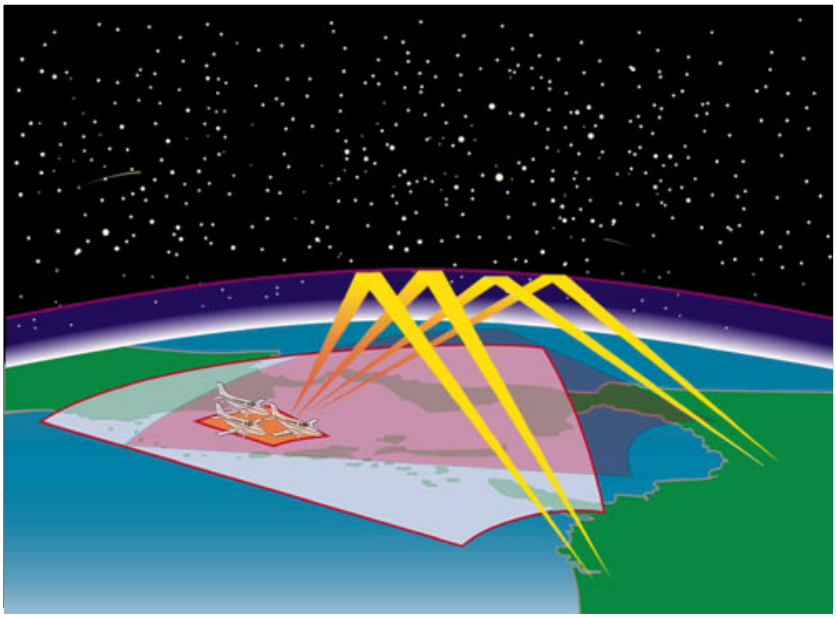
The Relocatable Over-The-Horizon Radar (ROTHR, designated AN/TPS-71), is a ground-based, bi-static, HF radar system designed to provide long-range detection tracking and reporting of air and surface targets operating within its coverage area. Two systems exist. The first is located in Virginia and the second is located in Texas. The primary coverage area for both overlap and are in the Caribbean. A third system is planned for future installation. Its primary coverage will be over the northern region of South America.

The ROTHR transmitter emits FM radio energy in the HF range, between 5 and 28 MHz. The transmitted energy is refracted in the ionosphere back onto the earth's surface in the area of interest. The surface of the earth, as well as moving targets in the area of interest, reflect some of this energy back through the ionosphere to a separate receive site. At the receiver, target-like echoes are processed to generate target track information. The information has varying degrees of accuracy due to changes and uncertainties in the ionosphere caused by factors such as time of day, season, sun spot number, and other solar activity. At the consolidated Operations Control Center, tracks are generated and forwarded to the user based on his tasking criteria.

Objectives for the ROTHR Project team are to develop revised government acceptance test procedures for the anticipated, shortened receive array of system 3; develop measures of effectiveness/performance and test procedures for government testing of system enhancements to be incorporated in Block Upgrades of the AN/TPS-71; develop and field the interface to provide ROTHR surveillance products to the operational user; assure interoperability with Joint Inter-Agency Task Force-EAST (JIATF-EAST) and the Caribbean Regional Operations Center (CARIBROC); and support AN/TPS-71 site preparation and installation in the Commonwealth of Puerto Rico.

NRaD has provided multifaceted technical support to COMSPAWARSYSCOM (PEO/SCS) and COMNAVSPACECOM (VN65) in the development, test, and deployment of the AN/TPS-71 system. Currently, ROTHR systems are employed as joint over-the-horizon surveillance assets in support of U.S. Atlantic Command and U.S. Southern Command's detection and monitoring mission. The Director, Joint Inter-Agency Task Force-EAST plans system usage, while

Commander, Caribbean Regional Operations Center, NAS Key West, FL, is the tasking agent.



Relocatable Over-the-Horizon Radar (ROTHR).

All production AN/TPS-71 systems are operated under O&M contract to the Fleet Surveillance Support Command, Chesapeake, VA. Funding is through the Office of Assistant Secretary of Defense/Drug Enforcement Policy and Support (OASD/DEP&S).

FY 95 accomplishments included the following: Provided acceptance testing and government oversight to the installation and Fleet certification of the ROTHR second production system in Texas; upgraded the ROTHR consolidated Operational Control Center in Virginia; tested the installation of the Multiple ROTHR data fusion of slant tracks in order to provide a single surveillance product to the Joint Inter Agency Task Force–East; served as task leader for the data fusion part of the U.S./Australia MOA on OTH radar technology; and fielded the JOTS/ROTHR Interface segment.

Shallow-Water Environmental Cell Experiment-4 (SWELLEX-4)

During FY 95, NRaD accomplished SWELLEX-4 experimental objectives. The joint experiment between NRaD, the Marine Physical Laboratory (MPL) at Scripps Institution of Oceanography, the Naval Research Laboratory (NRL), and the Defence Research Establishment Atlantic (DREA) (Canada) continued the SWELLEX series of experiments to increase understanding of acoustic surveillance issues in the critical littoral region by conducting carefully designed ocean acoustic experiments in the waters off Southern California, with precisely measured ocean environmental conditions and strong baseline “truth” parameters.

Shallow-Water Sensor System (SWSS)

SWSS-1, deployed off Pt. Loma in June 1994, was successfully recovered from its location approximately 6 nautical miles off the coast after being in the water for 10 months. An alternate power supply and RF communication link is being developed for the system, which will eliminate the need for the shore cable.

Shipboard Infrared Search and Track

Navy surface platform survivability is reduced by the inability of existing surveillance systems to detect, identify, and target low observable airborne and surface threats; e.g., missiles, stealth aircraft, and small surface craft. This problem is enhanced under emission control condition (EMCON) or when low-probability-of-intercept affects the operation of surveillance resources. These problems and deficiencies apply to a number of requirements: strike, littoral, and surveillance; all create the need for investigating advanced passive and electro-optical techniques. The objectives of the Shipboard Infrared Search and Track program are to develop and maintain baseline algorithms for infrared missile detection and tracking, integrate software into hardware, and test. During FY 95, the program demonstrated a multiprocessor algorithm suite including image processing, target detection, and tracking; and modified a contract to include a near-real-time, multiple-hypothesis tracker.

SITE 7800

The objective of the SITE 7800 program is to plan for occupancy and initial operational capability (IOC) of a new IUSS site, a joint operation with a foreign country, by generating a site performance specification that incorporates the specific system specifications for FDS, SDS, SOSUS, and SURTASS and provides for an integrated approach to the system installations.

FY 95 accomplishments included the following: Fielded Site 7800 Program Management System, Version 2; built Document Management System Prototype, Milestone 0; participated in JTG: Site 7800 JTG (2), FDS JTG (3), FDS TECHEVAL Working Group (3), Communication Working Group (4), Shore Processing JTG (1), Site 7800 Steering Group (2); participated in Sensor-level Testing during FDS SAT/IOC tests; completed coordination test efforts; coordinated with CUS/Site Personnel on Integration Test; completed the draft Site Integration Test Procedure.

Spatial Processing for Deployables/Robust Environmentally-Based Adaptive Broadband Beamforming/Automated Track-Before-Detect Processing

The Spatial Processing for Deployables/Robust Environmentally Based Adaptive Broadband Beamforming/Automated Track-Before-Detect Processing

programs develop improved passive detection processing for shallow-water deployable surveillance systems.

Spatial Processing for Deployables

The Spatial Processing for Deployables project develops and evaluates robust autonomous adaptive spatial processing methods that assume both planewave and environmentally derived wavefront models; internode processing techniques for increased detection range and improved localization that account for target Doppler and provide for adaptive noise cancellation; and classification techniques to reduce false alarms.

During FY 95, the project demonstrated signal coherence and detection of a target-of-opportunity between two widely separated horizontal line arrays (HLAs) in Straits of Gibraltar.

Robust Environmentally Based Adaptive Broadband Beamforming

The Robust Environmentally Based Adaptive Broadband Beamforming project will develop innovative, environmentally based, broadband beamforming designed to address the strongly directional bottom-interacting nature of the acoustic field expected in shallow water. Specifically, the inherent mismatch between actual and beamformer-calculated wavefronts due to environmental parameter uncertainty or error will be addressed.

The approach will be to represent the uncertain environment as a random acoustic channel, and use the uncertainty to broaden the definition of signal wavefront used in the adaptive beamformer. In addition, the project will exploit acoustic sources of opportunity to refine the environmental parameter assumptions, extend the approach to broadband processing, non-adaptive beamforming, and horizontal array apertures.

During FY 95, the project continued development and validation of MV-EPC robust adaptive matched field beamformer using vertical line array (VLA) data from Strategic Air Command, Atlantic (SACLANT) and SWELLEX experiments.

Automated Track-Before-Detect Processing

The Automated Track-Before-Detect Processing program will develop and demonstrate signal processing technology designed to exploit the littoral scenario characterized by moving short-range targets. This processing is intended for implementation in an autonomous environment (e.g., processor in array node). The project will develop and test track-before-detect processing algorithms for both horizontal and vertical array apertures.

During FY 95, the project developed and refined track-before-detect processing and evaluated with ADS datasets.

Standard TRE Display 95 (STRED 95)

The objective of the Standard TRE Display 95 (STRED 95) program is to develop a low-cost tactical display designed to exploit data received from national sensors via the Tactical Related Applications Broadcast System

(TRAP), the Tactical Data Information Exchange System B (TADIXS B), or the TIBS. The program was a new start in FY 95.

SURTASS and Low-Frequency Active (LFA)

The SURTASS and Low-Frequency Active (LFA) programs provide system engineering for development efforts and conduct development, acceptance, and certification tests as TDA.

FY 95 accomplishments included the following: Conducted LFA 13 and Project M At-Sea Tests; supported Fleet Operations with *Cory Chouest*; completed LFA Employment Guide; completed LTS Operational Guideline's for *Cory* Operations; characterized aging effects on LTS array; submitted Magellan II Final Report; and generated single and twin line signal-to-noise ratio and noise comparisons.

Surveillance All-Optical Towed Array (SAOTA) Program

The objectives of the Surveillance All-Optical Towed Array (SAOTA) program are to design and develop a prototype array for surveillance applications using fiber-optic technologies for all wet-end components, resulting in affordable surveillance assets. During FY 95, the SAOTA program completed design of fiber-optic hydrophones, tow cable, connectors, electro-optic circuit boards, and other components critical to the development of an all-optical array.

Tactical Aircraft Mission Planning System (TAMPS)

The objectives of the Tactical Aircraft Mission Planning System (TAMPS) program are to develop the architecture design and approach, including an A-spec, for TAMPS 7.0, and define the JMCIS/GCCS integration for the mission planning network.

FY 95 accomplishments included the following: Prepared draft System Specification for TAMPS 7, including new requirements for force-level and strike-level planning as well as support for collaborative planning; delivered performance requirements study report; submitted proposal for mission planning network test bed; and installed TAMPS 6.03 in the NRaD System Engineering Facility.

Tactical Cryptological Systems/Information Warfare Exploit

The objectives of the Tactical Cryptological Systems/Information Warfare Exploit program are to (1) develop Afloat Tactical Cryptological Systems, including OUTBOARD/COBLU, Combat DF, Ship Signal Exploitation Equipment (SSEE), and Battle Group Passive Horizon Extension System (BGPHES), and (2) develop an open systems architecture, called Cryptologic Unified Build

(CUB), that provides a common operating system for the afloat cryptologic applications that is JMCIS Unified Build compliant. During FY 95, the program successfully completed testing on CUB version 2.2.

Theater Acoustic Warfare (ThAW)/Data Fusion

The objective of the Theater Acoustic Warfare (ThAW)/Data Fusion program is to develop advanced technology for theater-level systems that fuse undersea warfare data with other sources of data.

The Theater Commander must have the correlator/tracker and data fusion tools available to assimilate a large variety of data from geographically separated sensors with a variety of processing capabilities. The Theater Commander must use information extracted from these data to assess the theater situation, and must then make decisions on how and where to use the assets to accomplish his ASW objectives.

This program provides the technology necessary to develop systems that will maintain a consistent ASW/IUSS picture for the Theater Commander, and assist the Theater Commander in allocating his assets in an optimal manner. The program focuses primarily on the fusion of acoustic data with data from all sensors and tactical platforms, and the tools to allocate assets that provide acoustic data.

The last year for the THAW program was FY 95. Its major accomplishments were the demonstration of a correlator/tracker independent distributed fusion process; an automated correlator/tracker and classification algorithm for acoustic and subset of nonacoustic sensors; and a resource allocation and assessment test bed.

FY 95 accomplishments included the following: Completed Data Sources and Fusion Methods and Data Fusion Evaluation. A sensor report that provided an overview of sensor technology and data fusion methodologies was written. Thirteen scenario OTG message sets developed for testing data fusion systems were delivered in electronic form. Two automated classification methods were developed and a resource optimization technique was initiated. This project was completed as of 30 December 95 and technologies developed transitioned to the Deployable Autonomous Distributed Systems (DADS) Program.

Tomahawk In-flight Position Reporting System (TIPRS)

The objective of the Tomahawk In-flight Position Reporting System (TIPRS) program is to develop the TIPRS ground-based Tomahawk Receiver Unit (TRU). When the TRU is located within the footprint of the relay satellite, it will simultaneously provide missile position, missile health, and status information to the Tomahawk Mission Distribution System for up to 48 missiles equipped with in-flight Tomahawk Transmitting Systems (TTS). FY 95 accomplishments included the following: Completed successful operational flight demonstration of TIPRS and completed two production TRUs.

TRAP Data Dissemination System (TDDS)

The TDDS program is developing a system that provides near-real-time contact report data through a global netted message broadcast system to a variety of Tactical Receive Equipment (TRE) users via the Navy UHF SATCOM system and terrestrial communication links.

Through NRaD's roles in the areas of system engineering, design, and development, TDDS has evolved from a proof-of-concept demonstration for TRE, which NRaD conceived and developed, to become a joint service, world-wide operational network. The TDDS Program Management Office (PMO) has tasked NRaD to continue updates and enhancements to the TDDS.

During FY 95, the program developed, tested, and delivered TDDS Update 5.0. The elements of the task included system engineering, design, development, testing, and documentation of the software upgrades to the CP-2110 TRAP Processor and the TRAP Operator Terminal (TOT). Concurrently, TDDS Upgrade 6.0 was being developed. This task replaces the current TDDS Processor with hardware and software that will meet the requirements of a centralized TDDS network. The elements of this task include defining and documenting system requirements for the centralized TDDS architecture in the form of a baseline system specification; defining and documenting TDDS software and hardware requirements; developing and testing TDDS software; defining, developing, and testing system and software test plans, descriptions and reports; and developing hardware requirements, specifications, and installation drawings for the centralized architecture at the Network Management Center (NMC), the Back-up Network Management Center (BNMC), and the MILSATCOM Uplink Sites (MUS).

The following deliverables were completed in FY 95: System Specification, Update 6.0 Source Data Specification (SDS), Update 6.0 System Description Document (SDD), DCC Software Requirements Specification (SRS), DOT SRS, DOT/DCC Interface Requirements Specification (IRS), DCC Object Diagrams and Narrative, DDC/DOT Interface Object Diagrams and Narrative, Draft DCC Software Design Document (SDD), Draft DOT SDD, System Level Test Plan, Draft DCC/DOT Test Plan, draft System Test Descriptions, NMC/BNMC/MUS Hardware Issues and Trade-off Recommendations, NMC Hardware Design Specification and the MUS Hardware Design Specification.

Vertical Launch ASROC (VLA) Missile Program

The U.S. Navy is replacing older launching systems with the Vertical Launching System (VLS). The Vertical Launch ASROC (VLA) is currently the U.S. Navy's ASW standoff weapon for ships with the VLS. The VLA provides an intermediate range, all-weather, quick-reaction ASW capability for surface ships equipped with a VLS and AN/SQQ 89.

NRaD supports U.S. and Foreign Military Sales (FMS) production. Specifically, NRaD acts as the Technical Direction Agent, System Integration Agent, and the Acquisition Agent in support of PMO-416 for the VLA program; conducts analysis of VLA test events; manages land and sea flight databases; and plans and coordinates VLA Test and Evaluation as required.

FY 95 accomplishments included the following: Supported production of U.S. and Japanese FMS units; provided fire control training and test data analysis for JDS KARISHIMA CSQT; completed USS *Curtis Wilbur* (DDG 54) DT/OT test report; completed JDS KONGO test report; developed spreadsheet for summarizing VLA flight accuracies; developed VLA flight database; began development of a program to process SPY radar data to track missile flights; modified telemetry retrieval program from VAX to PC platform; and conducted Service Life Extension Program (SLEP) planning.

Virtual Lab

The Virtual Lab program provides tools for collaboration among engineers at the National Exploitation Lab, NRaD, Rome Labs, and the Topographic Engineering Center. The virtual laboratory is an initiative of the Central Imagery Office. FY 95 accomplishments included the following: Established circuits for the wide-area network; established and accredited computer networks; installed and checked out software for white boarding and video teleconferencing (VTC).

An Integrated Hybrid Neural Network and Hidden Markov Model Algorithm for Classification Applications

The objective of this Indpendent Research project is to develop a robust classifier algorithm that can better handle one-dimensional signals with high degrees of temporal variability such as acoustic transients so as to increase the classification performance.

Detection and classification of underwater submarines using non-traditional signals, i.e., acoustic transients have been a subject of recent U.S. Navy interest. Due to strong inter-class discriminative power, the neural nets have been widely used for classifying these signals with varying degrees of success. However, classification of short-duration acoustic signals obtained from passive sonar is a complex problem because of the large variability in temporal characteristics, even when signals are obtained from the same source. The hidden Markov model (HMM) is well-suited to classification of one-dimensional signals with substantial temporal variability such as speech.

Recently completed work has demonstrated and confirmed the success of the hidden Markov model in classifying the acoustic transients using the DARPA Dataset I. Moreover, recent work has transients using the DARPA Dataset I suggests that the classification results would be more robust by combining both HMM and NN into one single classifier.

During FY 95, the project completed the theoretical development of the hybrid HMM/NN classifier, preliminary hybrid classifier design, preliminary testing of classifier, journal article, and final report.

Command, Control, and Communication Modeling and Analysis

C^3 Simulation and Technology

The C^3 Simulation and Technology program advances the technologies of large-scale simulation and networking and assesses next-generation technologies applicable to advance C^3 systems/information systems.

FY 95 accomplishments included the following:

KB 95 SSIT

Conducted Kernel Blitz 95 (KB 95) Sub-System Integration Test (SSIT). This event was designed to test interactions of Distributed Interactive Simulation (DIS) protocol entities generated by the KB 95 simulation sites over the Defense Simulation Internet (DSI). Entities were generated by Naval Undersea Warfare Center (NUWC), Newport, RI, Naval Air Warfare Center-Aircraft Division (NAWC-AD), Patuxent River, MD, Fleet Combat Training Center, Atlantic (FCTCLANT), Dam Neck, VA, and WISSARD Lab, NAS Oceana, VA. John Hopkins University Applied Physics Laboratory (APL) Warfare Analysis Laboratory (WAL) participated as a DSI Viewport. Testing was controlled from NRaD. A successful digital voice communications test was also conducted between NRaD and NAWC-AD during the SSIT.

Synthetic Theater of War-Europe (STOW-E)

Successfully completed SSIT No. 8 at approximately 15 sites. During the first 2 days, the DSI had zero-percent reliability/availability; the last 2 days were near 100-percent reliability/availability

STOW Engineering Demonstration #1

Successfully completed the integration of Army, Navy, Marine Corps, and Air Force Synthetic Forces with dynamic Synthetic Environmental Effects using the advanced technologies of Real-Time Information Transfer and Networking. Integrated the first behavior representation of command decision making in the Synthetic Forces technology area in the new Command Forces area. Real-Time Information Transfer and Networking incorporated dynamic multicast for the first time.

MAGTF Tactical Warfare Simulation (MTWS) System

The objective of MAGTF Tactical Warfare Simulation (MTWS) System program is to provide the next-generation Marine Corps Tactical Training System.

The new requirements for the current operational Tactical Warfare Simulation, Evaluation, and Analysis System (TWSEAS) have exceeded the hardware capacity, thus making the implementation of additional enhancements difficult or nearly impossible. In addition, the current TWSEAS does not have the capability to conduct a Command Post Exercise and a Field Exercise simultaneously, an important USMC training requirement. USMC has tasked NRaD to alleviate these shortcomings.

MTWS will provide a capability to conduct computer-assisted command and control exercises in support of Marine Corps amphibious training programs, meeting the following requirements:

- Simulate primary aspects of Marine Corps tactical operations, including air, ground, and amphibious operations
- Provide realistic combat situations that will stimulate a commander and his staff to perform command and control decision making as though they were in combat
- Support Command Post Exercise (CPX), Field Exercise (FEX), and integration of CPX and FEX
- Support all exercises from Marine Expeditionary Unit (MEU) to Marine Expeditionary Force (MEF) level
- Interoperate/interface with selected Marine Tactical Systems (MTS): Digital Communication Terminal (DCT); Position Location Reporting System (PLRS); Tactical Air Operation Module (TAOM).

MTWS was approved for service use by the Commanding General, Marine Corps System Command in June 1995. It was fielded at four sites: (1) MEF, Camp Pendleton, (2) MEF, Camp Lejeune, (3) MEF, Okinawa, Japan, and (4) the Marine Corps Combat Development Center, Quantico, Virginia. MTWS is now the primary combat simulation for use in computer-assisted exercises that involve Marine forces. MTWS can support a MEF-level exercise with ground units modeled at the company level, including a full range of command and control capabilities for all phases of combat operations. MTWS successfully completed Aggregate Level Simulation Protocol (ALSP) testing for use in joint service modeling and simulation confederation exercises.

MAGTF Tactical Warfare Simulation (MTWS) System.

Research, Evaluation, and Systems Analysis (RESA)

Research, Evaluation, and Systems Analysis (RESA) provides a large-scale computer simulation/wargaming system supporting architecture assessment, concept of operations development, advanced technology evaluation, joint exercises, and test and evaluation of advanced systems.

RESA is a large computer simulation developed in Rational FORTRAN and based on VAX hardware. Various programs use the RESA simulation as a tool for meeting their program objectives. The process includes establishing objectives, defining the scenario to be simulated, determining measures of effectiveness and performance to be used, developing an analysis plan, conducting a pre-exercise "dry-run," conducting the exercise (typically 5 days), conducting a hot "washup," and preparing a Quicklook Report and a Final Report.

During FY 95, RESA participated in the ULCHI FOCUS LENS exercise in the Republic of Korea. The FMS of RESA to the Republic of Korea (ROK) was finalized. NRaD will perform RESA installation and training for the ROK.

Ocean Engineering

Air-Mobile Ground Security and Surveillance System (AMGSSS)

The objectives of the Air-Mobile Ground Security and Surveillance System (AMGSSS) program are to design, develop, and demonstrate a rapidly deployable, air-mobile, sensor system that will provide extended range surveillance, detection, and identification of hostile ground forces to both personnel and vehicles for force protection and tactical security. The system consists of three air-mobile remote sensing packages and a controlling base station.

FY 95 accomplishments included the following: Designed, built, and demonstrated a Mission Payload Prototype (MPP). The MPP has all the prototype sensors — normal visual, infrared, acoustic and laser rangefinder — as is currently envisioned for incorporation into the air mobile platform. An easy-to-use, Windows control display operator's interface was developed and implemented on a laptop computer. The system has been demonstrated with hand-held and larger SINCGARS tactical radios as well as commercial radio frequency (RF) modems. The MPP represents a unique development with subsystems and radios communicating over Ethernet using TCP/IP. This implementation has allowed for distributed systems development and operation and offers the potential of modular, distributed surveillance systems operating with Ethernet or Internet connectivity.

Flying Plug

During FY 95, NRaD performed tests of the Flying Plug at the NRaD Transducer Evaluation Center (TRANSDEC). During these tests, man-in-the-loop control was used. Several successful dockings were made, verifying that the hardware additions and modifications implemented since the last test were successful. When docked, the Plug relayed a 100-Mbps, real-time color television signal over the fiber-optic microcable link.

The Flying Plug optical docking system was made fully operational and tested in the NRaD Transducer Evaluation Center (TRANSDEC) facility. Tests were performed under both dark and highly lighted ambient conditions; preamp saturation due to operation of the optical tracker in bright sunlight was noted. Redesign steps were taken to minimize these problems by altering the preamp and installing blue-green optical filters ahead of the tracker lens. An Odyssey unmanned undersea vehicle provided by the MIT SeaGrant Office was modified to integrate a Flying Plug optical docking sensor. Preliminary testing was performed in San Diego Bay, in which Odyssey was trained to home and dock with a universal docking station for the eventual purpose of battery recharging and data exchange.

TRANSDEC Facility at Night.

Marine Materials

NRaD has developed the application of nonmetallic materials for use in pressure hulls for deep submergence use. These hulls can be used to house electronics, batteries, sensors, or anything that requires a dry, 1-atmosphere environment. Materials that have been investigated include alumina and beryllia and ceramic metal matrix materials such as boron carbide/aluminum and silicon carbide/aluminum. These materials offer significant advantages for deep submergence pressure housings including low weight-to-displacement ratios and excellent corrosion resistance at costs lower than those of titanium housings. Current efforts include the development of acrylic light pipes for interior illumination of hyperbaric chambers and improved syntactic foam for buoyancy.

Mine Neutralization System (MNS)

The Mine Neutralization System (MNS) program provides engineering and management support for the AN/SLQ-48(V) MNS, including the unmanned, tethered Mine Neutralization Vehicle (MNV).

FY 95 accomplishments included the following: Supported NAVSEA/NMWEA in numerous new areas of Handling System problems related to the Mine Hunter, Coastal (MHC) class of minesweepers; assisted with MHC-unique design requirements and production problems; designed/fabricated/tested and installed improved MNV and SSA components and wrote and submitted Mission Package Depot Plan; supported NAVSEA/MNWEA in design improvements and MPC testing; generated SSA launch and recovery procedures for MHC-unique problems related to MPC; supported two test sessions aboard ship to aid analysis and plans for improving the systems.

Mobile Detection, Assessment, and Response System (MDARS)

The Mobile Detection, Assessment, and Response System (MDARS) program will develop and implement an automated intrusion detection and inventory assessment capability for use in DoD warehouses and storage sites. MDARS will provide multiple mobile platforms that perform random patrols in interior and exterior warehouse and storage site environments. MDARS is a Joint service program. NRaD provides Technical Direction for the Interior and Exterior MDARS programs and is developing the Multiple Robot Host Architecture (MHRA) that will control and coordinate many autonomous robotic platforms.

During fy 95, the program installed an MDARS Interior robot in an office environment and continued evaluations with an installation in a warehouse environment. The MDARS Exterior platform was operated successfully in a teleoperation mode. For the exterior program, the sensors, intrusion detection, and collision avoidance systems were demonstrated in a standalone mode. A new version of the MHRA software was released and software conversion to the Windows NT operating system and Ada programming language was initiated.

Test and Evaluation

NRaD continues to support a variety of test and evaluation efforts, including the test and evaluation of undersea sensors; missile systems; sonobuoys; underwater communications; and rapidly deployable, small diameter fiber-optic cables. NRaD also maintains a full military and civilian dive locker that enables scientists and engineers to participate first-hand in the undersea test and evaluation of equipment and systems.

Unmanned Undersea Systems

The Unmanned Undersea Systems program is developing unmanned undersea systems for search and work systems and major mission requirements, including TDA functions for the Advanced Tethered Vehicle (ATV) and the Advanced Unmanned Search System (AUSS).

During FY 95, NRaD delivered the AUSS to the Navy Supervisor of Salvage (NAVSEA OOC) and provided engineering and technical support to Submarine Development Group I on their unmanned vehicles, deep submergence vehicles, and deep submergence rescue vehicles.

USS *Dolphin*

USS Dolphin enroute to NRaD, Bayside.

The deep-diving submarine USS *Dolphin* is unique, both in equipment and capability. NAVSEA PMS-395 has tasked NRaD with providing engineering support to this vessel to ensure that equipment repairs and refurbishment meet the special needs of deep-submergence work.

FY 95 accomplishments included the following: Performed Qualification Corrosion Testing of High-Alloy Fasteners for the *Sea Wolf*/NAS program; provided instrumented target services for Mk 50 Torpedo Shallow-Water Testing [Southern Calilfornia (SOCAL) and Pacific Northwest (PACNORWEST)]; provided baseline target field surveys for T&E of EC 17 upgrades to BQS-15 submarine sonar systems; demonstrated HF e-mail using COTS Automatic Link Establishment Transceivers beyond 1000 miles during deployment to PACNORWEST. Other programs supported include MIUW-SU, Periscope Detection, Advanced Seal Delivery System, and WESMAR OAS Sonar T&E.

USS Dolphin and crew arriving at NRaD, Bayside.

Navigation

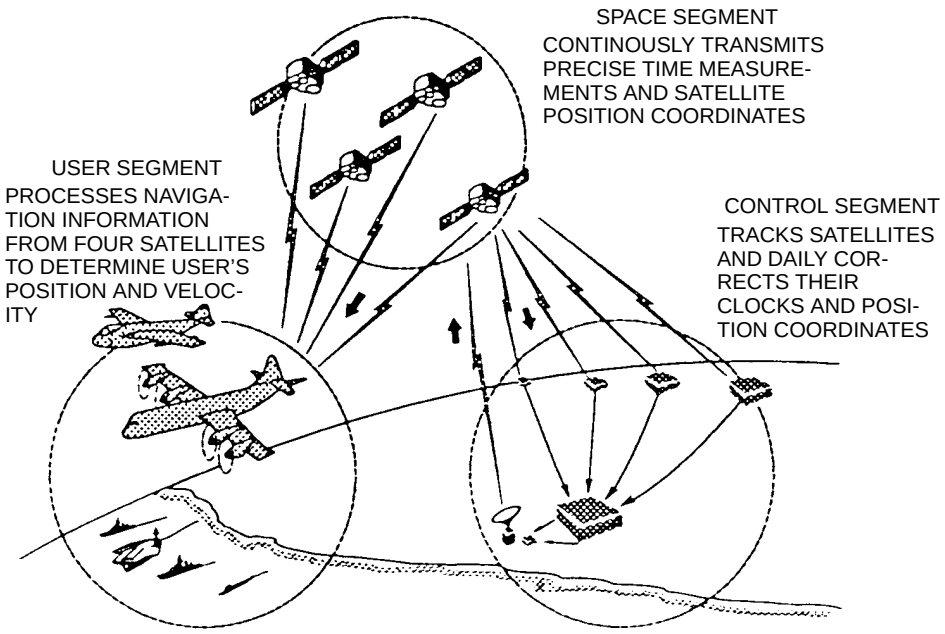
Air Navigation

The Air Navigation program provides basic analysis and systems development functions for airborne navigation systems, including hybrid navigation systems and inertial navigation subsystems; develops experimental navigational systems and performs feasibility demonstrations aboard air platforms; and provides engineering support to major system project offices in the areas of navigation and systems integration.

FY 95 accomplishments included the following: completed formal qualification testing of the Control Display Navigation Unit (CDNU) operational flight program for the CH-46 and CH-53 aircraft. The CH-46 has since successfully completed TECHEVAL. Initiated development of the CDNU modification for the EA-6B and the F-14A/B software. For the KC-130, CH-53, CH-46 and UH-1N, NRaD is developing the CDNU software operational training program. Completed integration of ARC-210 VHF/UHF radio control software into CDNU. This software is now flying in USMC KC-130 aircraft. Finished installation of GPS into HC-130 aircraft. Successfully completed Development Testing at NAWCAD PAX and Operational Testing with the Coast Guard.

Global Positioning System (GPS)

The Global Positioning System (GPS) program provides accurate, continuous, worldwide, three-dimensional position and velocity, and precise time to all DoD users through development and applications engineering of the GPS user equipment for Navy aircraft, surface ships, and submarines. The program manages, directs, and/or coordinates other participating activities and industry in support of the Joint Service Program as the Navy's lead laboratory in GPS user equipment.



NAVSTAR GPS program segments.

FY 95 accomplishments included the following: Enhanced GPS Satellite Simulator accuracy to subcentimeter accuracy to support FAA Cat IIIb landing approach system evaluations; performed factory acceptance testing for Coast Guard Reference Station/Integrity Monitor system; completed developmental testing and supported initial operational testing of the GPS Intertial Navigation Assembly (GINA) for T-45 Trainer aircraft; performed core testing of GPS function in Embedded GPS Inertial (EGI) Navigation Unit; performed indoor and outdoor performance characterization tests for Control Reception Pattern Antenna (CRPA) for GPS Joint Program Office (JPO); performed RAIM functional evaluation of ASN-128/B EDR; enhanced Simulated Inertial GPS Navigation Laboratory capability to evaluate dynamic blended inertial/GPS solutions; performed specification requirements testing for Special Operations Lightweight GPS Receiver (SOLGR) and Miniature Underwater GPS Receiver (MUGR); completed testing of four GPS commercial receivers under the JPO's Commercial Receiver Test Program (CRTP); evaluated jamming and spoofing enhancements to the JPO's standard aircraft and shipboard receivers; evaluated potential GPS signal interference by changes in GLONASS frequencies; performed Jamming Spoofing Characterization (JSC) of JPO receivers; and completed Advanced Commercial Receiver Evaluation Program (ACREP) for the GPS JPO. Supported an operational test flight failure analysis and performed Independent Validation & Verification testing of a new GPS Flight Software (GFS) program for the Tomahawk Land Attack Missile (TLAM) Block III program. Initiated the development of a GPS Transition Laboratory for installation at facilities in Imperial Beach. This Laboratory would support on-going NRaD GPS commitments during relocation of the GPS from its current location in Warminster, PA to San Diego, CA.

Navigation Sensor System Interface (NAVSSI)

The Navigation Sensor System Interface (NAVSSI) program is developing a system designed to integrate the shipboard navigation sensors and systems and to provide a single best source of navigation information to all users. The program will develop and provide preplanned product improvement of the NAVSSI, including incorporation of ship navigation planning aids, digital nautical charts, plotting capabilities, addition of navigation sources and users, and accuracy improvements.

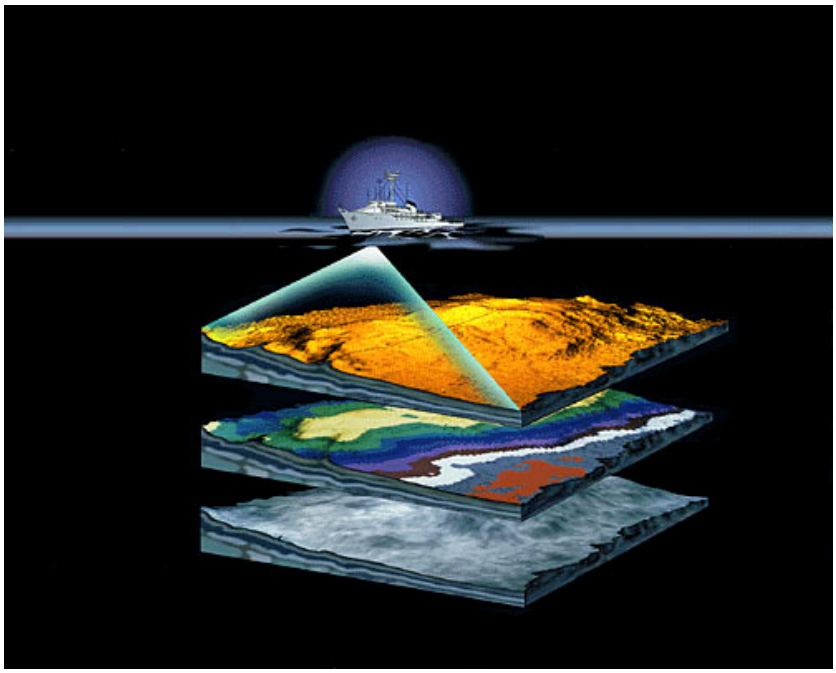
FY 95 accomplishments included the following: Successfully completed the development of the initial version of the NAVSSI product line, namely Block 0 and introduced it into the Fleet aboard cruisers and destroyers. Through an evolutionary acquisition process, the Block 2 development was initiated and will have significantly expanded capability to support a broader class of ships including carriers, LHA's, frigates, cruisers, and destroyers. Block 2 will be a dual redundant system for combat survivability and will host the next-generation GPS, which will be a GVRC. A Fiber-Optic Antenna Link (FOAL) is also undergoing development to connect the GVRC to the antenna. The NAVSSI submarine program, which only included the NSSN, has been expanded to include all other classes of submarines.

Navigation Technology Programs

The Navigation Technology Programs perform research and development for sensors/systems unique to navigation applications.

FY 95 accomplishments included the following: Completed the development of a marine navigation quality Fiber-Optic Gyro (FOG) under the ONR 6.2 Navigation Block Program. This FOG has been transitioned to the NAVSEA Navigation System Acquisition Manager and is available for use in the next generation of marine gyrocompasses. Results of this FOG development also provided the basis for the new FY 96 High-Accuracy FOG Program conducted by NRaD, also under the ONR 6.2 Navigation Program.

Ocean Survey Program (OSP)



Ocean Survey Program.

The Ocean Survey Program (OSP) produces ocean bottom contour charts for direct use by the Fleet using a precise navigation subsystem and a multibeam sonar array subsystem integrated with an advanced data processing complex. The program also conducts a continuous program to extend the capability, accuracy, reliability, and maintainability of these systems by advancing the state-of-the-art in navigation, sonar, and data enhancement techniques in response to increasingly stringent Fleet requirements for bathymetry, gravity, magnetics, and other geophysical parameters.

FY 95 accomplishments included the following: Developed and successfully integrated and conducted an at-sea demonstration of equipment and software designed to demonstrate improved Mk 86 gunfire accuracy by using GPS navigation data. Successfully completed the design, development, field test and evaluation, and delivery of 18 production-type Differential GPS Data Link Systems. These portable, field deployable units are used by NAVOCEANO for hydrographic surveys carried out in 22 undeveloped nations under the Hydrographic Cooperative Program (HYCOOP). Successfully completed the integration, test, and evaluation of upgrades to the multimission survey system aboard the newest NAVOCEANO survey ship, USNS *John Mcdonnell* (T-AGS 51). These upgrades, designed and developed by NRaD , included (1) a new broadband acoustic Doppler current profile that separates, processes, time correlates, and refines analog sonar echoes to produce accurate ship's fore-aft, athwartship, and vertical velocity data for use by the survey system; and (2) integration of a sound velocity system that measures speed of sound in water at the ship's keel.

Ring Laser Gyro Navigation (RLGN)

The Ring Laser Gyro Navigation (RLGN) program will develop and field the next-generation inertial navigation system for the Navy's surface combatants and attack class submarines. The RLGN will replace current fleet inertial navigation systems with a single system that will improve system performance, operational capability, and system reliability, and significantly reduce system life-cycle costs.

During FY 95, the RLGN competitive procurement process was successfully completed by NAVSEA with significant NRaD technical support. The contract was awarded to Sperry Marine Systems, Charlottesville, VA. The development program was initiated to configure the RLGN system to meet both surface ship and submarine requirements. NRaD was designated by NAVSEA to serve as the U.S. Navy technical representative at the contractor's plant to monitor contractor activities/progress and to provide the necessary technical guidance to ensure that all U.S. Navy requirements were met. NRaD initiated the effort to plan the U.S. Navy's test program in accordance with the RLGN Test and Evaluation Master Plan (TEMP) requirements and objectives.

Marine Mammals

Marine Mammal Systems (MMS)

The objectives of the Marine Mammal Systems (MMS) include the following: Develop, produce, and support operational Fleet MMS for object detection, location, marking, and recovery missions; enhance MMS for SW/VSW MCM; develop improved methods for care and maintenance of marine mammals and to predict performance on long-term deployments to a variety of environments; support efforts in determining impact of Navy tests and operations on marine mammals in the wild; and conduct research in biosonar.

FY 95 accomplishments included the following: Developed and introduced a Shipboard Forward Deployment capability into the Fleet so that MMS can be transported, housed, and worked internal to the Task Force (from ship); upgraded Fleet MMS with GPS to eliminate need for land-based navigation; enhanced capabilities of Fleet MMS for SW/VSW MCM; turned over additional trained animals to all MMS; made first measurements of effect of depth/pressure on marine mammal hearing and sonar; provided highest quality vet care to all Navy marine mammals. Also, the Navy Marine Mammal Program and facilities were accredited by the American Association for the Accreditation of Laboratory Animal Care (AAALAC).

Dolphin with trainer.

Dolphins at NRaD.

Integration of Space Communication and Surveillance Systems

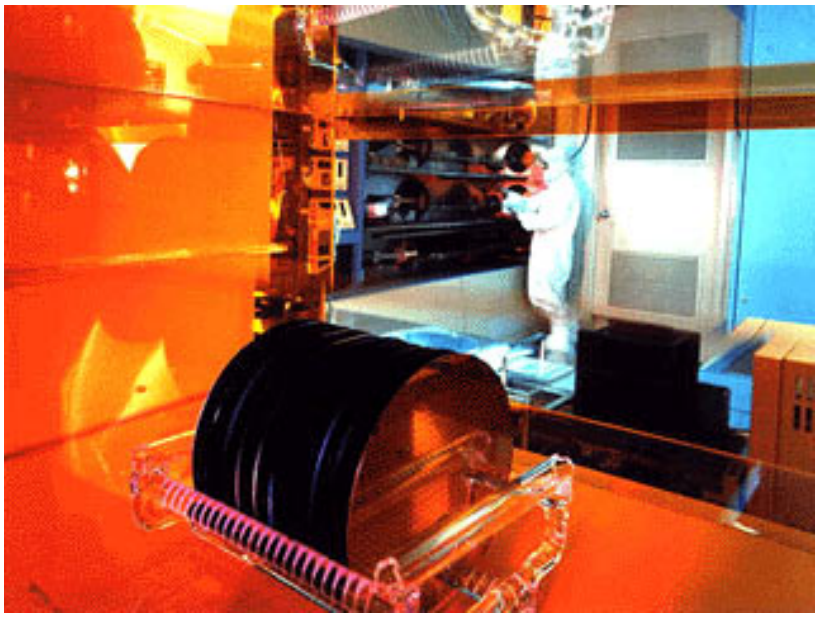
AN/USQ-101(V) TADIXS B/TRE

The objectives of the AN/USQ-101(V) TADIXS B and Tactical Receive Equipment (TRE) System programs are to develop a system that receives, demodulates, decodes, decrypts, processes, and distributes TADIXS B broadcast contact reports.

TRE Access Kernel (TREAK) Version 9.03

TREAK was developed as a "drop-in" module to provide user systems with access to the TRE data product and to allow control of the TRE device. The TREAK resides in the user system's operating environment and provides the communication interface to the TRE device. The user system communicates with the TRE device via an inter-process interface, with TREAK using data and control packets. The TREAK alleviates the need for user systems to develop their own low-level protocol for creating and sending individual commands to the TRE device and retrieving the responses. During FY 95, NRaD completed test and evaluation (T&E) of TREAK Version 9.03.

Electronic Sciences and Technology



NRaD Microelectronics Laboratory. (LRO 2034-8-87)

Analog Photonic Link Dynamic Range

The Analog Photonic Link Dynamic Range program is developing advanced photonics for shipboard antenna systems. During FY 95, NRaD demonstrated (with UCSD and Fermionics Corporation) the highest analog photonic link dynamic range ever reported using a single optical modulator. The link uses semiconductor electroabsorption modulators developed under ONR support and offers a simple and superior approach for shipboard antenna link designs requiring high dynamic range.

Infrared Focal Plane Array (IRFPA)

The objectives of the Infrared Focal Plane Array (IRFPA) program are to (1) test and evaluate long wavelength infrared (LWIR) focal plane arrays, detectors, filters, and materials in support of DoD and NASA technology and system development programs; and (2) conduct research and provide consultation on Infrared Focal issues related to infrared radiometry and environmental effects for both strategic systems and orbital missile defense programs.

FY 95 accomplishments included the following: Completed measurements on several state-of-the-art focal plane arrays: 64X64 Quantum well focal plane from Martin-Marietta for the U.S. Air Force; 128X128 Mercury-Cadmium-Telluride from Santa Barbara Research for the U.S. Army Pilotline Experiment Technology (PET) program; optical characterization of three diamond

windows/substrates for U. S. Army EKV program LWIR in-band and out-of-band radiometric characterization of NASA AIRS filters; and conducted radiometric and radiation effect characterization of three filters for the NASA LANDsat-Thematic Mapper program.

Low-power Electronics

Since the late 1970s, ARPA has been involved in development of new microelectronics technology. The advances of the technology have been promoted by ARPA, extending into new and advanced technologies. This project promotes and monitors the development of new technology in microcircuit concepts, designs, processes, applications, and development. Eventual extension of the technologies to military and commercial applications is the goal. The effort supports the development of technologies for new advancements in microelectronics and their applications to high-speed and/or low-power devices. This is done by technical monitoring of contracts let by NRaD and other agencies, in house evaluation of materials and their properties, and demonstrations of process developments.

During FY 95, NRaD was selected by ARPA to be the agent for the Advanced Materials and Device Processing portion of the new Low-Power Electronics (LPE) program. This program will be run jointly by two offices at ARPA, the Microelectronics Technology Office and the Electronics Systems Technology Office. NRaD was chosen because of previous strong contractual support and the in-house fabrication facility for metal oxide semiconductor (MOS) circuits.

Memory Chip

The Memory Chip program is developing non-volatile memory for strategic applications. During FY 95, NRaD demonstrated excellent results for the 1k ferroelectric non-volatile memory chips fabricated for the Strategic Systems Project Office. First-pass yield can be expected from the memory devices. Because of robust SPICE parameters and a mature, well-controlled process, two new circuits fabricated in ultra-thin silicon-on-sapphire in the last year have shown first-pass yield. Battery Ashburn is currently one of the only sources in the U.S. that can quickly deliver fully depleted silicon-on-insulator circuits.

PINC Wavelength Division Multiplexing (WDM)

The PINC Wavelength Division Multiplexing (WDM) program is investigating index-of-refraction changes in fused-fiber devices. This includes permanent changes due to irradiation with high-intensity ultraviolet light, and temporary changes due to absorption changes in couplers made with rare-earth doped fibers when they are optically pumped.

Low-loss, high-isolation, environmentally stable wavelength division multiplexors can be produced using the fused-fiber technique, where two optical fibers are positioned side by side, melted together, and pulled to form a tapered structure. The wavelength channel separation and the location of the operating

wavelengths are dependent on the optical length of the device, which is a product of the physical length times the index of refraction of the glass in the fused region. By altering the refractive index, the amount of light at a given wavelength that couples into each of the two output fibers can be adjusted.

Fused-fiber PINC WDMs form the basis of this work. Their wavelength properties will be altered by changing the index of refraction of the glass within the coupling region of the device. Permanent changes will be demonstrated by shining high-intensity ultraviolet light on the fused region to change the index of refraction. Devices capable of temporary changes will be produced from short sections of rare-earth doped fiber, with the index change being accomplished by optically pumping the device with an appropriate wavelength of light.

During FY 95, the program experimentally confirmed theory of wavelength response tuning of PINC WDM fiber couplers. The theory is based on effecting an index-of-refraction change in the coupler fused glass region by irradiating it with intense ultraviolet light from a krypton fluoride eximer laser. The resulting change in index shifts the wavelength-dependent coupling function of the PINC WDM, thus "tuning" it to match the specified channel wavelengths of a WDM optical fiber system. This tuning is controllable by varying the ultraviolet laser intensity or exposure time.

Silicon-on-Sapphire (SOS)

The Silicon-on-Sapphire (SOS) program is exploiting SOS technology for next-generation electronics.

During FY 95, the program characterized deep sub-micron n- and p-channel transistors fabricated in 500 angstroms of SOS. These devices were shown to have useful gain at frequencies in excess of 50 GHz, comparable to the fastest silicon devices previously reported in the literature. At 2 GHz, a frequency used in personal, hand-held communications, the power gain was measured to be almost 20 dB.

The program also completed a Cooperative Research and Development Agreement (CRADA) to assist in the technology transfer of NRaD's SOS technology to develop active-matrix liquid crystal displays. The goal is to commercialize a pending NRaD patent and subsequently produce low-cost projection displays that can be used by the Fleet in future COTS upgrades to the Aegis command centers and the ACDS.

Stochastic Resonance (SR)

Stochastic resonance (SR) is currently of considerable interest in analyzing the response of nonlinear dynamic systems to weak signals buried in noise. It has been demonstrated in a variety of nonlinear devices including lasers and SQUIDs. However, its utility as a detection tool is still in doubt because even though the effect leads to enhanced SNRs at the output of nonlinear devices, the critical elements for detection including the probability of detection and the false-alarm rate may actually be unacceptable when compared to optimal linear detectors.

The SR program performs basic research on SR effect in noisy nonlinear dynamic systems; enhanced SR effect in many-body systems; role of SR in information/signal processing by sensory neurons; application to SQUID sensors for military/civilian remote sensing applications; and signal detection statistics of nonlinear dynamic sensors.

FY 95 accomplishments included the following: Successfully demonstrated SR, including new (externally controlled) optimization scheme, in laboratory SQUID sensor (phase 1 SBIR with Quantum Magnetics Inc.); awarded Phase 2 SBIR for development of fully optimized high-Tc SQUID and design of prototype SQUID array utilizing SR; developed Information-theoretic generalization of SR for aperiodic signals and application to simple neural model; demonstrated SR effect in signal detection statistics (detection probability, false- alarm probability) of nonlinear dynamic sensors; developed theory of Array Enhanced SR and noise-induced spatio-temporal synchronization in large arrays of nonlinear elements driven by periodic external signals; received invitation to write review article for Physics Today, to appear with cover feature in March 1996 issue.

Tri-Service Support

Because of rapid technology changes and decreasing fabrication lifetimes, the Navy frequently encounters the loss of electronic equipment production and repair abilities due to manufacturing cessations (obsolescence) of microcircuits. The increasing rate of obsolescence of microcircuits has a direct, detrimental impact on the readiness and ability and useful life of key electronic systems. The Tri-Service Support program supports the development of microelectronic components no longer commercially available but needed to support Fleet systems.

FY 95 accomplishments included the following: Hosted Tri-Service Generalized Emulation Microcircuit (GEM) Program review; provided GEM technical interface to Air Force (Warner Robins Air Logistics Center (F-15), Hanscom AFB (JSTARS)), Navy (Aviation Supply Office, NAVAIR S-3) Army (Redstone Arsenal) NASA/Rockwell Space Systems Division (Space Shuttle), and Defense Electronic Supply Center; directed contract effort to develop new emulation capability for non-procurable high-speed and high-voltage microcircuits; provided technical definition for GEM Production Program and next-generation microcircuit emulation; reverse engineered circa 1985 Hewlett Packard 7907-60095 hard disk controller card for ATS-Vi (Avionics Test Set).

Trident Missile

The NRaD Trident Missile program provides navigation and fire control support for Trident missile programs.

FY 95 accomplishments included the following:

D5 (Trident II) MTRE

Successfully completed Phase 3A Interface Testing of the Missile Test and Readiness Equipment (MTRE) Mk 10 applications software, including tactical Launch and Missile Test. The test configuration included an actual Fire Control System, Guidance and Flight Control modules, MTRE Mk 10, and the NRaD Missile simulator.

Trident Stellar Sensor

Developed an entirely new fabrication process to fabricate the charge-coupled device optical sensor used in the Trident guidance system. This process is a transition to all-ion implantation, as opposed to the older process of doping by diffusion and thermal annealing. All-ion implantation simplifies the processing by eliminating several steps required in the diffusive method. Fluorine is being investigated as a possible dopant to improve the radiation hardness of the final device. Ion implantation, as a processing method, provides greater control and greater precision in the doping profiles and concentrations, especially at interfaces where these factors can be critical. Yield on the most recent lot averaged 84 percent. An improvement in dark current with the incorporation of fluorine was also seen.

Environmental Assessment

Marine Environmental Support Office (MESO)

Naval operations in bays and harbors must comply with local, state, and Federal regulatory requirements. These requirements will be extended and made more rigorous, especially in vulnerable coastal and estuarine zones that receive multiple impacts from many sources, that provide important economic and ecological resources, and are where the Navy has and operates the majority of its assests. The Navy is also required to investigate potential hazardous waste sites on its property and remediate if necessary. Ecological risk assessment is an emerging science that will allow the Navy to conduct comprehensive studies to determine the need for remediation. Biotechnological applications such as bioremediation through biodegradation and biodetoxification are also becoming increasingly important in the actual cleaning up of these sites. To effectively comply with environmental regulations, the Navy must be able to anticipate the environmental effects of its operations and legally defend those operations with scientifically sound data and practical alternatives.

The Marine Environmental Support Office (MESO) provides Navy-wide technical and scientific support and research for marine environmental science, protection, and compliance. MESO also provides expanded support on a cost-reimbursable basis for various sponsors. Information is provided on biology, chemistry, biochemistry, hydrography of coastal regions, harbors, estuaries, and other marine environments. MESO provides liaison between personnel involved in naval operations and facilities and the R&D community for environmental problems concerning marine pollution, environmental and toxicity assessments, bio-degradation and bio-detoxification, and compliance with local, state, and Federal environmental regulations.

FY 95 accomplishments included the following:

Integrated Naval Shipyard Compliance Project — Provided NAVSEA with a Draft Report on the current status of compliance of naval shipyards and made short-term and long-term recommendations for an integrated approach to compliance for the shipyards.

Uniform National Discharge Standards — Provided POA&M to NAVSEA to support technical data collection in support of a uniform standard approach to environmental regulations relating to USN vessel discharges in various ports.

Butyltin Sample Study — Completed report on “Butyltin Concentrations in Water Samples Collected during USS Leftwich Antifouling Point Removal Operations at Pearl Harbor Naval Shipyard - June 1994 through January 1995” for Pearl Harbor Naval Shipyard.

San Diego Bay Sediment Risk Assessment — Conducted extensive biological and chemical testing to study environmental effects from long-term naval operations and hazardous waste sites in San Diego Bay. Contaminant dispersion modeling is in progress.

SINKEX — Provided support to NAVSEA to conduct an ecological risk assessment to determine the potential hazards posed to the marine environment from deep-sea

disposal of Navy ships. Additionally, initial planning is occurring for a sampling effort on several naval hulks that have been used in the artificial reef program along the East Coast. Data are required in order to resume Fleet sinking exercises using decommissioned naval vessels.

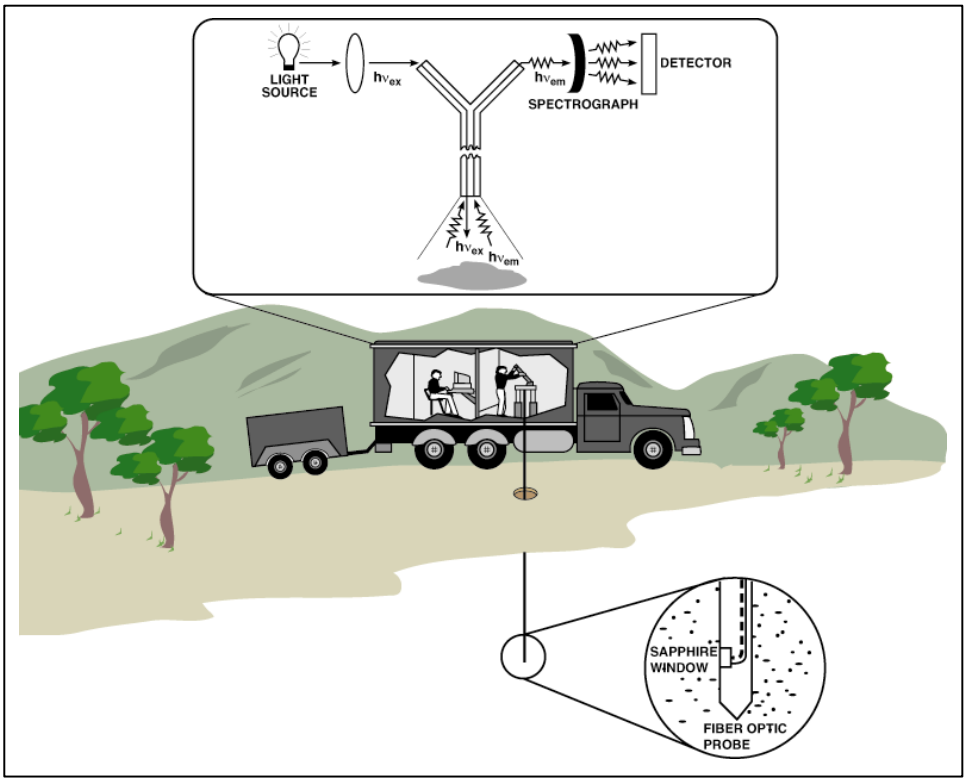
Ecological Risk Assessment

Completed Draft Final Estuarine Ecological Risk Assessment for Portsmouth Naval Shipyard in partial fulfillment of NAVSHIPYD PORTSMOUTH's RCRA Corrective Measures Permit and CERCLA RI/FS requirements.

Site Characterization and Analysis Penetrometer System (SCAPS)

The objective of the Site Characterization and Analysis Penetrometer System (SCAPS) program is to develop and deploy a suite of real-time in situ sensors for rapid assessment of hazardous waste sites at reduced costs.

SCAPS is a tri-service technology effort led by the U.S. Army. Initial integration of a fiber-optic-based, laser-induced florescence sensor for petroleum, oil, lubricant (POL) contaminants into a standard geotechnic cone penetrometer was a collaborative effort between U.S. Army Waterways Experiment Station (WES) and NRaD. The initial technical success led to rapid maturation, technical transfer, and commercialization of the technology for use at POL-contaminated hazardous waste sites. Acquisition and dual-use of SCAPS has been achieved. Regulatory Acceptance initiation at the national, regional, and state levels are progressing.



Cone Penetrometer Fiber-Optic Fluorometer (Double Fiber System).

FY 95 accomplishments included the following:

Accepted by the Environmental Protection Agency (EPA) Environmental Monitoring Systems Laboratory, Las Vegas, NV, as the first program for Technology Verification under the EPA Consortium Program. NRaD, on behalf of the DoD Tri-Services, combined this program effort with similar programs already initiated with Western Governors and the California EPA. A formal demonstration of the LIF technology was successfully conducted at the Hydrocarbon National Test Site, Port Hueneme, CA (Spring 1995) and at Sandia National Laboratories, Albuquerque, NM (Fall 1995).

Selected by the California EPA (lead agency for the Interstate Technology and Regulatory Cooperation Committee) for fast-track reciprocal acceptance of pending Cal EPA Technology Certification. In addition to the 13 western states, New Jersey, Massachusetts, and Illinois have signed Memorandums of Understanding for the effort.

Delivered EDM-2 and EDM-3 to Naval Facilities Engineering Support Center (NFESC). Both systems are fully active, conducting subsurface field screening of POL contamination at designated Navy activities.

Deployed EDM-1 (home based at NRaD) to conduct subsurface field screening of POL contamination at Navy Training Center, San Diego, CA; Navy Outlying Landing Field, Imperial Beach, CA; Engine Test Cell, Point Mugu, CA; and Naval Air Station, San Diego, CA. EDM-1 also conducted field testing of a Raman Laser at Naval Air Station, San Diego, CA.

Signed CRADA with Loral Corporation for commercialization and integration of SCAPS with Rapid Optical Scanning Tool (ROST).

Marine Sciences and Technology

Waterside Security System (WSS)

The objective of the Waterside Security System (WSS) program is to develop an integrated multiple-sensor system designed to detect, classify, localize, and assess waterborne threats attempting to gain access to critical DoD assets. These critical assets include moored ships, nuclear and conventional ordnance handling piers, installations where nuclear capable ships moor, shipyards, naval facilities with classified material, and general waterfront facilities.

During FY 95, the ongoing WSS Command, Control, Communications and Display (C^3D) contract with Computing Devices Canada, Ltd. was closed out with receipt of C^3D element Serial 001. As a result of alternative sonar testing conducted at NRaD, a decision was made to replace the WSS-1 sonar in the WSS baseline with the AN/WQX-2 Swimmer Detection Sonar (SDS), adopted for WSS use as a Non-Developmental Item. Subsequent testing and analysis at NRaD prompted the development of a single point moor to facilitate installation at NAVSUBASE Bangor, WA. The WSS installation at NAVSUBASE Bangor was completed with installation of (1) thermal imaging sensors (TIS) in February 1995 and (2) the SDS in September 1995. The SDS remains in a test status until equipment software can be further modified to preclude generation of excessive false tracks. Anticipate problem resolution in the 2nd QTR, FY 96.

Independent Research (IR)

Independent Research Program

Independent Research is an ONR-sponsored 6.1 program that provides the Warfare Centers funding with which to conduct in-house research. It is funded under program element 601152N and is governed by both Department of Defense instruction 3201.4 of 8 October 1993 and Office of Naval Research instruction 3900.37 dtd 3 June 94. According to the latter instruction, the purpose of the Navy's IR program is to allow Technical Directors to support research important or promising to the accomplishment of their assigned missions and to develop and maintain a cadre of active researchers at the Warfare Centers who are in a position to distill, modify, and refine research results that can be applied and transitioned to higher categories of the Navy's RDT&E program.

The NRaD FY 95 IR program consisted of 29 projects totalling $2463K. Accomplishments included (1) theoretical and experimental demonstrations of enhanced diffusivity in San Diego Bay, (2) derivation of algorithms suitable for blind equalization of M-ary quadrature amplitude modulation (QAM) in complex communications channels, (3) an explicit analytic solution for the behavior of a combined adaptive spatio-temporal communications receiver, and (4) demonstration of a wide-dynamic range, efficient mixer using photonic techniques that operates well into the tens of gigahertz range.

Detailed coverage of the IR program may be found in NRaD TD 2868, "IR 1995 Annual Report," October 1995.

Appendix A
Awards—1995

Technical Society Recognition

Fellows

Institute of Electrical and Electronic Engineers

Dr. James Zeidler “for contributions to adaptive signal processing and its applications”

Acoustical Society of America

Dr. Barbara Sotirin “for leadership of research acoustic propagation in the Arctic”

Association for Computing Machinery Distinguished Service Award

Dr. Gilbert Myers for chairing the Numerics Working Group which developed two international mathematical standards

People in Preservation National Legacy Award

NRaD for establishment of the Pt. Loma Ecological Reserve

Distinguished Young AFCEAns (Armed Forces Communications and Electronics Association)

Donna Fisher
Steve Hart

Military Communications Conference (MILCOM ’95) Best Unclassified Paper

Dr. Richard North
Mike Reuter
Dr. James Zeidler

American Institute of Architects Award

Don Lydy

Ohio State University Outstanding Dissertation Award

Dr. John Meloling

National Oceanic and Atmospheric Administration Coastal America Regional Leadership Award

Pete Seligman for contributions to the restoration and protection of the nation’s coastal environment

Navy Meritorious Civilian Service Award

Ben Barlin for efforts in submarine communications, particularly for his vision in development of the Submarine Communications Support System

Dr. George Byram for expertise in many disciplines, particularly for his ability to integrate theoretical fundamental physics and mathematics with state-of-the-art engineering practices

Randy Cieslak for service as operations system site manager at Headquarters, Commander-in-Chief, U.S. Pacific Fleet

Christine Dean for her contributions to speech interaction technology in development of advanced concepts in speech recognition and speaker identification

Richard Gamble for technical achievements in manufacturing technology, directing development of technology that improved quality, reliability, affordability, and timeliness of deliverables

Wayne Gerth for efforts in submarine communications, specifically in development and deployment of Verdin capabilities and the Minimum Essential Emergency Communications Network Message Processing Node

Dr. Eric Hendricks for service as program manager for dual use in the Office of Naval Research's Industrial Outreach Division

Barry Hunt for leadership of and contributions to development of numerous surveillance and intelligence systems

Carmela Keeney for technical leadership in accomplishment of significant milestones on the Waterside Security System program

William Lang for design and maintenance of shipboard topside communications systems for the Navy, the Coast Guard and U.S. allies

Ric Millen for leadership in development of the Advanced Combat Direction System

Vic Monteleon for major contributions to technology advancements in C^4I, including service on top Navy and DoD policy panels and committees

Stan Miyashiro for signicant contributions to development of identification, air traffic control and landing systems

Dr. David Morin for architectural network design on the Integrated Undersea Surveillance System

Rod Ondis for managing tactical aircraft projects such as the Tactical Aircraft Mission Planning System and Digital Photographic Laboratory

Wayne Patterson for efforts while on temporary assignment to the Office of Naval Research Ocean, Atmosphere and Space Science and Technology Department, managing cohesive, multi-laboratory scientific investigations

Jerry Peake for technical and programmatic leadership on the Advanced Technology Demonstration for a voice processing proposal

Susan Schagunn for project management for the Commandant, U.S. Coast Guard Office of Military Readiness, establishing and managing C^4I projects

Dr. James Schukantz for his technical leadership in the field of electromagnetics and electromagnetic applications

John Schwartz for technical contributions to the Global Positioning System as Navy GPS program manager

Jim Walton for his development of ocean engineering systems, particularly for his role as systems engineer for the Advanced Unmanned Search System

Navy Science Assistance Program Manager of the Year

Chuck Francis

Captain Joseph P. Kelly Award

Captain Kirk Evans for "visionary leadership and technical excellence in undersea surveillance"

Surveillance Towed Array Sensor System (SURTASS) Award

Dan Rountry

Fixed Distributed System (FDS) Award for Outstanding Performance

Roger Harris
Albert Knight
Michael Reaves

Navy Award of Merit for Group Achievement

Advanced Unmanned Search System

Stephen Bryant
Kenneth Collins
Michael Cooke
Norm Estabrook
Gary Gilbert
Dr. Alan Gordon
Jimmy Held
Harold Jones
Tenny Keil
Michael Kono
Jerry Mackelburg
Rick Marrone
Howard McCracken
Arthur Munson
Satch Nickerson
Patrick Osborne
John Pryor
Marc Rasmussen
Michael Rutkowski
Dr. Jerry Stachiw
Ed Tallerino
Jim Walton
Richard Uhrich
Stanely Watson

"Team NRaD" for Synthetic Theatre of War-Europe

Tom Tiernan–Team Leader
Kevin Boner
Chris Burns
Dan Coppock
Dave Fusco
Cal Goodrich
Doug Hardy
Susie Hartzog
Paul Iordanides
Art Ketteringham
Cindy Keune
Lt. Randy Knapp
Chuck Peters
Chris Poulos
Dave Roberts
Roseann Steinhardt
Jackie Stull
Paul Sutton
Paul Swanson
Mary Tarantino
Anh Truong
Mike Truong
Kevin Wu
Bob Zebuda

Planning and Decision Aid System

Rik Pierson–Original Team Leader
Deborah Porter–Project Manager

Barry Ault
Pete Donich
Teresa Hayward
Pat Johnson
Lindao Kochanski
Anne Liang
Al Poindexter
Anette Thanner
Lee Zimmerman

NRAD AWARDS

Lauritsen-Bennett Award

Dr. Richard Freund for excellence in science for his contributions in distributed and high-performance computing including directing develpment of the SmartNet network scheduling and planning software

Tom Tiernan for exellence in engineering for his contributions in advanced distributed simulation, making possible the combining of live exercies, virtual simulators, and constructive wargames from many sites for more effective large-scale training at lower cost

Executive Director Award

Larry Core for continuous and outstanding technical contributions in the area of advanced tactical computers, specifically for his major efforts in awarding of the Tactical Advanced Computer (TAC–4) acquistion contract

Secretarial Awards

Sherian Bassett
Lori Cahan
JoAnn Kissinger

Exemplary Achievement Awards

Charles Anfuso
Dr. Sabine Apitz
James Babcock
Patricia Bain
Sue Bakken
Steve Barnett
Luis Biaggi
Sharon Biddinger-Crawford
Ken Boyd
Glenn Brown
Chris Burns
Cecilia Burrus
Mary Butterbrodt
James Clinkenbeard
Candace Conwell
Marc Dilemmo
Ramona Flowers
Patrick Garcia
Joseph Germano
Sissy Gillihan
Linda Grossman
Lewis Gutman
Gab Haduch
William Hays
Allen Heaberlin
Rich Heidecker
Dr. Eric Hendricks
Rodman Hill
Steve Hashowsky
John Iaia
Lynn Johnson
Richard Johnson
Eleanor Kerbs
Yolanda Kerr
JoAnn Kissinger
Michael Klausen
Robert Leone
Scott Little
David Lowenstein
Sandra Manchor
Bill Marn
Stephen Martin
Nanette Mata
Vincent McDonald
Charles McGrath
Lee Moribe
Richard Nguyen
Debbie Nienow-Smith
Bob Ollerton
Bruce Oshiro
Frederick Pappalardi
Bob Parsley
Melody Petersen
Bruce Plutchak
Jose Ramos
Mike Reaves
Joelle Rose
Dan Rountry
Tom Roy
John Saad
Barbara Scuito
Bernard Shostack
John Smaldino
Lupe SmithMarvin Stubblefield
Basit Syed
Minh Ta
Robert Tafel
Mabel Vares
Jeff Waters
Terri Weisbecker
Ronald Whitsel
Mike Wills
Victor Ybarra

Publications Awards

Publications of the Year

Kenneth Anderson
Amalia Barrios
Claude Hattan
Dr. Eric Hendricks
Herbert Hitney
Daniel Ladd
Gary Lindem
John McDonnell
Wayne Patterson
Richard Paulus
Don Waagen
Dr. Carl Zeisse

Distinguished Publication Awards

Robert Abramo
Amalia Barrios
Dr. James Bond
Vincent Broman
Bruce Offord
Dr. Stephen Russell
Dr. Randy Shimabukuro
Dr. David Stein
John Townsend
Dr. James Zeidler

Publication Awards of Excellence

Amalia Barrios
Mark Berry
Dr. Newell Booth
Dr. Adi Bulsara
David Chadwick
Dr. George Chen
Dr. Charles Persons
Stephen Hart
Lance Koyama
Dr. Shing Li
Dr. Thomas Mautner
John McDonnell
Richard Orazi
Stephen Pappert
Dr. Dave Rees
Dr. Sam Ridgway
Sheri Stanley
Don Waagen
Christopher Young

Publication Awards of Merit

Douglas Grimmett
Dr. Cynthia Hanson

Community Award

Laura Smith Award for contributions to the Associated Community Theatres of San Diego

Dr. Michael Shapiro

MILITARY AWARDS

Meritorious Service Medal

LCDR Greg Mangus for technical expertise in supporting development and improvement of the Navy Tactical Command System-Afloat

Navy Commendation Medal

LCDR James Schofield for supporting timely development of highly critical advanced oceanographic systems for the fleet

Lt. Bruce Mathers for service as Global Positioning System test director, fleet liaison officer and user equipment project officer at the GPS Joint Program Office

OS1 (AW) Charles Briggs for service as program tester and leading petty officer, supporting development of the Advanced Combat Direction System

Navy Achievement Medal

ET2 (SW) Brian Welch for support of C^4I system development

OSCM Harry Ozmun for his contributions to the Advanced Combat Direction System program

Naval Command, Control and Ocean Surveillance Center
Shore Sailor of the Year

OS1 (AW) Charles Briggs

NRaD Sailor of the Quarter

OS1 (SW) Jeffrey Shott

Good Conduct Award

OS2 Bryan Lewis

Appendix B
Patent Awards—CY 95

PATENT AWARDS
CY 95

Inventor(s)	Title	Patent No.	Date
Russell, Stephen D. Sexton, Douglas A. Orazi, Richard J.	Method for Laser-Assisted Silicon Etching using Halocarbon Ambients	5,385,633	31 Jan 95
Miller, Stephen A.	Method and Apparatus for Locking Laser Wavelength to an Atomic Transition	5,390,203	14 Feb 95
DiLoreto, Aldo G.	Coherent Integrator	5,390,154	14 Feb 95
Sullivan, Patrick M. Reaves, Pat H.	Diamond Multilayer Multichip Module Substrate	5,391,914	21 Feb 95
Miller, Howard A.	Water Expanded Compressed Sponge Cable Fairing	5,390,619	21 Feb 95
Chadwick, David B.	Feedback-Controlled Oxygen Regulation System for Benthic Flux Chambers and Method for Maintaining a Constant Volume of Oxygen Therefor	5,395,568	7 Mar 95
Aklufi, Monti E.	Method of Forming Thin Films on Substrates at Low Temperatures	5,399,388	21 Mar 95
Sexton, Douglas A. Walker, Howard W.	Ultra-High Vacuum/Chemical Vapor Deposition of Expitaxial Silicon-On-Sapphire	5,402,749	4 Apr 95
Walters, Glenn A.	Small Wideband Passive/Active Antenna	5,406,298	11 Apr 95
Scheps, Richard	Intracavity Sum Frequency Generation Using a Tunable Laser Containing an Active Mirror	5,408,481	18 Apr 95
Scheps, Richard	Compact Rapidly Modulatable Diode-Pumped Visible Laser	5,412,674	2 May 95
Mattox, Douglas M.	Glassy Binder System for Ceramic Substrates, Thick Films and the Like	5,416,049	16 May 95
North, Mark H.	Chlorinated Hydrocarbon Sensor for Cone Penetrometer	5,416,320	16 May 95
Jacobs, Everett W. Boss, Roger D. Fisher, Yuval	Method of Encoding a Digital Image Using Iterated Image Transformations to Form an Eventually Contractive Map	5,416,856	16 May 95
Zirino, Albert R.	Ion-Selective Reference Probe	5,419,826	30 May 95
Holtzschuh, Jack E. Hightower, John D.	Towed Fiber Optic Data Link Payout System	5,419,512	30 May 95
Russell, Stephen D. Dubbelday, Wadad B. Shimabukuro, Randy L. Szaflarski, Diane M.	Method of Controlling Photoemission From Porous Silicon Using Ion Implantation	5,420,049	30 May 95
Ho, Thinh Q. Hart, Stephen M.	Uniplanar Microstrip to Slotline Transition	5,422,609	6 Jun 95

Inventor(s)	Title	Patent No.	Date
Ho, Thinh Q. Hart, Stephen M.	Broadband Coplanar Waveguide to Slotline Transition Having a Slot Cavity	5,426,400	20 Jun 95
Slack, Robert A.	Instantaneous Bit-Error-Rate Meter	5,426,646	20 Jun 95
Johnson Leopold J.	Current Controlled Variable Inductor	5,426,409	20 Jun 95
Imthurn, George P. Walker, Howard	Silicon to Sapphire Bond	5,441,591	15 Aug 95
Kevorkian, Aram K.	Method and Apparatus for Pre-Processing Inputs to Parallel Architecture Computers	5,446,908	29 Aug 95
Dooley, Carol A. Lindner, Elek	Partially Unsaturated Triorganotin Compounds for Use in Biocidal Paint	5,451,618	19 Sep 95
Russell, Stephen D. Sexton, Douglas A.	Photon Controlled Decomposition of Nonhydrolyzable Ambients	5,451,378	19 Sep 95
Walker, Howard W. Garcia, Graham A.	Method for Forming Low and High Minority Carrier Lifetime Layers in a Single Semiconductor Structure	5,468,674	21 Nov 95

Appendix D
Meetings—1995

JANUARY

26 Jan: Ice Exercise (ICEX)-96 Planning Meeting

30 Jan–2 Feb: Office of Naval Research Navy Wideband RF Science and Technology Workshop

FEBRUARY

6–9 Feb: Navy/Army Tactical Missile System (NATCMS) Test Readiness Review

14 Feb: Over-The-Horizon Targeting Configuration Control Board Meeting

MARCH

7–9 Mar: Submarine Command, Control, Communnications,Computers and Intelligence (C^4I) Working Group Meeting

7–9 Mar: American Defense Preparedness Association (ADPA) Undersea Warfare Systems Division 1995 Spring Meeting and Integrated Undersea Surveillance Conference

28–29 Mar: National Security Industrial Association (NSIA) 35th Undersea Warfare Conference

28–30 Mar: Weather Impact Decision Aids Conference

APRIL

4–5 Apr: Aggregate Level Simulation Protocol Interface Working Group Meeting

4–6 Apr: Tri-Service Technology Information Sharing Network Annual Meeting

18–19 Apr: Joint Directors of Laboratories Technical Panel for C^3 Meeting

24–28 Apr: Joint Maritime Command Information System Joint Requirements Working Group Meeting

MAY

1–2 May: Communications Requirements Working Group Meeting

1–4 May: The Technical Cooperation Program (TTCP) Subgroup U Action Group 15 Meeting

3–5 May: NRaD/Armed Forces Communications and Electronics Association (AFCEA) Joint C^4I Symposium

8–12 May: Naval Studies Board Navy/Marine Corps Regional Conflict Study for 1995

23–24 May: Theatre Missile Defense Wargame Working Group Meeting

JUNE

5–8 Jun: Exploitation Technology Symposium

20 Jun: Over-The-Horizon Targeting Configuration Control Board Meeting

20–22 Jun: Joint DAMA Implementation Work Group Meeting

JULY

17–28 Jul: Naval Research Advisory Committee (NRAC) 1995 Summer Study

18–20 Jul: Defense Research Engineering Network (DREN) Technical Advisory Panel Meeting

27–28 Jul: Joint Directors of Laboratories Technical Panel for C3 Meeting

AUGUST

1–2 Aug: Joint Logistics Commanders Joint Commanders' Group for Communications and Electronics Meeting

21–22 Aug: Tactical Advanced Computer Four (TAC-4) Technical Expo

24 Aug: Ice Exercise (ICEX) Meeting

SEPTEMBER

6–8 Sep: Multi User Domain Workshop II

18–29 Sep: Joint Warrior Interoperability Demonstration (JWID) '95

28 Sep: Interstate Technology & Regulatory Cooperation Western Governors' Association (Cone Penetrometer Technology Specific Task Group)

OCTOBER

11–12 Oct: IEEE Standards of Organization Section 32 Meeting

12–13 Oct: Intelligent Transportation Society of America (ITSA) Standards and Protocols Meetings

24–25 Oct: Multifunctional Information Distribution System (MIDS) Steering Gorup Committee Meeting

30 Oct–2 Nov: Tactical Related Applications (TRAP) Tactical Data Information Exchange System B (TADIXS B) Users' Working Group Conference

NOVEMBER

6–8 Nov: Military Communications Conference (MILCOM '95)

15 Nov: Ice Exercise 2-96 Planning Meeting

15–16 Nov: Marine Corps Global Positioning System Military Requirements Operational Effectiveness Group Meeting

28 Nov: Global Positioning System (GPS) Precise Positioning Service (PPS) Users Workshop

28–30 Nov: Tactical Decision Making Under Stress (TADMUS0 Advisory Board Meeting)

28–30 Nov: Office of Naval Research Tactical Picture Agent Advanced Capabilities Initiative Workshop II

DECEMBER

4–5 Dec: Ballistic Mission Defense Organization United States/United Kingdom Meeting

4–7 Dec: Multifunctional Information Distribution System (MIDS) Implementation and Interoperability Working Group

4–8 Dec: Army TENCAP Users Conference

11 Dec: Commercialization of Defense Technology by Small Businesses

18–19 Dec: Science Ice Exercise 95

Appendix E
Program Information

This appendix lists program information (Project Number(s), Role, POC, Principal Site, Supporting Sites, and Leadership Area) when available for the programs/projects listed in the main document. The appendix follows the same organization as the main document. Information is accurate as of 30 September 1995 and was originally submitted for the FY 95 Navy Laboratory/Center Coordinating Group (NLCCG) Management Brief.

Command and Control (C^2)

Major NRaD Command and Control programs include the following:

- Advanced Combat Direction System (ACDS) Block 0
- Advanced Combat Direction System (ACDS) Block 1
- Command and Control Processor (C^2P)
- E-2C Airborne Tactical Data System Software Support
- High-Performance Computing
- Human Computer Interface (HCI)
- Joint Maritime Command Information System (JMCIS)
- Joint Tactical Information Distribution System (JTIDS)
- Multi-functional Information Distribution System (MIDS)
- Range Naval Tactical Data System (NTDS) Upgrade

ADVANCED COMBAT DIRECTION SYSTEM (ACDS) BLOCK 0

Project Number(s): CA21
Role: TDA, SSA
POC: LT Stone
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Command, Control, and Communications (C^3) Systems

ADVANCED COMBAT DIRECTION SYSTEM (ACDS) BLOCK 1

Project Number(s): CC66
Role: TDA
POC: E.M. Reilley
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Command, Control, and Communications (C^3) Systems

COMMAND AND CONTROL PROCESSOR (C^2P)

Project Number(s): CD27
Role: System engineering and integration
POC: R.J. Morin
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Command, Control, and Communications (C^3) Systems

E-2C AIRBORNE TACTICAL DATA SYSTEM SOFTWARE SUPPORT

Project Number(s): CA28, CA32, CA33, CA34, CA36
Role: TDA, SSA
POC: G. Nunez
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Command, Control, and Communications (C^3) Systems

HIGH-PERFORMANCE COMPUTING (HPC)

Project Number(s): EC31, 7D02H
Role: Research & Development, Modeling & Simulation, Software Development
POC: L. A. Parnell
Principal Site: NRaD, San Diego, CA
Supporting Sites: None
Leadership Area: Command, Control, and Communications (C^3) Systems, Surveillance Systems; Marine Sciences

HUMAN COMPUTER INTERFACE (HCI)

Project Number(s): CE85
Role: Concept development, integration, and evaluation
POC: J. Grossman
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Command, Control, and Communications (C^3) Systems

JOINT MARITIME COMMAND INFORMATION SYSTEM (JMCIS)

Project Number(s): CA60
Role: System engineering; integration; SSA
POC: J. Kadane
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Command, Control, and Communications (C^3) Systems

JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM (JTIDS)

Project Number(s): CC54
Role: System engineering; test & evaluation; integration
POC: D. Andersen
Principal Site: NRaD SD
Supporting Sites: NISE/W SD
Leadership Area: Command, Control, and Communications (C^3) Systems

MULTI-FUNCTIONAL INFORMATION DISTRIBUTION SYSTEM (MIDS)

Project Number(s): CG99
Role: Test & evaluation; integration
POC: G. Mangus
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Command, Control, and Communications (C^3) Systems

RANGE NAVAL TACTICAL DATA SYSTEM (NTDS) UPGRADE

Project Number(s): CD12
Role: Technical Development Agent (TDA)
POC: M. Stubblefield
Principal Site: NRaD SD
Supporting Site: None
Leadership Area: Command, Control, and Communications (C^3) Systems

Communications

Major NRaD Communications programs include the following:

ELECTROMAGNETICS

- Application of EM Technology
- Antenna Design/Modeling
- Modeling and Simulation
- Signal Processing
- High Data Rate Communications
- Electromagnetics Technology

INFOSEC

- Information Security Systems/Architecture
- Information Security Support

MOBILE COMMUNICATIONS

- Multiplatform Links
- SATCOMM Systems
- Terrestrial Links
- Advanced Concepts in Communications
- Communication Architectures
- Mobile Communications Technology

NETWORKS

- Advanced Digital Networks
- LANS/WANS
- Switching
- Information Systems
- Interior Communications
- RF Networks
- Network Technology

SUBMARINE COMMUNICATIONS

- SUBCOMM Architecture
- Integration of C4I

- SUBCOMM Management
- Strategic SUBCOMM System Engineering
- Upgrade Existing SUBCOMM Assets
- SUBCOMM Software Management Process
- SUBCOMM Technology

COMMUNICATIONS SUPPORT

- Communications Software Support Activity
- SATCOMM Support
- Communications Software Support Technology
- Communications Support Technology

ELECTROMAGNETICS

Application of EM Technology

Project Number(s): CM02, CM41, CM47, CT39, CT62
Role: Engineering, Modeling, Analysis, Design
POC: L. Russell
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems
Note: No accomplishments documented for FY 95.

Antenna Design/Modeling

Project Number(s): CH75, CH94, CM08
Role: System Engineering, Design, Development, Testing
POC: W. Kordela
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

Modeling and Simulation

Project Number(s): various, not specific project.
Role: Research and Analysis
POC: L. Russell
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

Signal Processing

Project Number(s): CA64, CA71, CA81, CD34, CD36, CG17, CH65, CH69, CH81, CH81, SD07, SXBJ, SXBX, ZF21, ZU05
Role: System Design, Analysis, Research, Computing
POC: G. Adams
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

High Data Rate Communications

Project Number(s): CH73, CH74, CH92, CH99, ZU12, ZU23, ZU24
Role: Design, Development, Research, and Test
POC: T. Sampite
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

Electromagnetics Technology

Project Number(s): CA63, CH41, CS42, EE02, EE30, EE37, EE48, EE51, ET65, SA30, SD05, SD06
Role: Research
POC: J. Rockway
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

INFOSEC

Information Security Systems/Architecture

Project Number(s): CM69
Role: Coordination, Implementation, Support
POC: G. Engh
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

Information Security Support

Project Number(s): Under development
Role: Integration, Evaluation, Support
POC: G. Engh
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems
Note: No accomplishments documented inf FY 95.

MOBILE COMMUNICATIONS

Multiplatform Links

Project Number(s): XA23
Role: System Engineering, Development and Testing
POC: D. Milstead
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

SATCOMM Systems

Project Number(s): CG25, CH77, CH80, CH83, CM80, SY01
Role: System Engineering, Design, Development, and Testing

POC: J. Marr
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

Terrestrial Links

Project Number(s): CM76
Role: System Architecture, Design, Development, Testing
POC: T. Danielson
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

Advanced Concepts in Communications

Project Number(s): CG48, CH76
Role: System Architecture, Counter Systems Engineering, Research
POC: B. Anderson
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

Communication Architectures

Project Number(s): CH78, CS41
Role: System Architecture
POC: J. Wilson
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

Mobile Communications Technology

Project Number(s): ZU19, SW05
Role: Design, Engineering, Testing
POC: D. MilsteadPrincipal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

NETWORKS

Advanced Digital Networks

Program Name: Advanced Digital Networks
Project Number(s): CD48, CH71, CH72, CM66
Role: System Architecture, Development, Engineering and Implementation
POC: R. Kochanski
Principal Site: NRaD
Supporting Sites: Ships, CINCs.
Leadership Area: Command, Control, and Communications (C^3) Systems

LANS/WANS

Project Number(s): CC80, CC86, CD11
Role: System Engineering and Implementation

POC: J. Rhode, Gallenberger
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

Switching

Program Name: Switching
Project Number(s): CF09, CS99 Role: Design, Implementation, and Testing
POC: Al Ong
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

Information Systems

Project Number(s): CD15, CH09, CM67
Role: Architecture, Development and System Engineering
POC: R. Gallenberger
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

Interior Shipboard Communications

Project Number(s): CN19, CS23, EE74
Role: System Engineering, Design, Implementation and Testing
POC: R. Merk, F. Robinson
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

RF Networks

Project Number(s): CG98, CM63, CM86
Role: System Design, Development, and Evaluation
POC: C. Morrin
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

Network Technology

Project Number(s): CC75, ZU11, ZU22
Role: Development, Testing and Evaluation.
POC: R. Kochanski
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

SUBMARINE COMMUNICATIONS

SUBCOMM Architecture

Project Number(s): CH55R, CH96, CM18
Role: System Architecture and Engineering

POC: D. Bauman, J. Greenhill
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

Integration of C4I

Project Number(s): CH55A, CH55G, CM13, CM16R
Role: System Engineering and Implementation
POC: B. Barlin
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

SUBCOMM Management

Project Number(s): CM20, CM97
Role: System Architecture, Design and Implementation
POC: G. Crane
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

Strategic SUBCOMM System Engineering

Project Number(s): CM07, CM11, CM90
Role: System Engineering
POC: R. Williams, J. Greenhill
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

Upgrade Existing SUBCOMM Assets

Project Number(s): CM01, , CM16, CM17, CM19, CM21, CN08
Role: Planning, Engineering, Design and Implementation
POC: G. Crane, J. Greenhill, B. Barlin
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

SUBCOMM Software Management Process

Project Number(s): M16F
Role: Development, Implementation, Training and Management
POC: B. Barlin
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

SUBCOMM Technology

Project Number(s): CM51, CM92
Role: Development, Test and Evaluation

POC: R. Williams, B. Barlin
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

COMMUNICATIONS SUPPORT

Communications Software Support Activity

Project Number(s): CM28, CM42, CM45, CM48, CM50
Role: Software Maintenance
POC: G. Engh
Principal Site: NRaD
Supporting Sites: NISE-W
Leadership Area: Command, Control, and Communications (C^3) Systems

SATCOMM Support

Project Number(s): CH77, CM24, CM25, CM33
Role: System Engineering, Validation, Training
POC: G. Engh
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

Communications Software Support Technology

Project Number(s): None at present. Other projects support.
Role: Software Analysis
POC: G. Engh
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems
Note: No accomplishments documented in FY 95.

Communications Support Technology

Project Number(s): EM08, EM09, EM11, EM26, ET17, TA26, XA35, XA90
Role: Software Development, Training
POC: G. Engh
Principal Site: NRaD
Supporting Sites:
Leadership Area: Command, Control, and Communications (C^3) Systems

Ocean Surveillance

Major NRaD Ocean Surveillance programs include the following:

- Acoustic Sources
- Advanced (COMINT) Voice Processing ATD
- Advanced Deployable System (ADS)

- Advanced Sensor Application Program (ASAP)
- Autonomous Sensor Concepts Project
- Bottom Limited Active Classification (BLAC)
- CERCIS
- Common Aperture Multi-Band Radar (CAMBR)
- Common Integrated Platform
- dbMASTER
- Deployable Autonomous Distributed Systems (DADS)
- Distributed Surveillance Technology
- Electromagnetic Field
- Fixed Distributed System (FDS)
- Flying Plug
- Hayfield Multi-Chip Module
- High-Frequency Surface Wave Radar (HFSWR) ATD
- Intelligence, Surveillance, and Reconnaissance (ISR)
- IUSS Surveillance Direction System (SDS) Shore Systems Engineering
- LEO SPO Support
- Man Transportable Socrates (MTS)
- Mine-Laying Surveillance
- Mobile Undersea Warfare System, System Upgrade (MIUW-SU)
- Multimission Advanced Tactical Terminal (MATT)
- Multistatic Active Project
- Non-Acoustic Distributed Systems Components (NDSC)
- Project Spinnaker: Iceshelf-95
- Radiant Jade Demonstrations
- Rapid Imagery Transmission (RIT)
- Relocatable Over-the-Horizon Radar (ROTHR)
- Shallow Water Environmental Cell Experiment-4 (SWELLEX-4)
- Shallow-Water Sensor System (SWSS)
- Shipboard Infrared Search and Track
- SITE 7800
- Spatial Processing for Deployables
- Robust Environmentally-Based Adaptive Broadband Beamforming
- Automated Track-Before-Detect Processing
- Standard TRE Display 95 (STRED 95)

- SURTASS and Low Frequency Active (LFA)
- Surveillance All-Optical Towed Array (SAOTA) Program
- Tactical Aircraft Mission Planning System (TAMPS)
- Tactical Cryptologic Systems/IW Exploit
- Theater Acoustic Warfare (ThAW)/Data Fusion
- Tomahawk In-flight Position Reporting System (TIPRS)
- TRAP Data Dissemination System (TDDS)
- USS Dolphin
- Vertical Launch ASROC (VLA) Missile Program
- Virtual Lab
- Independent Research: An Integrated Hybrid Neural Network and Hidden Markov Model Algorithm for Classification Applications

ACOUSTIC SOURCES

Project Number: SUB4/SU17
Role: Development of Acoustic Source Technology
POC: Ed Rynne
Principal Site: NRaD SD
Supporting Sites: NUWC
Leadership Area: Ocean Surveillance Systems

ADVANCED (COMINT) VOICE PROCESSING ATD

Project Number(s):
Role: Systems Engineering, Testing, Program Management
POC: Mark Reinig
Principal Site: NRaD
Supporting Sites: Contractor-Lockheed/Martin-Sanders
Leadership Area: Ocean Surveillance Systems

ADVANCED DEPLOYABLE SYSTEM (ADS)

Project Number: SV98
Role: System Engineering, Integration, Test and Evaluation
POC: Steve Whiteside
Principal Site: NRaD SD
Supporting Sites: NFESC; NCEL; NRL; NSWC; NAWC; ARL/UT
Leadership Area: Ocean Surveillance Systems

ADVANCED SENSOR APPLICATION PROGRAM (ASAP)

Project Number(s): SX08
Role: NAASW
POC: David K. Forbes
Principal Site: NRaD, San Diego CA
Supporting Sites: None
Leadership Area: Ocean Surveillance Systems

AUTONOMOUS SENSOR CONCEPTS PROJECT

Project Number: SUC1
Role: System Concept Development, Design, Prototype Development, Test and Evaluation
POC: Gary L. Davis
Principal Site: NRaD San Diego
Supporting Sites: ARL/UT
Leadership Area: Undersea Surveillance

BOTTOM LIMITED ACTIVE CLASSIFICATION (BLAC)

Project Number(s): SUBP
Role: Exploratory Development
POC: J. C. Lockwood
Principal Site: NRaD
Supporting Sites: None
Leadership Area: Ocean Surveillance Systems

CERCIS

Project Number(s): SX15
Role: System engineering & integration
POC: Bill Carper
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Ocean Surveillance Systems

COMMON APERTURE MULTI-BAND RADAR (CAMBR)

Project Number(s): SXBD
Role: Technical Development Agency
POC: Dr. Thomas Tice
Principal Site: NRaD, San Diego CA
Supporting Sites: None
Leadership Area: Ocean Surveillance Systems

COMMON INTEGRATED PLATFORM

Project Number(s):
Role: Developer
POC: Tom Knight
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Integration of Space Communication and Surveillance Systems

DBMASTER

Project Number(s): SY86
Role: Development; Integration; Maintenance
POC: David Lowenstein
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Integration of Space Communication and Surveillance Systems

DEPLOYABLE AUTONOMOUS DISTRIBUTED SYSTEMS (DADS)

Project Number(s): SX27
Role: Research and development
POC: J. W. Aitkenhead
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Ocean Surveillance Systems
Note: No accomplishments documented in FY 95.

DISTRIBUTED SURVEILLANCE TECHNOLOGY

Project Number: SUBD
Role: Deployable system hardware component and system exploratory development, test, and evaluation
POC: Ken Rogers
Principal Site: NRaD SD
Supporting Sites: NSWC, NASA Dryden Flight Research Center
Leadership Area: Ocean Surveillance Systems

ELECTROMAGNETIC FIELD

Project Number(s):
Role:
POC:
Principal Site:
Supporting Sites:
Leadership Area: Ocean Surveillance Systems

FIXED DISTRIBUTED SYSTEM (FDS)

Project Number(s): SV14
Role: Test Agent, T&E
POC: L. O. Harris
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Ocean Surveillance Systems

FLYING PLUG

Project Number(s):
Role:
POC:
Principal Site:
Supporting Sites:
Leadership Area: Ocean Surveillance Systems

HAYFIELD MULTI-CHIP MODULE

Project Number(s): SA24
Role: Cryptographic Design
POC: Dennis Hurst
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Integration of Space Communication & Surveillance Systems

HIGH-FREQUENCY SURFACE WAVE RADAR (HFSWR) ATD

Project Number(s): SY85
Role: Technical Development Agency
POC: Dr. Robert Dinger
Principal Site: NRaD, San Diego CA
Supporting Sites: None
Leadership Area: Ocean Surveillance Systems

INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR)

Project Number(s): SUC3
Role: System Engineering
POC: J. A. Aitkenhead
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Ocean Surveillance Systems
Note: No accomplishments document in FY 95.

IUSS SURVEILLANCE DIRECTION SYSTEM (SDS) SHORE SYSTEMS ENGINEERING

Project Number(s): SV87
Role: System engineering
POC: B. J. Lee
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Ocean Surveillance Systems

LEO SPO SUPPORT

Project Number(s): SA36
Role: System Engineering, Development and Installation
POC: Dudley Reese
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Integration of Space Communication and Surveillance Systems

MMATS

Project Number(s): SV54
Role: Marine animal injury mitigation and prevention
POC: L. E. Griffith
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Ocean Surveillance Systems

MAN TRANSPORTABLE SOCRATES (MTS)

Project Number(s): SY84
Role: System Engineering, Integration and Fabrication
POC: Rus Maddox
Principal Site: NRaD SD
Supporting Sites: None

Leadership Area: Integration of Space Communication & Surveillance Systems

MINE-LAYING SURVEILLANCE

Project Number(s):
Role:
POC:
Principal Site:
Supporting Sites:
Leadership Area: Ocean Surveillance Systems

MULTI-MISSION ADVANCED TACTICAL TERMINAL (MATT)

Project Number(s): SY84
Role: System Engineering
POC: Frank Tirpak
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Integration of Space Communication and Surveillance Systems

MOBILE UNDERSEA WARFARE SYSTEM, SYSTEM UPGRADE (MIUW-SU)

Project Number(s): S0214
Role: Technical Development Agent, Systems Integrator, Software Support Activity
POC: Celia Metz
Principal Site: NRaD SD
Supporting Sites: NISE-WEST, NISE-EAST
Leadership Area: Ocean Surveillance Systems

MULTISTATIC ACTIVE PROJECT

Project Number: SUB2, SUBV
Role: Technology base for activation of bistatic sonars in shallow water
POC: Angela D'Amico
Principal Site: NRaD SD
Supporting Sites: Alliant TechSystems
Leadership Area: Ocean Surveillance Systems

NON-ACOUSTIC DISTRIBUTED SYSTEMS COMPONENTS (NDSC)

Project Number: SUBT
Role: Shallow Water Surveillance to Support ASW
POC: Thomas N. Roy
Principal Site: NRaD SD
Supporting Sites: NSWC, NRL/SSC, APL/UW, SIO
Leadership Area: Non-Acoustic Undersea Ocean Surveillance

PROJECT SPINNAKER: ICESHELF-95

Project Number(s): MA10
Role: Lightweight low-power low-cost ocean surveillance technology development.
POC: Dr. Barbara Sotirin
Principal Site: NRaD
Supporting Sites: NRaD ; Esquimalt Detachment, DREA, Canada
Leadership Area: Ocean Surveillance Systems

RADIANT JADE DEMONSTRATIONS

Project Number(s): SA24
Role: System Engineering, Development and Installation
POC: Chuck Lomicka
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Integration of Space Communication and Surveillance Systems

RAPID IMAGERY TRANSMISSION (RIT)

Project Number(s): SA24/SY84
Role: System Engineering
POC: David Lowenstein
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Integration of Space Communication and Surveillance Systems

RELOCATABLE OVER-THE-HORIZON RADAR (ROTHR)

Project Number(s): SX44
Role: System engineering & test
POC: T. J. Utschig
Principal Site: NRaD SD
Supporting Sites: NISE/E NF; NRL
Leadership Area: Ocean Surveillance Systems

SHALLOW WATER ENVIRONMENTAL CELL EXPERIMENT-4 (SWELLEX-4)

Project Number(s):
Role:
POC:
Principal Site:
Supporting Sites:
Leadership Area: Ocean Surveillance Systems

SHALLOW-WATER SENSOR SYSTEM (SWSS)

Project Number(s):
Role:
POC:
Principal Site:

Supporting Sites:
Leadership Area: Ocean Surveillance Systems

SHIPBOARD INFRARED SEARCH AND TRACK

Project Number(s): SXB5
Role: Algorithm development and processor integration
POC: Michael Klausen
Principal Site: NRaD SD
Supporting Sites: Hughes Aircraft, El Segundo, CA; Westinghouse, Baltimore, MD;Arete, Los Angeles, CA
Leadership Area: Ocean Surveillance

SITE 7800

Project Number(s): SV52
Role: Overall Site Integration
POC: G. L. Wilham
Principal Site: NRaD SD
Supporting Sites: None

SPATIAL PROCESSING FOR DEPLOYABLES/ROBUST ENVIRONMENTALLY-BASED ADAPTIVE BROADBAND BEAMFORMING/AUTOMATED TRACK-BEFORE-DETECT PROCESSING

Project Number: FY95 SUBU; FY96 SUBY, SUBZ
Role: Technology development and evaluation
POC: Dale Barbour
Principal Site: NRaD SD
Supporting Sites: Duke University, NRL, MPL
Leadership Area: Ocean Surveillance Systems

STANDARD TRE DISPLAY 95 (STRED 95)

Project Number(s): SA24
Role: Developer
POC: Tom Knight
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Integration of Space Communication and Surveillance Systems

SURTASS AND LOW FREQUENCY ACTIVE (LFA)

Project Number: SV70
Role: System Engineering/T&E
POC: P. Donahoe
Principal Site: NRaD, SD
Supporting Sites: NFESC
Leadership Area: Ocean Surveillance Systems

SURVEILLANCE ALL-OPTICAL TOWED ARRAY (SAOTA) PROGRAM

Project Number: SU74
Role: System Design, Development, Test and Evaluation
POC: Gary L. Davis
Principal Site: NRaD SD
Supporting Site: NRL, APL/JH
Leadership Area: Undersea Surveillance

TACTICAL AIRCRAFT MISSION PLANNING SYSTEM (TAMPS)

Project Number(s): SV46
Role: System Engineering
POC: H. S. Lachtman
Principal Site: NAWCWPNS, Pt. Mugu
Supporting Sites: NRaD, NRL
Leadership Area: Ocean Surveillance Systems

TACTICAL CRYPTOLOGIC SYSTEMS/IW EXPLOIT

Project Number(s): SS16
Role: Software engineering, systems engineering, test & evaluation
POC: Lenny Coppenrath
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Ocean Surveillance Systems

THEATER ACOUSTIC WARFARE (THAW)/DATA FUSION

Project Number(s): SUBW
Role: Research and development
POC: J. W. Aitkenhead
Principal Site: NRaD SD
Supporting Sites: NSWC-CSS
Leadership Area: Ocean Surveillance Systems

TOMAHAWK IN-FLIGHT POSITION REPORTING SYSTEM (TIPRS)

Project Number(s): SX89
Role: Technical Development Agency for Tomahawk Receive Unit
POC: John Nugent
Principal Site: NRaD, San Diego CA
Supporting Sites: NAWC, Indianoplis
Leadership Area: Ocean Surveillance Systems

TRAP DATA DISSEMINATION SYSTEM (TDDS)

Project Number(s): SA26
Role: System Engineering, Development and Installation
POC: Shari Milstead
Principal Site: NRaD SD

Supporting Sites: None
Leadership Area: Integration of Space Communication and Surveillance Systems

USS DOLPHIN

Project Number: MS06
Role:
POC:
Principal Site:
Supporting Sites:
Leadership Area: Ocean Surveillance Systems

VERTICAL LAUNCH ASROC (VLA) MISSILE PROGRAM

Project Number: WM16
Role: Technical Direction Agent, System Integration Agent, Acquisition Agent, Test and Evaluation
POC: Paul W. Leupold
Principal Site: NRaD SD
Supporting Sites: NAWC, NWAD
Leadership Area: Ocean Surveillance Systems

VIRTUAL LAB

Project Number(s): SX14
Role: System Engineering
POC: Tom Knight
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Integration of Space Communication and Surveillance Systems

INDEPENDENT RESEARCH: AN INTEGRATED HYBRID NEURAL NETWORK AND HIDDEN MARKOV MODEL ALGORITHM FOR CLASSIFICATION APPLICATIONS

Project Number(s): ZU04
Role: Independent Research
POC: J. W. Aitkenhead
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Ocean Surveillance Systems

Command, Control, and Communication Modeling and Analysis

Major NRaD command, control, and communication modeling and analysis programs include the following:

- C^3 Simulation and Technology
- MAGTF Tactical Warfare Simulation (MTWS) System)
- Research, Evaluation, and Systems Analysis (RESA)

C^3 SIMULATION AND TECHNOLOGY

Project Number(s): CC28
Role: System engineering
POC: T. Tiernan
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Command, Control, and Communication Modeling and Analysis

MAGTF TACTICAL WARFARE SIMULATION (MTWS) SYSTEM

Project Number(s): CC43
Role: System engineering
POC: J. Chang
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Command, Control, and Communication Modeling and Analysis

RESEARCH, EVALUATION, AND SYSTEMS ANALYSIS (RESA)

Project Number(s): CC90
Role: Development, evaluation, and analysis
POC: C. M. Burns
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Command, Control, and Communication Modeling and Analysis

Ocean Engineering

Major NRaD ocean engineering programs include the following:

- Air-Mobile Ground Security and Surveillance System
- MAGELLAN and Other Systems
- Mine Neutralization System (MNS)
- Mobile Detection, Assessment and Response System - (MDARS)
- Telerobotics
- Unmanned Undersea Systems

AIR-MOBILE GROUND SECURITY AND SURVEILLANCE SYSTEM

Project Number(s): CH87
Role: System Engineering
POC: John Bott
Principal Site: NRaD SD
Supporting Sites:
Leadership Area: Ocean Engineering

MAGELLAN AND OTHER SYSTEMS

Project Number(s):
Role: System engineering

POC:
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Ocean Engineering
Note: No accomplishments document in FY 95.

MINE NEUTRALIZATION SYSTEM (MNS)

Project Number(s):
Role:
POC:
Principal Site:
Supporting Sites:
Leadership Area: Ocean Engineering

MOBILE DETECTION, ASSESSMENT AND RESPONSE SYSTEM - (MDARS)

Project Number(S): CH01
Role: Systems Engineering, Technical Direction Agent
POC: Bart Everett
Principal Site: NRaD SD
Supporting Sites:
Leadership Area: Ocean Engineering

TELEROBOTICS

Project Number(s):
Role: System engineering
POC: Douglas Murphy
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Ocean Engineering
Note: No accomplishmens documented in FY 95.

UNMANNED UNDERSEA SYSTEMS

Project Number(s):
Role: Systems engineering
POC:
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Ocean Engineering

Navigation

Major NRaD navigation programs include the following:

- Air Navigation
- Global Positioning System (GPS)
- Navigation Sensor System Interface (NAVSSI)
- Navigation Technology Programs

- Ocean Survey Program (OSP)
- Ring Laser Gyro Navigation (RLGN)

AIR NAVIGATION

Project Number(s): ND03, NG01
Role: System engineering
POC: D. Krasnjanski
Principal Site: NRaD WR
Supporting Sites: None
Leadership Area: Navigation Support

GLOBAL POSITIONING SYSTEM (GPS)

Project Number(s): NG01, NG02, NG03
Role: System engineering; CEA
POC: John Phanos
Principal Site: NRaD WR
Supporting Sites: NISE-W
Leadership Area: Navigation Support

NAVIGATION SENSOR SYSTEM INTERFACE (NAVSSI)

Project Number(s): NCO6
Role: System engineering; DA; TDA
POC: Herbert Seligman
Principal Site: NRaD WR
Supporting Sites: None
Leadership Area: Navigation Support

NAVIGATION TECHNOLOGY PROGRAMS

Project Number: ND02, ND04, ND05, 2W81, 2W90
Role: Principal Investigator
POC: Neal Barnett
Principal Site: NRaD - WR
Supporting Sites: None
Leadership Area: Navigation Support

OCEAN SURVEY PROGRAM (OSP)

Project Number(s): NR01
Role: System engineering
POC: John Handal
Principal Site: NRaD WR
Supporting Sites: None
Leadership Area: Navigation Support

RING LASER GYRO NAVIGATION (RLGN)

Project Number(s): NB13, NB16
Role: System engineering; TDA
POC: Joseph Gentile
Principal Site: NRaD WR
Supporting Sites: Sperry Marine Systems, Charlottesville, VA
Leadership Area: Navigation Support

Marine Mammals

MARINE MAMMAL SYSTEMS (MMS)

Project Number(s): MU14, MM40, MS12, MMA1, MM47, MM77, MM78
Role: Project management, R&D, MMS, Production, Fleet Support, Veterinary Medicine
POC: Les Bivens, Biosciences Division
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Marine Mammals

Integration of Space Communication and Surveillance Systems

Major NRaD integration of space communication and surveillance systems programs include the following:

- AN/USQ-101(V) TADIXS B/TRE
- Tactical Related Applications Broadcast System (TRAP)

AN/USQ-101(V) TADIXS B/TRE

Project Number(s):
Role: System engineering; fabrication
POC:
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Integration of Space Communication and Surveillance Systems

TACTICAL RELATED APPLICATIONS BROADCAST SYSTEM (TRAP)

Project Number(s):
Role: System engineering & installation
POC:
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Integration of Space Communication and Surveillance Systems
Note: No accomplishments documented in FY 95.

Electronic Sciences and Technology

Major NRaD electronics sciences and technology programs include the following:

- Analog Photonic Link Dynamic Range
- Infrared Focal Plane Array (IRFPA)
- Low Power Electronics
- Memory Chip
- PINC Wavelength Division Multiplexing (WDM)
- Reduced-Power Digital Filter (REDFIL)
- Silicon-on-Sapphire (SOS)
- Stochastic Resonance
- Tri-Service Support
- Trident Missile

ANALOG PHOTONIC LINK DYNAMIC RANGE

Project Number(s): CH75
Role: R&D
POC: Dr. S.A. Pappert
Principal Site: NRaD
Supporting Sites: UCSC, Rit, Fermionics
Leadership Area: RF Photonics

INFRARED FOCAL PLANE ARRAY (IRFPA)

Project Number(s): XA02
Role: RDT&E
POC: Keith Bentley
Principal Site: NRaD
Supporting Sites: S-Cubed
Leadership Area: Intrared Test and Evaluation

LOW POWER ELECTRONICS

Project Number(s): SD08
Role: R&D, Contract Monitor
POC: Graham Garcia
Principal Site: IBM, East Fishkill
Supporting Sites: NRaD, NIST, Lincoln Labs
Leadership Area: Silicon-on insulator.

MEMORY CHIP

Project Number(s): WM23
Role: R&D
POC: Bruce Offord
Principal Site: NRaD
Supporting Sites: Ratheon Corp., Charles Stark Draper Labs
Leadership Area: Microelectronics, non-volatile memory

PINC WAVELENGTH DIVISION MULTIPLEXING (WDM)

Project Number(s): ZU27
Role: Principal Investigator
POC: Richard Orazi
Principal Site: NRaD
Supporting Sites: NA
Leadership Area: Fiber Optics

REDUCED-POWER DIGITAL FILTER (REDFIL)

Project Number(s):
Role:
POC:
Principal Site:
Supporting Sites:
Leadership Area:
Note: No accomplishments document in FY 95.

SILICON-ON-SAPPHIRE (SOS)

Project Number(s): EEB3
Role: R&D
POC: Paul de la Houssaye/Steve Russell
Principal Site: NRaD
Supporting Sites: Proxima Corporation
Leadership Area: Microelectronics/Flat Panel Displays

STOCHASTIC RESONANCE

Project Number(s): MA19, ZU03
Role: Research and Development
POC: A.R. Bulsara
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Electronic Sciences and Technology

TRI-SERVICE SUPPORT

Project Number(s): EE78, EE47
Role: Technical Direction Agent, COR, R&D, Design
POC: Harvey Hanson, Marion McCord
Principal Site: NRaD
Supporting Sites: NA
Leadership Area: Microelectronics, Naval Aviation Depot, NI

TRIDENT MISSILE

Project Number(s): WM06
Role: Design Agent
POC: Gene Haviland
Principal Site: NRaD
Supporting Sites: SWFLANT
Leadership Area: Guidance Command Control

Environmental Assessment

Major NRaD enviornmental assessment programs include the following::

- MESO
- SCAPS

MARINE ENVIRONMENTAL SUPPORT OFFICE (MESO)

Project Number(s): ME83
Role: Research, Analysis, and Information Transfer
POC: S.J. Harrell
Principal Site: NRaD SD
Supporting Sites: Marine Environmental Support Office East, Rhode Island
Leadership Area: Environmental Assessment

SITE CHARACTERIZATION AND ANALYSIS PENETROMETER SYSTEM (SCAPS)

Project Number(s): ME 85
Role: Research, Development, and Validation
POC: T.W. Hampton
Principal Site: NRaD SD
Supporting Sites: None
Leadership Area: Environmental Assessment

Marine Sciences and Technology

WATERSIDE SECURITY SYSTEM (WSS).

Project Number(s): S0812-04 & S1769-04
Role: Program Manager (as defined in DoDINST 5000.2/SECNAVINST 5000.2A), Technical Direction Agent, Software Support Activity & In-Service Engineering Agent.
POC: Ed Baxter
Principal Site: NRaD SD
Supporting Sites: NAVSUBASE Bangor, WA
Leadership Area: Marine Sciences and Technology

Independent Research (IR)

INDEPENDENT RESEARCH

Project Number(s): ZW* and ZU*
Role: NRaD Discretionary Research Program
POC: Dr. Alan Gordon
Principal Site: NRaD, SD
Supporting Sites: NRaD, Warminster
Leadership Area: All NRaD Mission and Leadership Areas

Appendix F
FY 95 NRaD Facilities

This appendix lists and describes FY 95 NRaD facilities. Organization is by major area of effort. Information is accurate as of 30 September 1995 and was originally submitted for the FY 95 Navy Laboratory/Center Coordinating Group (NLCCG) Management Brief.

Command and Control (C^2)

Facilities:

Combat Direction System (CDS) Development and Evaluation Site (CDES),

Display technology laboratory

Distributed command and control (C^2) laboratory

E-2C airborne tactical data system integration laboratory

High-performance computing laboratory

Intelligence system advanced development laboratory

Navy Command and Control System-Ashore (NCCS-A) integration and test facility

Navy Tactical Command System-Afloat (NTCS-A)

Ocean Surveillance Information System (OSIS) Evolutionary Development (OED) laboratory

OTH-T Reconfigurable Land-Based Test Site (RLBTS),

Range Naval Tactical Data System integration laboratory

Systems Integration Facility (SIF)

Combat Direction System (CDS) Development and Evaluation Site (CDES), a secure facility for development of the Advanced Combat Direction System (ACDS) Block 0, ACDS Block 1, and Command and Control Processor (C^2P).

Display technology laboratory that supports development and application of new technologies to C^2 systems.

Distributed command and control (C^2) laboratory that provides hardware, software, and communications connectivity to support the development and application of distributed processing technology to C^2 systems.

E-2C airborne tactical data system integration laboratory for software support of the three fleet baselines and foreign military sales (FMS).

High-performance computing laboratory that provides a wide range of advanced computer systems for the scientific investigation of next-generation architectures.

Intelligence system advanced development laboratory with RFI-shielded, vault-level security and capability to receive and process data from various sources through on-line communications.

Navy Command and Control System-Ashore (NCCS-A) integration and test facility that provides hardware, software, and communications for full operational testing of command systems.

Navy Tactical Command System-Afloat (NTCS-A) test bed and integration facility that provides a mockup of a CV installation to support development, integration, and interoperability testing.

Ocean Surveillance Information System (OSIS) Evolutionary Development (OED) laboratory that provides hardware, software, and communications connectivity for development of replacement systems and full integration testing.

OTH-T Reconfigurable Land-Based Test Site (RLBTS), a secure interoperability test laboratory to support Navy and joint Over-the-Horizon Targeting (OTH-T) interoperability testing.

Range Naval Tactical Data System integration laboratory, including UYK-43 computer with UYQ-32 console emulators and peripherals.

Systems Integration Facility (SIF) for testing and integrating Navy Joint Tactical Information Distribution System (JTIDS) terminals with aircraft data systems and shipboard combat direction systems, and for testing the interoperability of Link-16 systems.

Communications

Facilities:

Commercial SATCOM facility

EHF SATCOM terminal test facility

Environmental test facility

High-Data-Rate Mobile Internet (MONET)

Information transfer management structure (ITMS)

Manufacturing facility for prototype development

Navy UHF Satellite Communications Test Facility (NUSTF)

Secure facilities, vaults, and underground bunkers

SHF SATCOM test facility

Ship antenna model range

Ship antenna simulation facility

Ship Motion Simulator Facility

Southern California communications networking test range

Structural Materials Sciences Laboratory

Submarine Communications Integrated Test Facility

Survivable Adaptable Fiber-Optic Embedded Network (SAFENET) development site

Commercial SATCOM facility to buy, integrate, and test commercial and nondevelopment items.

EHF SATCOM terminal test facility that provides a basis for ship, submarine, and shore site terminal development and follow-on support in MILSTAR EHF systems.

Environmental test facility for performing mechanical shock, vibration, climatic condition, and EMI/RFI tests.

High-Data-Rate Mobile Internet (MONET), a test bed for high-data-rate tactical communication technologies. MONET will incorporate new applications using commercial standards such as Asynchronous Transfer Mode (ATM) and the Synchronous Optical Network (SONET) high-data-rate military radios, and DoD and commercial satellite communication (SATCOM) links.

Information transfer management structure (ITMS) that provides integrated management of the automated, distributed, fiber-optics-connected information transfer system and management of the connectivity between all major C^4I and ocean surveillance facilities at NRaD.

Manufacturing facility for prototype development that is connected to the local area network for remote transmission of digital manufacturing data.

Navy UHF Satellite Communications Test Facility (NUSTF) that provides information exchange subsystem development and testing, direct support to fleet exercises, determination of new requirements, and development of system improvements.

Secure facilities, vaults, and underground bunkers for development, testing, and operation of communication systems that use highly classified data.

SHF SATCOM test facility that contains a complete SHF SATCOM terminal and test equipment to support follow-on SHF equipment development.

Ship antenna model range for simulation and modeling of ship communications, consisting of ground planes, model ships, track, towers, control systems, test equipment, data collection systems, data-reduction computers, and analysis software and components.

Ship antenna simulation facility that operates with the ship antenna model range to provide software modeling and simulation of systems, confirmation of models, and extensions beyond the test capability of the model range.

Ship Motion Simulator Facility for testing motion-compensated antennas, optics, etc., in various simulated sea-states.

Southern California communications networking test range that maintains and controls sites at Pt. Mugu, San Nicolas Island, San Clemente Island, Seal Beach, and NRaD, San Diego, for use in multiforce communications testing and support of west coast fleet exercises.

Submarine Communications Integrated Test Facility that includes a full-capability VLF/LF RDT&E laboratory, simulated terminals, a submarine radio room, RF equipment, control devices, software evaluation, test equipment, and analysis tools.

Structural Materials Sciences Laboratory for investigation and analysis of metals, composite, corrosion, and failure effects.

Survivable Adaptable Fiber-Optic Embedded Network (SAFENET) development site, used to develop hardware, software, and firmware for ship interior communication.

Communications Support System (CSS) simulation facility that provides an environment for evaluating software components being developed for communication control systems; analysis includes fleet protocol definition, operator interfaces, and system engineering.

Ocean Surveillance

Facilities:

Cryptologic Systems Land-Based Test Facility (LBTF)

HF propagation software integration and application laboratory

High Performance Computing Systems Support Facility

Joint Space and Tactical Systems Division RF Lab

Microwave and Millimeter-Wave Antenna Range

Processing and Data Exploitation Center (PDEC):

Signals Warfare Integrated Facilities Testbed (SWIFT)

Surveillance Radar Development Facility

Surveillance Test and Integration Center (STIC)

Real-Time Embedded High Performance Computing Facility (RTEHPCF)

Tactical Engineering Analysis Lab (TEAL):

Tactical Surveillance Laboratory (TSL)

Cryptologic Systems Land-Based Test Facility (LBTF) supports the prototyping, integration, validation and testing of tactical cryptologic and information warfare exploitation systems.

HF propagation software integration and application laboratory that provides an RDT&E facility for multiuser hardware/software development.

High Performance Computing Systems Support Facility, established with the support of the DoD High Performance Computing Modernization Office, provides a secure environment with encrypted external network access for state-of-the-art applications of parallel computing and visualization to naval and DoD problems and systems.

Joint Space and Tactical Systems Division RF Lab: A test facility with state-of-the-art RF test equipment, a 100-dB shielded enclosure, UHF and SHF satellite terminal facilities.

Microwave and millimeter-wave antenna range complex supports development of surveillance antennas for numerous operational applications.

Processing and Data Exploitation Center (PDEC): An in-house laboratory facility to conduct data fusion and information processing research for the exploitation of national systems products for National, Unified and Specified Command, and Joint service and tactical applications.

Signals Warfare Integrated Facilities Testbed (SWIFT) is a secure EMI/EFI facility that supports the full spectrum of analysis, system development, test and evaluation, simulation and integration in a multisystem environment supporting signals intelligence (SIGINT), countercommunications, signal security (SIGSEC), Information Warfare, and related cryptologic systems.

Surveillance radar development facility provides a test bed for development of radar waveforms, techniques, and equipment to support inverse synthetic aperture radar (ISAR), radar cross section (RCS) measurements, and higher resolution radar developments.

Surveillance Test and Integration Center (STIC) is an RFI-shielded vault that can receive and process data from various sources through on-line communications. STIC supports the Integrated Undersea Surveillance System (IUSS) (including Surveillance Towed Array Sensor System (SURTASS) and Sound Surveillance System (SOSUS)), Relocatable Over-the-Horizon Radar (ROTHR), Fixed Distributed System (FDS), Surveillance Direction System (SDS), and other tactical or communication efforts which support joint warfare efforts and the C4I warrior. STIC provides a test bed for the support of software development, integration, developmental verification and validation testing, life-cycle support, data acquisition, and real-time signal processing and display.

Real-Time Embedded High Performance Computing Facility (RTEHPCF), established with the support of the DoD High Performance Computing Modernization Office, provides highly parallel compute resources in a secure environment with encrypted external network access for state-of-the-art applications of parallel computing and visualization to naval and DoD problems and systems.

Tactical Engineering Analysis Lab (TEAL): An in-house laboratory facility which provides computers and communications for the analysis and development of classified tasks.

Tactical Surveillance Laboratory (TSL): A centralized facility for multiservice and national organizations to display and analyze tactical data systems.

Electronic Sciences and Technology

Facilities:

Electronic Materials Sciences Laboratory

Integrated circuit (IC) design, fabrication, and packaging laboratory

Materials research laboratory

Specialized systems including parallel and vector supercomputers and visualization workstations

Electronic Materials Sciences Laboratory with facilities for research on fiber-optics technology and semiconductor materials of technological interest.

Integrated circuit (IC) design, fabrication, and packaging laboratory with facilities for materials research and silicon IC technology development.

Materials research laboratory for experimental investigations of high-technology materials such as high-temperature superconductors and conducting polymers.

Microelectronics Laboratory for manufacture of microelectronic components no longer commercially available but needed to support fleet systems.

Specialized systems support for high-interest problem areas and scientific, general-purpose, and business applications on a diverse suite of computer systems, including parallel and vector supercomputers and visualization workstations.

Marine Sciences

Facilities:

Bioscience facility

Ocean Sciences Laboratory

Bioscience facility for acoustical physiological research, training, and handling of marine animals to perform naval tasks in the open ocean.

Ocean Sciences Laboratory with special facilities for work in marine biology and toxicology, environmental chemistry research, analytical instrumentation development, marine environmental quality assessment and monitoring, environmental biotechnology, radiation sensor development, lasers, and microelectronics.

Design Engineering, Testing, and Prototype Development

Facilities:

Transducer Evaluation Center (TRANSDEC)

USS *Dolphin* (AGSS 555)

Transducer Evaluation Center (TRANSDEC), a sonar transducer calibration pool that is anechoic at all frequencies.

USS *Dolphin* (AGSS 555), a unit of Submarine Development Group One, used for research and development of advanced sonar equipment and systems.

Corporate communications systems support for internal communications, networking, and electronic mail exchange on broadband, Ethernet, and high-speed, fiber-optic, local-area networks, interconnecting corporate information systems and NRaD's minicomputers, workstations, and personal computers throughout the San Diego complex and at NCCOSC field activities, and for connectivity with the external MILNET and commercial networks.

San Clemente Island

San Clemente Island is operated by the Naval Air Station North Island. NRaD and its predecessors have had a significant presence at the island for several decades. NRaD assets at San Clemente Island include the following:

The Sonobuoy Quality Assurance Program test center which houses all of the communications and electronics for collection and analysis of test sonobuoy data. This facility is located on a bluff overlooking the test area. The test area has a near ideal ocean environment for deep-water sonobuoy testing and line-of-sight to the test center.

The NOTS pier on the protected east side of the island which provides a calm water staging area for vessels to onload or offload equipment or personnel. There is also a pier-mounted hoist for launching a variety of small boats. Located at the foot of the pier is the NRaD dive locker which has a fully operational recompression chamber.

A missile impact area for both inert and live missile impact testing and a capability to deploy a variety of realistic targets in the impact area. This is supported with necessary field equipment for photo and video documentation as well as missile tracking and post impact analysis. A test control center for coordination of the test events is located approximately 5 miles away and has an unobstructed view of the impact area.

Additional San Clemente Island assets include necessary berthing and messing for project personnel, a weekly barge for transportation of equipment and supplies, and daily air service from Naval Air Station North Island.

NRaD Dive Locker

NRaD maintains a full military and civilian Navy dive locker which enables scientists and engineers to participate first hand in the undersea test and evaluation of equipment and systems. The NRaD Dive Locker includes a decompression chamber located at San Clemente Island.

Computer Support

Facilities:

Distributed Simulation Internet (DSI)Advanced Simulation Laboratory

Marine Air Ground Task Force (MAGTF)

Research, Evaluation, and Systems Analysis (RESA)

Distributed Simulation Internet (DSI) Advanced Simulation Laboratory (DASL), complemented by Secure DSI Integration hardware, software, simulations, and gateways to other simulations.

Marine Air Ground Task Force (MAGTF) Tactical Warfare Simulation (MTWS) laboratory for the development and testing of the MTWS system.

Research, Evaluation, and Systems Analysis (RESA) facility, a large-scale computer-based simulation/wargaming system used to support a variety of applications,

including command, control, communications, and intelligence (C^3I) architecture assessment, concept-of-operations development, advanced technology evaluation, joint exercises, and test and evaluation of advanced systems.

Command, Control, and Communications Modeling and Analysis

Facilities:

Aircraft Motion Simulator

Communications Laboratories

GPS Central Engineering Activity (CEA) laboratory

Inertial Test Facility (INFAC)

Ocean Survey Program and United Kingdom System Integration Laboratory (OSP/UK SIL)

RF Microelectronics Laboratory

Simulated Ship's Motion Facility (SCORSBY)

Navigation Sensor System Interface (NAVSSI) Laboratory

Aircraft Motion Simulator, a fully automated simulator providing a dynamic test environment for evaluating aircraft navigation systems.

Communications Laboratories, providing the capability to design, simulate, develop, and test sophisticated components and airborne communication systems for military applications.

GPS Central Engineering Activity (CEA) laboratory that provides a complete laboratory environment for test and evaluation of Global Positioning System (GPS) receivers.

Inertial Test Facility (INFAC), a low-noise, high-precision navigation sensor test laboratory.

Ocean Survey Program and United Kingdom System Integration Laboratory (OSP/UK SIL) that provides system development and integration of ocean survey systems prior to integration onboard ships.

RF Microelectronics Laboratory, a facility to design, develop, and create prototype state-of-the-art RF microelectronic circuitry using thick-film and thin-film technologies.

Simulated Ship's Motion Facility (SCORSBY), a facility that houses three large ship motion simulators and that can test navigation systems weighing up to 3000 pounds.

Navigation Sensor System Interface (NAVSSI) Laboratory, a facility to develop and test the NAVSSI software and hardware before installation on ships and submarines.

Index

A

Acoustic Sources, 39

Advanced (COMINT) Voice Processing ATD, 39

Advanced Combat Direction System (ACDS), 17

Advanced Deployable System (ADS), 40

Advanced Sensor Applications Program (ASAP), 40

Air Navigation, 64

air-Mobile Ground Security and Surveillance System (AMGSSS), 60

An Integrated Hybrid Neural Network and Hidden Markov Model Algorithm for Classification Applications, 56

AN/USQ-101(V) TADIXS B/TRE, 71

Analog Photonic Link Dynamic Range, 72

Autonomous Sensor Concepts Project, 40

B

Bottom Limited Active Classification (BLAC), 41

C

C3 Simulation and Technology, 57

CERCIS, 41

Command and Control Department, 17

Command and Control Processor (C2P), 19

Command, Control, and Communication Modeling and Analysis, 57

Common Aperture Multi-band Radar (CAMBR), 41

Common Integrated Platform, 42

Communications, 24

Communications Support, 37

D

dBMASTER, 42

Distributed Surveillance Technology, 42

E

E-2C Airborne Tactical Data System Software Support, 19

Electromagnetic Field, 43

Electromagnetics, 24

Electronic Sciences and Technology, 72

Environmental Assessment, 77

F

Facilities, 7

Finance, 10

Fixed Distributed System (FDS), 43

Flying Plug, 60

G

Global Positioning System (GPS), 64

H

Hayfield Multi-Chip Module, 44

High-frequency Surface Wave Radar (HFSWR) ATD, 44

High-performance Computing (HPC), 20

Human Computer Interface (HCI), 21

I

Independent Research (IR), 81

Independent Research Program, 81

Information Security (INFOSEC), 27

Infrared Focal Plane Array (IRFPA), 72

Integration of Space Communication and Surbeillance Systems, 71

Introduction to NCCOSC RDT&E Division (NRaD), 3

ISS Surveillance Direction System (SDS) Shore Systems Engineering, 45

J

Joint Maritime Command Information System (JMCIS), 21

Joint Tactical Information Distribution System (JTIDS), 22

L

LEO SPO Support, 46

Low-power Electronics, 73

M

MAGTF Tactical Warfare Simulation (MTWS) System, 57

Man Transportable Socrates (MTS), 46

Marine Environmental Support Office (MESO), 77

Marine Mammal Acoustic Tracking System (MMATS), 45

Marine Mammal Systems (MMS), 69

Marine Mammals, 69

Marine Sciences and Technology, 80

Memory Chip, 73

Mine Neutralization System (MNS), 61

Mine-Laying Surveillance, 47

Mobile Communications, 28
- Multiple Platform Links, 28
- Satellite Communications Systems, 28

Mobile Detection, Assessment, and Response system (MDARS), 62

Mobile Undersea Warfare System, System Upgrade (MIUW-SU), 47

Multifunction Information Distribution System (MIDS), 23

Multimission Advanced Tactical Terminal (MATT), 47

Multistatic Active Project, 47

N

Navigation, 64

Navigation Sensor System Interface (NAVSSI), 66

Navigation Technology Programs, 66

Networks, 31

Non-Acoustic Distributed Systems Components (NDSC), 48

NRaD Technical Programs, 4

NRaD's Mission and Leadership Areas, 4

O

Ocean Engineering, 60

Ocean Surveillance, 39

Ocean Survey Program (OSP), 67

Organization, 13

P

Personnel, 14

PINC Wavelength Division Multiplexing (WDM), 73

Project Spinnaker: Iceshelf-95, 48

R

Radiant Jade Demonstrations, 48

Range Naval Tactical Data System (NTDS) Upgrade, 23

Rapid Imagery Transmission (RIT), 49

Relocatable Over-the-Horizon Radar (ROTHR), 49

Research, Evaluation, and Systems Analysis (RESA), 59

Ring Laser Gyro Navigation (RGLN), 68

S

Shallow-Water Environmental Cell Experiment-4 (SWELLEX-4), 50

Shallow-Water Sensor System (SWSS), 51

Shipboard Ingrared Search and Track, 51

Silicon-on-Sapphire (SOS), 74

SITE 7800, 51

Site Characterization and Analysis Penetrometer System (SCAPS), 78

Spatial Processing for Deployables/Robust Environmentally-Based Adaptive Broadband Beamforming/Automated Track-Before-Detect Processing, 51

Standard TRE Display 95 (STRED 95), 52

Stochastic Resonance (SR), 74

Submarine Communications, 33

SURTASS and Low-frequency Active (LFA), 53
Surveillance All-Optical Towed Array (SAOTA) Program, 53

T

Tactical Aircraft Mission Planning System (TAMPS), 53
Tactical Cryptological systems/Information Warfare Exploit, 53
Technical Developments, 15
Theater Acoustic Warfare (ThAW)/Data Fusion, 54
Tomahawk In-flight Position Reporting System (TIPRS), 54
TRAP Data Dissemination System (TDDS), 55
Trident Missile, 75
Tri-Service Support, 75

U

Unmanned Undersea Systems, 62
USS Dolphin, 63

V

Vertical Launch ASROC (VLA) Missile Program, 55
Virtual Lab, 56

W

Waterside Security System (WSS), 80

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