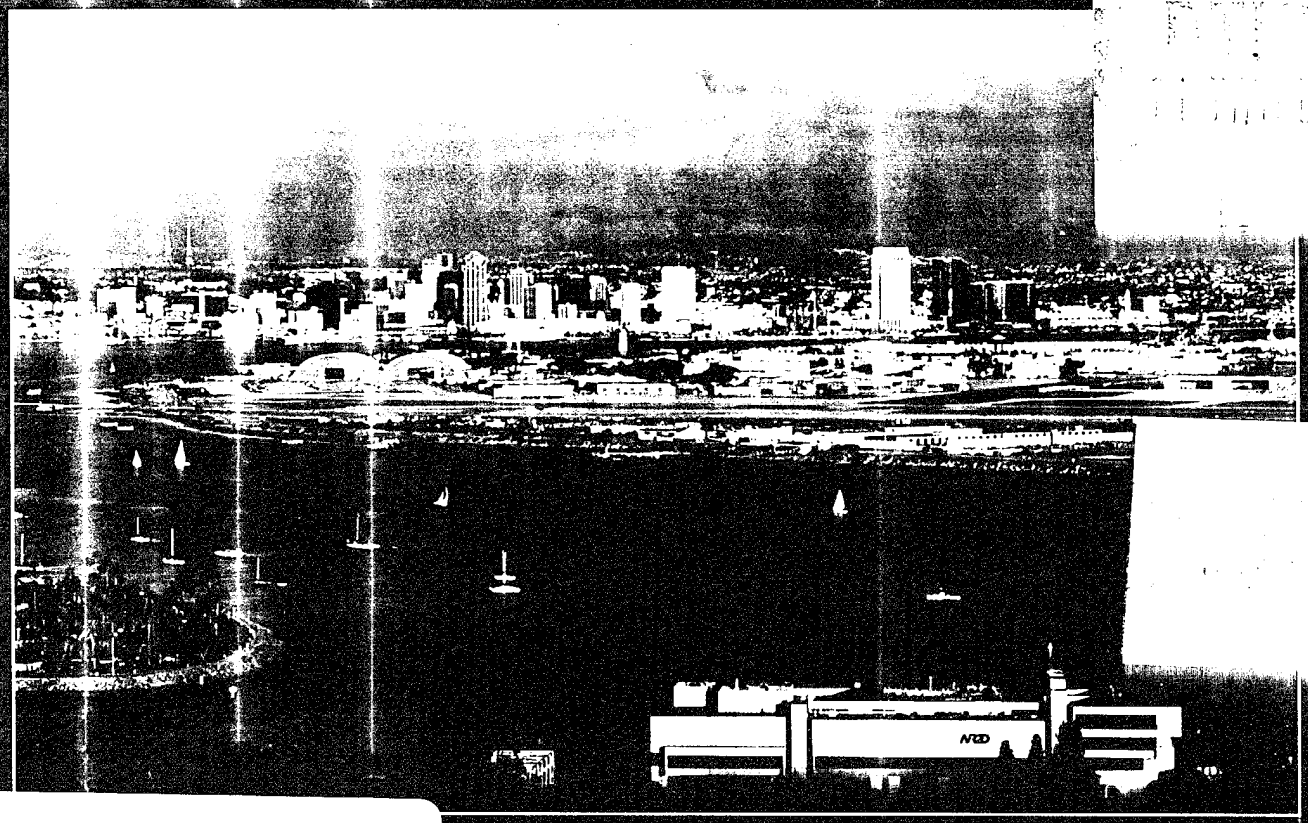
Naval Command, Control
and Ocean Surveillance Center
RDT&E Division

San Diego, CA 92152-5001
September 1994

# N R a D B R I E F



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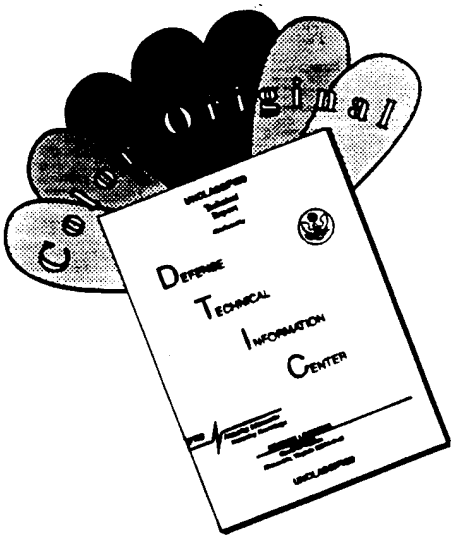


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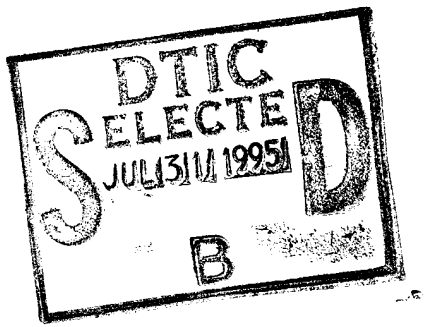
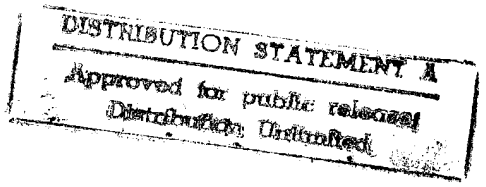


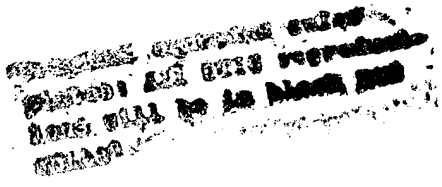

## FOREWORD

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.

**K.E. EVANS, CAPT, USN**
***Commanding Officer***

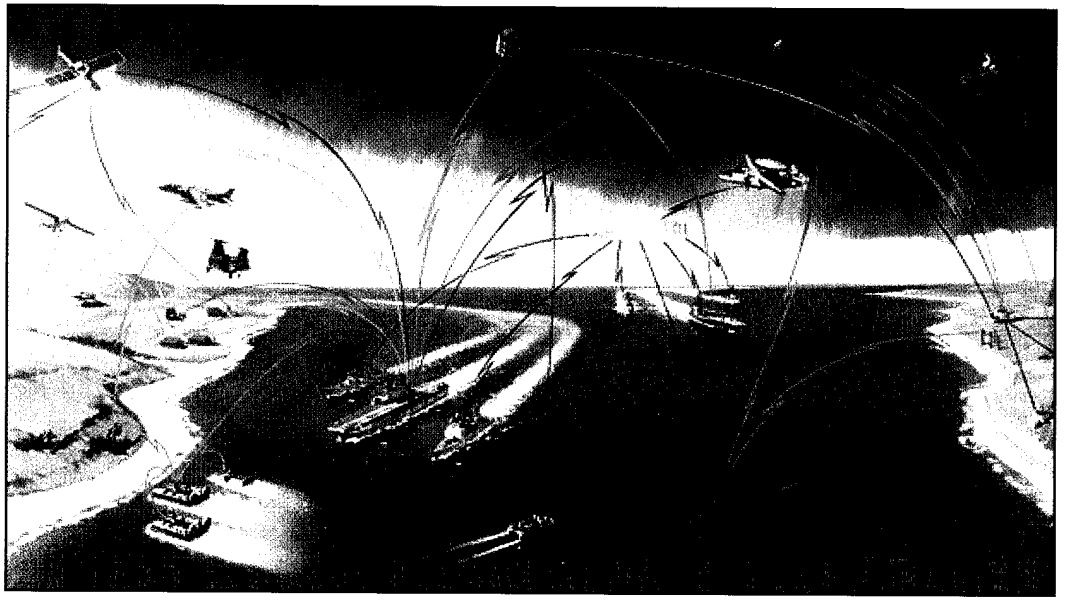
**R.T. SHEARER**
***Executive Director***



## MISSION

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.



## LEADERSHIP AREAS

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

# INTRODUCTION TO NCCOSC RDT&E DIVISION

***Contents***

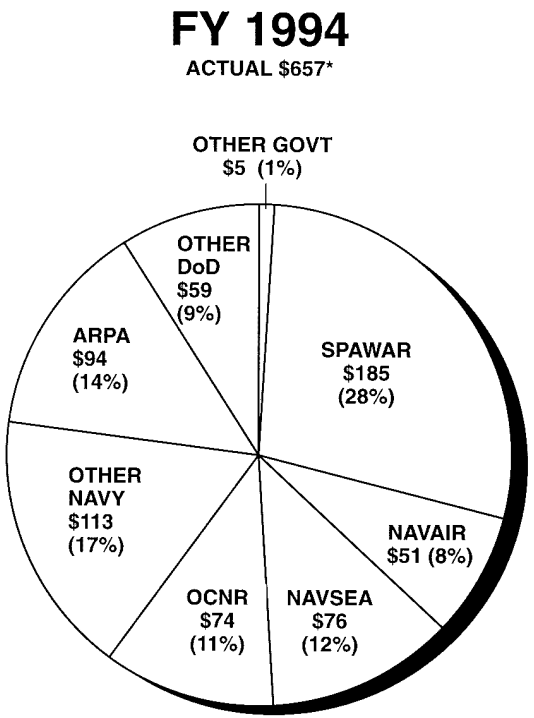


The Naval Command, Control and Ocean Surveillance Center (NCCOSC) RDT&E Division (or NRaD) is a full-spectrum RDT&E laboratory serving the Navy, Marine Corps, and other Department of Defense and national sponsors within its mission, leadership assignments, and prescribed functions. NCCOSC is one of the 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 Office of the Chief of Naval Operations, 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.



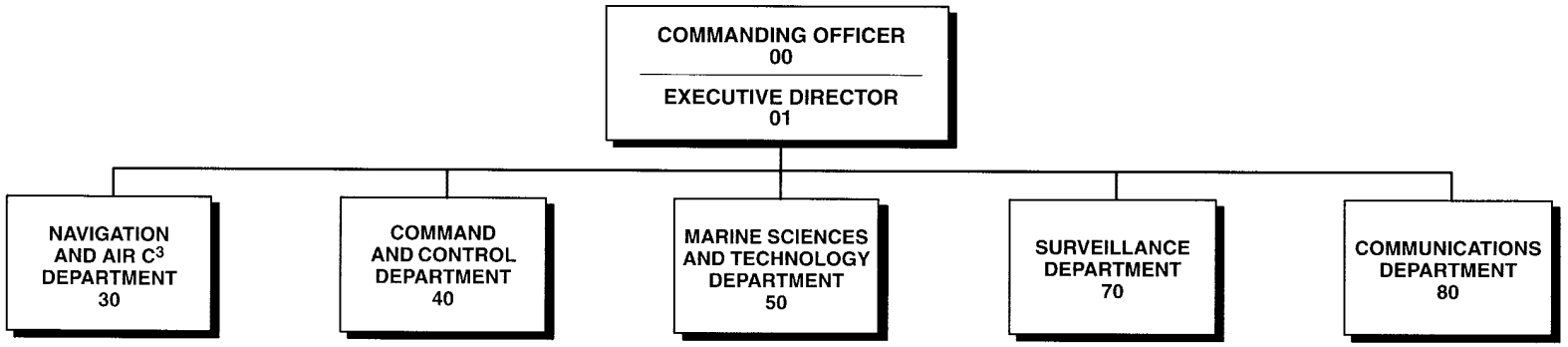

*Includes Direct Cites $207 million

*Funding by sponsor*

NRaD receives funding from sponsors that include SPAWAR, the Naval Sea Systems Command (NAVSEA), the Naval Air Systems Command (NAVAIR), the Office of the Chief of Naval Research (OCNR), and the Advanced Research Projects Agency (ARPA). In FY 94, NRaD received new orders of $657 million.

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 total number of personnel at NRaD at the end FY 94 was 2879, including 2782 civilians and 95 military personnel.

Additional funding, organizational, and personnel information may be found in later sections of this Brief.



## INTRODUCTION

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.

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 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.

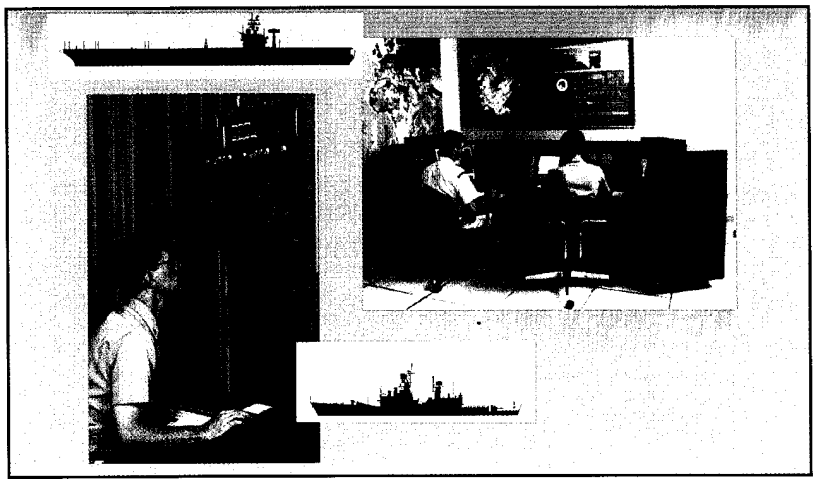
## Surveillance

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.

## Navigation

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.

*Specific NRaD facilities and resources, grouped by major areas of effort, are listed on the following pages.*



*Navy Tactical Command System-Afloat (NTCS-A)*

## COMMAND AND CONTROL ($C^2$)

**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.

**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.

**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.

**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.

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

**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 ($C^2P$).

**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.

**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.

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

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

**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.

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

## COMMUNICATIONS

**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.

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

**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.

**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.

**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.

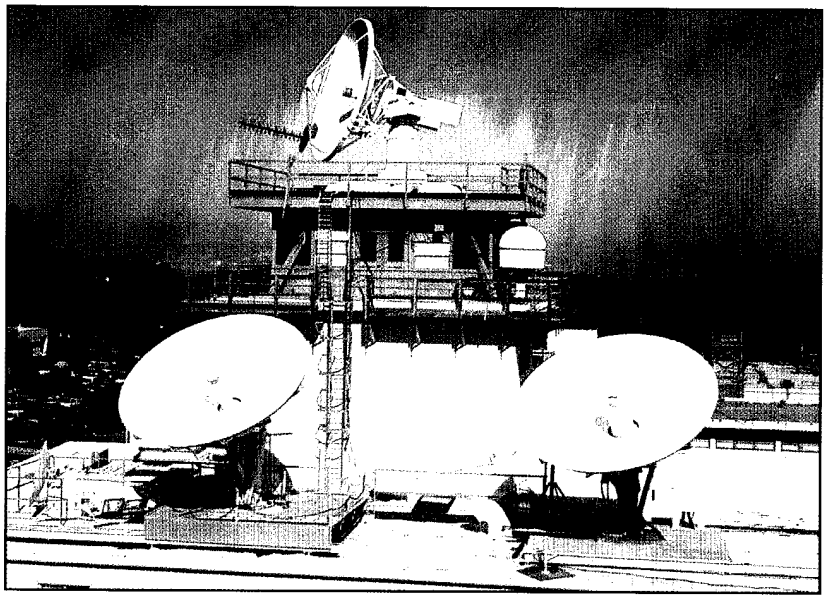
**Survivable Adaptable Fiber-Optic Embedded Network (SAFENET) development site,** used to develop hardware, software, and firmware for ship interior communication.

**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.

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

**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.

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



*SHF SATCOM Facility*

**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.

**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.

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

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

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

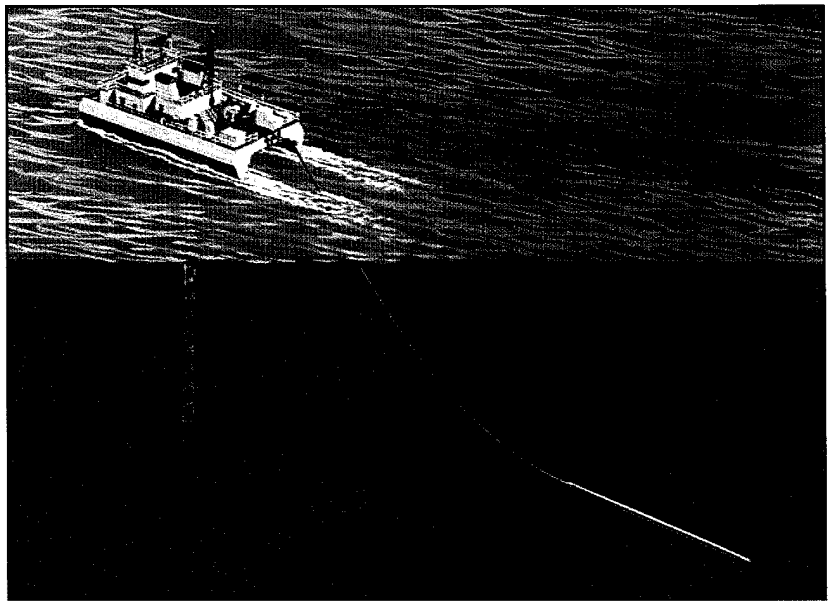
## OCEAN SURVEILLANCE

**Surveillance Test and Integration Center (STIC),** 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)), Low Frequency Active (LFA), Relocatable Over-the-Horizon Radar (ROTHR), Fixed Distributed System (FDS), and the Surveillance Direction System (SDS). 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.

**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.

**Signals Warfare Integrated Facilities Testbed (SWIFT),** a secure facility that supports the full spectrum of development efforts associated with signals intelligence (SIGINT) RDT&E, simulation, and integration in a multisystem environment.

**Signals warfare support facility** that provides a secure EMI/EFI area for analysis, system development, test, and evaluation of countercommunications, SIGINT and signals security (SIGSEC), and related cryptologic programs.



*Undersea Surveillance*

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

**Surveillance radar development facility** that 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.

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

**Tactical Surveillance Laboratory (TSL),** a centralized facility for multiservice and national organizations to display, demonstrate, test, evaluate, and analyze tactical data systems.

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

## ELECTRONIC SCIENCES AND TECHNOLOGY

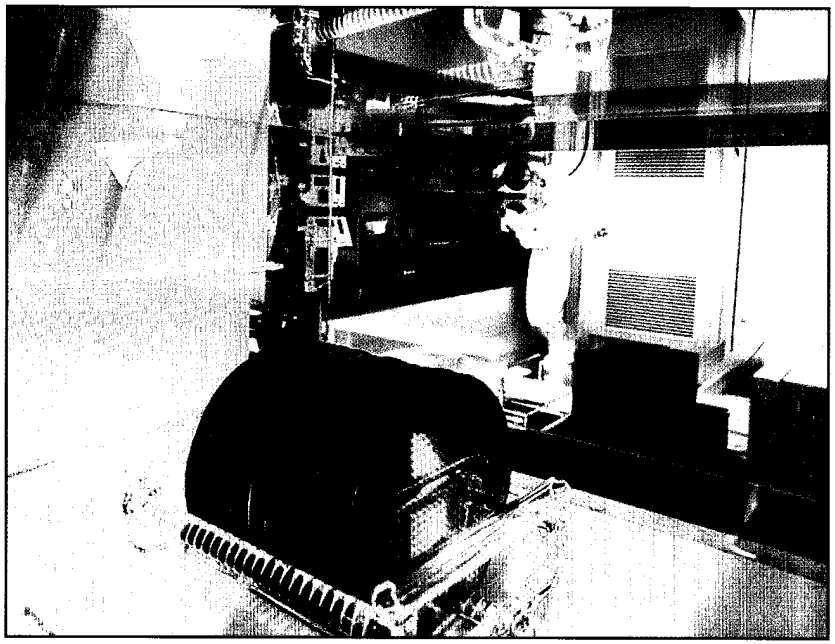
**Integrated circuit (IC) design, fabrication, and packaging laboratory** with facilities for materials research and silicon IC technology development.

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

**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.



*Microelectronics Laboratory*

## MARINE SCIENCES

**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.

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

## DESIGN ENGINEERING, TESTING, AND PROTOTYPE DEVELOPMENT

**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.

## COMPUTER SUPPORT

**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.

## COMMAND, CONTROL, AND COMMUNICATIONS MODELING AND ANALYSIS

**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.

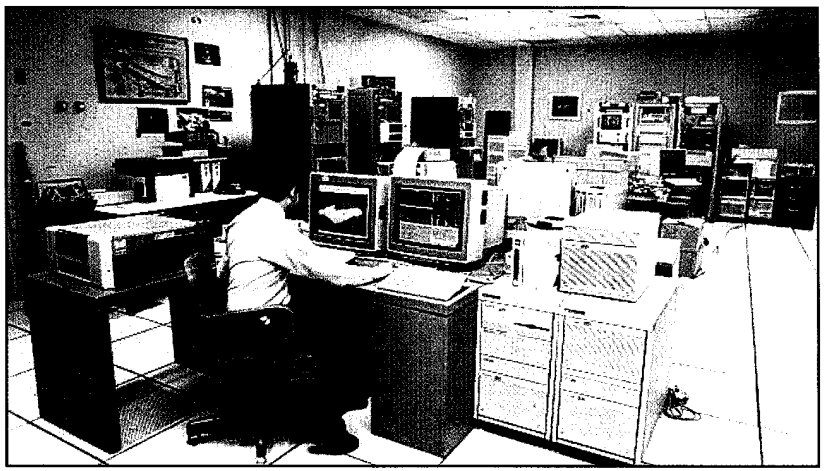
**Distributed Simulation Internet (DSI) Advanced Simulation Laboratory (DASL)**, complemented by the Secure DSI Integration hardware, software, simulations, and gateways to other simulations.

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

## NAVIGATION

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

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



*System Integration Laboratory*

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

**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.

**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.

**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.

## INTRODUCTION

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

## Command and Control ($C^2$)

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 Advance 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, 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 Communications Support System. 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

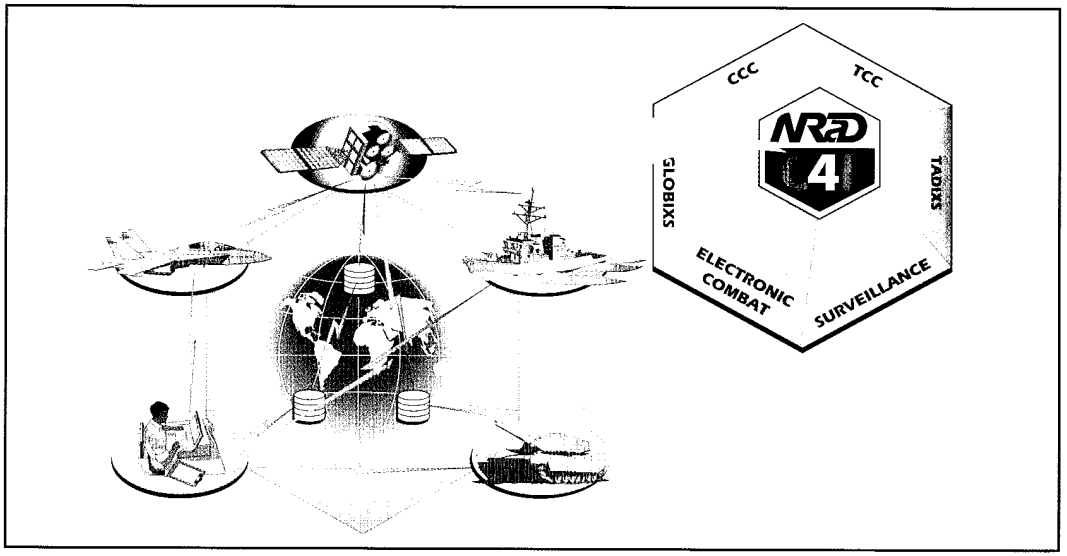
NRaD provides ocean engineering expertise in the areas of undersea research, survey, work, and reconnaissance systems. NRaD is also pursuing innovative research in robotics, materials, optical and acoustic undersea communications, and electro-optical and electromagnetic propagation.

NRaD's RDT&E work with marine mammals has demonstrated that marine mammals can perform tasks related to object detection, location, marking, and recovery. Such work has also resulted in improved diagnostic and treatment techniques for marine mammals.

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

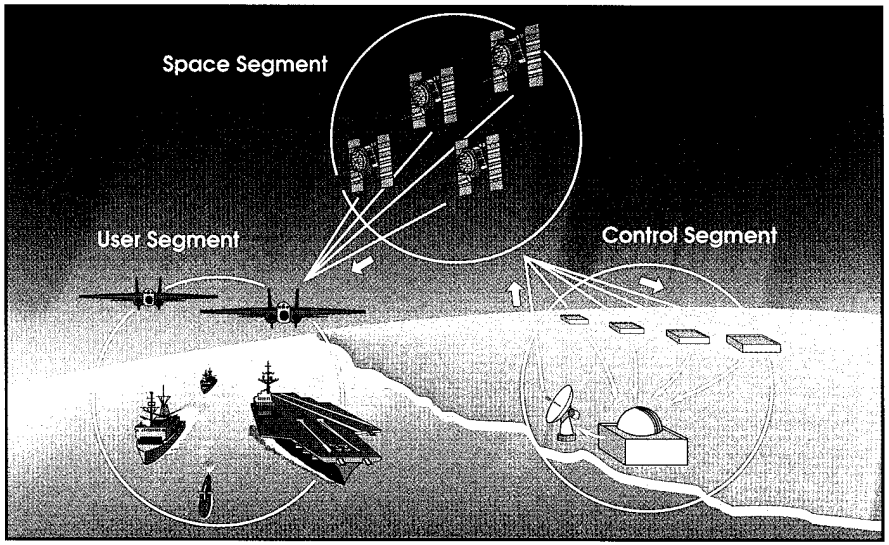
NRaD provides full-spectrum C$^4$I/Surveillance (C$^4$I/S) RDT&E capabilities–from theater-level systems architecture through specific systems design, development, test, and evaluation to evolutionary program support. These capabilities are provided to Navy, Marine Corps, Joint, and Allied customers.




*NRaD's capability-based, Integrated Joint Perspective ensures sustainable C$^4$I/S systems.*

## 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.

*Specific technical programs, grouped by major areas of effort, are listed on the following pages.*

## COMMAND AND CONTROL ($C^2$)

**$C^4I$ Architecture.** Provide a $C^4I$ architecture defined by a CINC Command Complex and a Tactical Command Center, both of which are built from standard hardware/software building blocks to perform $C^2$ at the tactical and theater levels.

**Operations Support System (OSS).** Provide an automated $C^2$ support system to receive, process, display, and assess the readiness and warfighting capabilities of own and allied forces to carry out the full range of Navy missions; and to receive, correlate, and display neutral and enemy positional data in near real time.

*Operations Support System (OSS)*

**Joint Tactical Information Distribution System (JTIDS).** Provide an integrated communications-navigation-identification system featuring multichannel, multinet, high-data-rate communications and relative navigation capabilities for tactical operations.

**Navy Tactical Command System-Afloat (NTCS-A).** Provide an affordable system to support flag- and unit-level information requirements. NTCS-A is the first program to receive production approval using nondevelopmental item and commercial off-the-shelf software and open system standards.

**Joint Maritime Command Information System (JMCIS).** 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 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.

**Joint Maritime Operations Command Center (JMOCC).** Provide the Joint Maritime component commander with a transportable JMCIS-based $C^4I$ capability for ashore deployment. The system consists of three primary components: Mobile Ashore Support Terminal (MAST); Mobile Integrated Command Facility (MICPAC); and the JMOCC Compiler. NRaD is the Principal Development Agency and Design Agent.

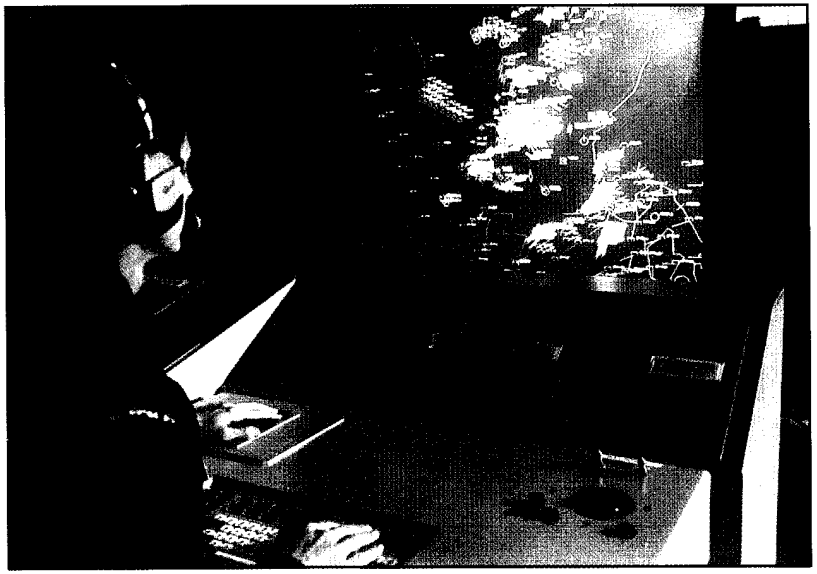
**Global Command and Control System (GCCS).** Provide Joint and service component commanders with a set of automated tools and communications for operations, planning, execution monitoring, and logistics sustainment of joint warfighting efforts. NRaD is the systems engineering advisor and the tester and integrator of the core GCCS component.

**OSIS Baseline Upgrade (OBU)/Evolutionary Development (OED).** Provide a hardware and software upgrade to the Navy's principal ashore $C^2$ and intelligence nodes.

**Command and Control Processor ($C^2P$).** Provide the centralized management and control of tactical digital information links in a multithreat environment.

**Advanced Combat Direction System Block 0 (ACDS Block 0).** Develop and maintain CV, CVN, LCC, LHA, and LHD combat direction system computer programs, other support programs, and related documentation.

**Advanced Combat Direction System Block 1 (ACDS Block 1).** Develop a replacement and upgrade for the Naval Tactical Data System, providing significant enhancements in the areas of sensor management, tactical data exchange, warfare area coordination, and system reliability.



*Advanced Combat Direction System*

**Range Naval Tactical Data System (NTDS) Upgrade.** Upgrade 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.

**E-2C Airborne Tactical Data System.** Develop and maintain E-2C tactical data system computer programs, other support computer programs, and related documentation.

## COMMUNICATIONS

**Communication Support System (CSS).** Provide flexible, survivable, optimal communications using efficient multimedia dynamic load-sharing architecture.

**C$^4$I for the Warrior.** Coordinate effort throughout NRaD and the Navy to develop the Copernicus architecture into the Global Grid System concept.

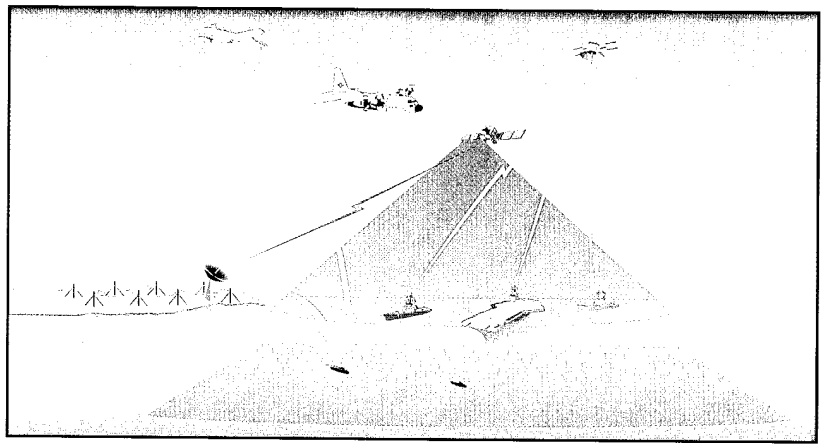
**Submarine Communications.** Provide system engineering, hardware and software development, improvements, installation, and training for submarine communications systems in VLF/LF/HF/VHF/EHF frequency bands; provide support to all platforms, including submarine, shore, ship, and aircraft.

**Strategic Communications.** Develop improved modes for communications from airborne strategic assets to fleet ballistic missile submarines and USAF bombers and launch control centers.

**Ada.** Provide leadership in Navy Ada and other software for the development of communications connectivity and control systems. Provide Ada software development and reuse environment.

**EHF SATCOM**. Develop and test EHF SATCOM terminals for ship, shore, and submarines. Support tri-service MILSTAR terminal testing and in-orbit MILSTAR and UHF follow-on (UFO) satellite testing.

**Automated Communications Management System (ACMS).** Provide system engineering and software development to ACMS, one element of the MILSTAR Mission Control Segment (MCS),



*Full-Spectrum Communications*

which provides real-time and non-real-time control and monitoring of the MILSTAR payload and terminal resources. The ACMS is the primary planning system that supports communications capacity allocations and resource utilization monitoring. The ACMS, using its Communications Plans, loads the network definitions into the EHF terminals, controls the activation and deactivation of networks, and controls the point of EHF satellite antennas.

**Submarine Communications Support System (SCSS).** Provides flexible and survivable communications through media sharing, multimedia access, and automated intelligent routing. The SCSS core elements consist of automated message handling, automated patch panels, packet switching, and fully integrated network management and control of submarine communications.

**Data Dissemination Program**. Provide technical support of the DDS-3 system at operational field sites.

**UHF DAMA SATCOM.** Provide design and analysis for UHF SATCOM systems, including existing fleet broadcast and demand-assigned multiple-access (DAMA) systems. Address secure and cryptographic interfaces and assist in designing and specifying new-generation systems.

**Shipboard Interior Communications.** Provide design and development of shipboard interior communications systems, with emphasis on fiber optics; support installation, test, and analysis aboard ships.

**High-Speed Switching.** Develop high-speed switching in Navy $C^3I$ facilities to allow rapid reconfiguration and installation of new equipment.

**SHF SATCOM.** Provide design, analysis, specifications, and technical support in the development of major SHF SATCOM systems, installation plans, procedures, and training information.

**Communications Systems Software Support.** Provide software maintenance, configuration management, systems engineering, and independent verification and validation for all software in Navy communication systems.

## COMMAND, CONTROL, AND COMMUNICATION SYSTEMS COUNTERMEASURES

**Electromagnetic Interference (EMI) Canceller.** Develop technology to detect and eliminate EMI in various types of antenna situations.

## OCEAN SURVEILLANCE

**Cryptological Unified Build.** Develop an open systems architecture for afloat cryptologic applications that is JMCIS Unified Build compliant.

**Advanced Deployable Surveillance (ADS).** Develop a rapidly deployable surveillance capability for regional conflict scenarios.

**Wide-Area Undersea Surveillance.** Support technology initiatives in undersea surveillance, including acoustic sources, acoustic and nonacoustic sensors, array technology, and signal processing.

**Surveillance Towed-Array Sensor System (SURTASS) and Low Frequency Active (LFA).** Provide system engineering for development efforts and conduct development, operational, acceptance, and certification tests as Technical Development Agent (TDA).

**Integrated Surveillance System (ISS) Surveillance Direction System (SDS) Shore Systems Engineering.** Support the development of the ISS integrated architecture and development of SDS including system engineering and software IV&V.

**Tactical Aircraft Mission Planning System (TAMPS).** Develop the architecture design and approach, including an A-spec, for TAMPS 7.0. Define the JMCIS/GCCS integration for the mission planning network.

**High-Frequency Surface Wave Radar (HFSWR) ATD.** Develop a High-Frequency Surface Wave Radar for earlier, over-the-horizon detection of low-flying, low-observable, high-speed, anti-ship missile threats. This radar will provide increased reaction time for ship defense and handover cuing of an engagement radar in range, velocity, and angle.

**Fixed Distributed System (FDS).** 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), SOSUS, and SURTASS upgrades.

**Tomahawk In-flight Position Reporting System (TIPRS).** Develop the TIPRS ground base Tomahawk Receiver Unit (TRU). When the TRU is located within the footprint of the relay satellite, it will provide missile position, missile health, and status information to the Tomahawk Mission Distribution System for up to 48 in-flight Tomahawk Transmitting Systems (TTS) equipped missiles simultaneously.

**Bottom Limited Active Classification (BLAC).** Develop automated techniques for active sonar target classification to support surveillance and tactical systems in littoral waters against diesel-electric submarine threats.

**Theater Acoustic Warfare (ThAW)/Data Fusion.** Develop advanced technology for theater-level systems that fuse undersea warfare data and direct acoustic sensors.

**NAVSTAR GPS.** Provide a management/technical team to administer the Navy contribution in the development, acquisition, and support of GPS, including all segments and aspects of system development, integration, test, procurement, and support for Navy platforms.

**Defense Meteorological Satellite Program (DMSP).** Assist in the development, acquisition, and launch of advanced space sensors designed to measure ocean and atmospheric conditions; develop system specifications and provide for integration of Navy environmental satellite systems within the DMSP; provide interfacing between the DMSP and other Navy and Marine meteorological systems.

**Space Test Program (STP).** Perform as executive agent for management of Navy participation in STP; provide liaison with AF Space Division STP office for all Navy and joint experiments.

**Follow-On Early Warning System (FEWS).** Provide Navy technical and management support to USAF contracts for Navy/Joint use participation in future years.

**SITE 7800.** 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.

**Advanced (COMINT) Voice Processing ATD.** Combine 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.

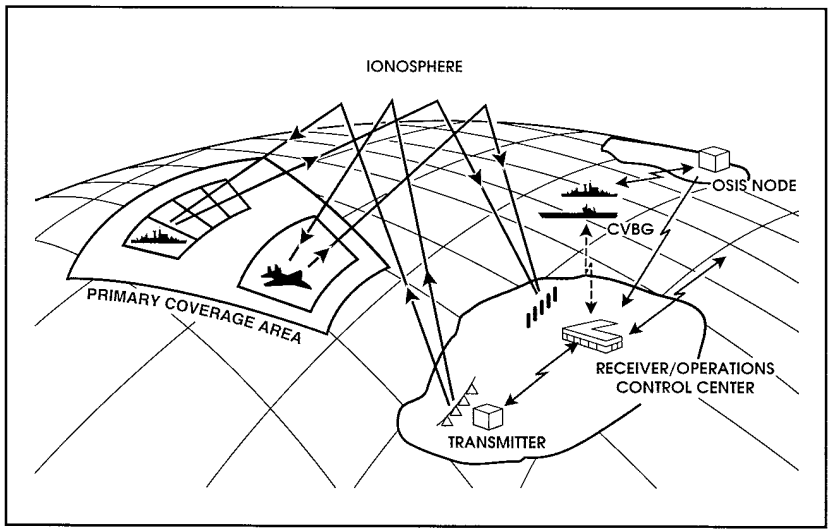
**CERCIS.** Provide the next-generation replacement of signals intelligence (SIGINT) Correlation of Recognized Emitters (SCORE) and SIGINT Universal Recognition Facility (SURF) analyst capabilities currently at operational SIGINT sites; design, develop, and implement all Navy-required capabilities for this theater-level system. CERCIS is installed at seven sites worldwide.

**SIGINT Waterfall Display.** Develop and field, at an operational SIGINT site, a prototype SIGINT tool to visually detect the presence of signals within the RF environment.

**Relocatable Over-the-Horizon Radar (ROTHR).** Develop test procedures for the Government Acceptance Testing of Production Systems; develop the ROTHR interface; assure interoperability with JTF-4 and CARIBROC; provide software upgrades to the production systems; and support installations in Texas and Puerto Rico, including acceptance testing.

## COMMAND, CONTROL, AND COMMUNICATION MODELING AND ANALYSIS

**JTIDS.** Provide the battleforce introduction of JTIDS, including the development of all networks and communication plans to support the full battle group use of JTIDS in all aspects of naval operations,




*Relocatable Over-the-Horizon Radar (ROTHR)*

including littoral warfare and forward presence; provide the system familiarization training in concert with the program concept of operations; provide analysis and simulation for prediction of system performance and air platform systems engineering to ensure full interoperability with surface and joint air/land forces.

**Multifunctional Information Distribution System (MIDS).** Perform as primary USN systems engineer supporting both the MIDS terminal development within the international community and its application and implementation in the U.S. lead platform, the F/A18; integrate MIDS into the overarching JTIDS tactical $C^3I$ structure to support battlespace dominance and power projection operations from littoral areas; provide the primary technical interface to NATO for the use of the system in meeting combined operations requirements.

**Synthetic Theater of War.** Demonstrate advanced distributed simulation technologies using a force structure composed of live entities,

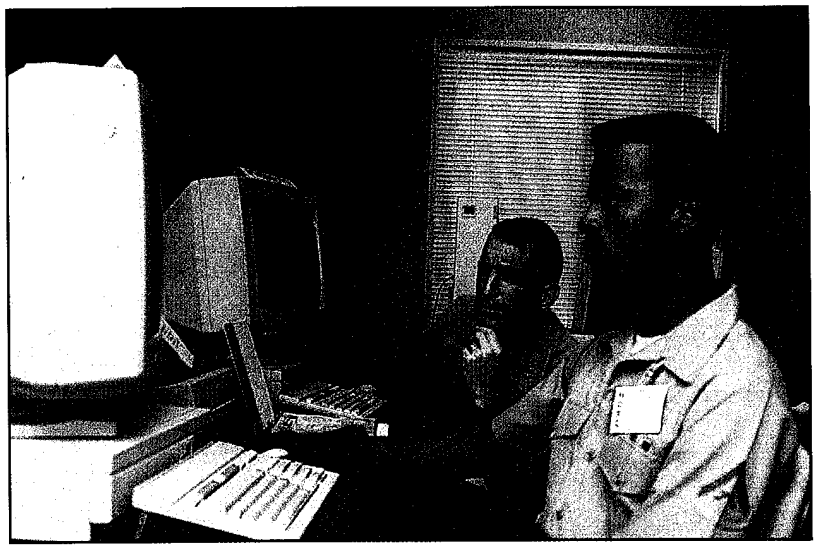
virtual simulators, and constructive simulations. NRaD is Systems Engineering and Integration Agent.

**$C^3$ Simulation and Technology.** Advance the technologies of large-scale simulation and networking and assess next-generation technologies applicable to advance $C^3$ systems/information systems.

**MAGTF Tactical Warfare Simulation (MTWS) System.** Provide the next-generation Marine Corps Tactical Training System.

**Battle Group Assessment.** Provide CINCLANTFLT with the capability to rapidly assess the performance of fleet units during exercises through use of nondevelopmental items and integration of existing systems; provide exercise participants with timely feedback.

**Research, Evaluation, and Systems Analysis (RESA).** Provide 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.



*MAGTF Tactical Warfare Simulation (MTWS) System*

**Electromagnetic Compatibility (EMC).** Provide EMC design, modeling, and analysis of ship torpedoes for ship topside communications suites and land-based antenna farms; perform simulation and modeling in both software and hardware ranges to minimize interference among systems.

**Electromagnetic Engineering.** Provide shipboard interior and exterior communication equipment design analysis to minimize interference issues.

## OCEAN ENGINEERING

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

**Unmanned Undersea Systems.** Develop 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).

**MAGELLAN and Other Systems.** Provide ocean engineering wet-end support for undersea surveillance systems, including MAGELLAN and Advanced Deployable Systems.

**Telerobotics.** Develop $C^3$ architectures that can supervise multiple autonomous (robotic) platforms for physical security and other Navy applications.

## NAVIGATION

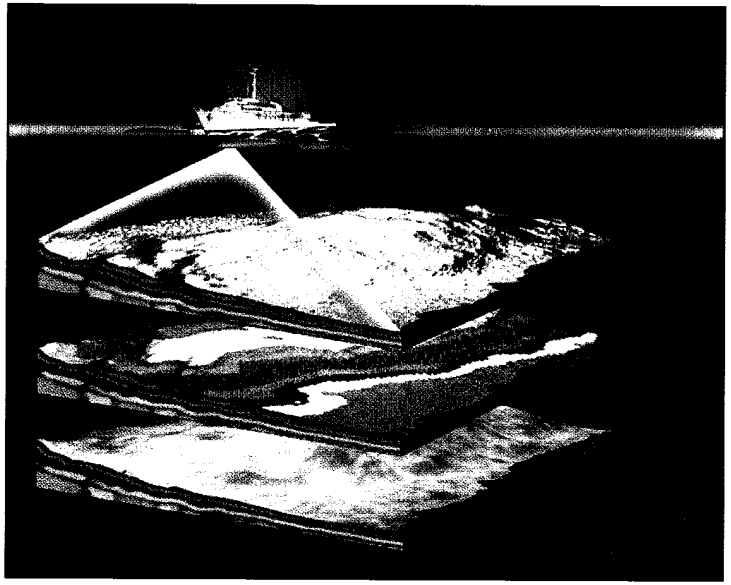
**GPS.** Provide accurate, continuous, worldwide, three-dimensional position and velocity and precise time to all DoD users through development and applications engineering of the GPS user equipment for Navy aircraft, surface ships, and submarines; manage, direct, and/or coordinate other participating activities and industry in support of the Joint Service Program as the Navy's lead laboratory in GPS user equipment.

**Air Navigation.** Provide basic analysis and systems development functions for airborne navigation systems, including hybrid navigation systems and inertial navigation subsystems; develop experimental navigational systems and perform feasibility demonstrations aboard air platforms; provide engineering support to major system project offices in the areas of navigation and systems integration.

**Ocean Survey Program (OSP).** Produce 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. Conduct 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.

**Ring Laser Gyro Navigator (RLGN).** Develop and transition the RLGN, the next-generation inertial navigation system for surface ships, into the Fleet. Make subsequent product improvements as TDA; provide an extended performance capability, a significantly improved reliability, and a much lower life-cycle cost.

**Navigation Sensor System Interface (NAVSSI).** Develop an interface designed to integrate the shipboard navigation sensors and systems and to provide a single best source of navigation information to all users; 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.



*Ocean Survey Program*

## MARINE MAMMALS

**Marine Mammals.** Develop marine mammal systems that can perform tasks related to object detection, location, marking, and recovery; improve diagnostic and treatment techniques for marine mammals.

## INTEGRATION OF SPACE COMMUNICATION AND SURVEILLANCE SYSTEMS

**AN/USQ-101(V) Tactical Data Information Exchange Subsystem Broadcast (TADIXS B) Tactical Receive Equipment (TRE) System.** Develop a system that receives, demodulates, decodes, decrypts, processes, and distributes TADIXS B broadcast contact reports.

**Tactical Related Applications Broadcast System (TRAP).** Develop a system that provides near real-time contact report data through a global netted message broadcast system to a variety of TRE users via the Navy UHF SATCOM system and terrestrial communication links.

**Multimission Advanced Tactical Terminal (MATT).** Maintain the receiver system that allows the user to simultaneously receive, decrypt, filter, correlate, and distribute the data contained on up to four UHF broadcasts.

## ELECTRONIC SCIENCES AND TECHNOLOGY

**Tri-Service Support.** Support the development of microelectronic components no longer commercially available but needed to support fleet systems.

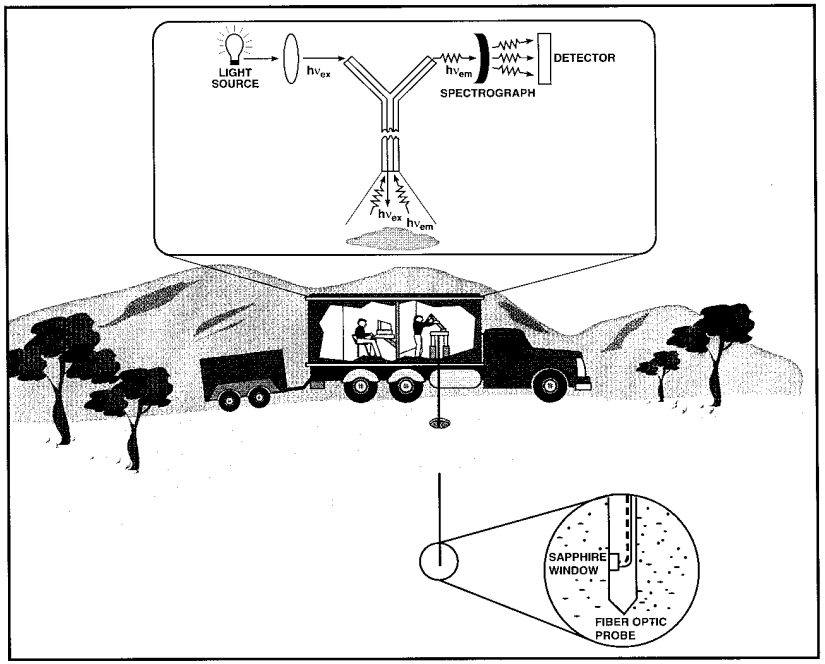
**Trident Missile.** Provide navigation and fire control support for Trident missile programs.

**Stochastic Resonance.** Investigate stochastic resonance with basic research in nonlinear responses with additive and multiplicative noise for both signal processing and neurophysiology.

**Reduced-Power Digital Filter (REDFIL).** Develop extremely low-power and high-speed analog-to-digital and digital-to-analog converter technology and devices.

## ENVIRONMENTAL ASSESSMENT

**Site Characterization and Analysis Penetrometer System (SCAPS).** Develop and deploy a fiber-optic-based, laser-induced fluorescence sensor for petroleum, oil, lubricant (POL) contaminants.




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

## DESIGN ENGINEERING, TESTING, AND PROTOTYPE DEVELOPMENT

**Manufacturing Sciences and Technology.** Develop enabling manufacturing technologies and implement these technologies on Navy weapon system production lines.

**Microelectronics.** Manufacture microelectronic components no longer commercially available but needed to support fleet systems.

**Unmanned Ground Vehicle.** Provide systems engineering and T&E support for the DoD Unmanned Ground Vehicle Joint Program Office (Principal Development Activity).

## COMMAND AND CONTROL ($C^2$)

*NRaD pursues an aggressive technology-based $C^2$ program that includes distributed $C^2$ technologies, information management, human systems interaction, modeling and simulation, advanced computing technologies, and Marine Corps technology applications. FY 94 program accomplishments in $C^2$ included the following.*

**Advanced Combat Direction System (ACDS) Block 0 Level 8 Deliveries.** Delivered the ACDS Block 0 Level 8 to USS *Essex* (LHD 2), USS *Abraham Lincoln* (CVN 72), USS *George Washington* (CVN 73), USS *Dwight D. Eisenhower* (CVN 69), USS *Carl Vinson* (CVN 70), USS *Theodore Roosevelt* (CVN 71), USS *Wasp* (LHD 1), USS *Constellation* (CV 64), USS *Independence* (CV 62), USS *America* (CV 66), and the Fleet Combat Training Center Atlantic (FCTCLANT).

**ACDS Block 1.** Installed and demonstrated ACDS Block 1 aboard USS *Constellation* (CV 64).

**ACDS Support.** Participated in ongoing $C^4I$ grooming onboard USS *Carl Vinson* (CVN 70) in Alameda, CA., and provided shipboard and battle force support of at-sea operations; provided ACDS support of the Block 0 program and provided Block 1 crew training onboard USS *Constellation* (CV 64) (efforts included installation of a VAX workstation and the first successful load of an ACDS Block 1 program); and provided Cooperative Engagement Capability (CEC) training onboard USS *Dwight D. Eisenhower* (CVN 69).

**Aggregate Level Simulation Protocol (ALSP).** Completed certification testing of RESA and MAGTF MTWS at the Warrior Preparation Center Germany for the ALSP Confederation of Models to be used in future joint and allied computer-aided exercises. RESA is certified as a fully interactive member of the confederation. MTWS is certified to receive ALSP objects.

**Simulator Network (SIMNET) Brigade/Battalion Simulation (BBS).** Successfully completed the 2-week functional validation test of NRaD's aggregation/de-aggregation work for the BBS system with the SIMNET system in Germany. This technology will be an integral part of the Southwest USA Synthetic Theater of War (STOW) and European Synthetic Theater of War (STOW-E) in late 1994.

**Link-16.** Successfully completed Link-16 TECHEVAL aboard USS *Carl Vinson* Battle Group. Link-16 supported all phases of Battle Group activities, including scheduled Anti-Air Warfare Exercises, with an excellent record of system availability, reliable inter-platform connectivity, and significantly improved situational awareness.

**JTIDS Demonstration at Pentagon.** Successfully completed three separate JTIDS Link-16 demonstrations from the SOCAL area to the Pentagon via satellite. The satellite communications link was used as a gateway to provide both a real-time tactical display of the *Vinson* Battle Group and slow-motion video images from the periscope of the submarine USS *Asheville* (SSN 758).

**Link-16 Gateway.** Demonstrated the basic concept of connecting geographically separate test beds to facilitate joint operability testing of combat data systems and their supporting tactical communications systems using the NRaD Systems Integration Facility (SIF) Gateway system.

**JTIDS Stand-Alone Antenna.** Passed all environmental and high-power tests for shipboard use of the AS-4400/URC JTIDS Stand-Alone Antenna. The Stand-Alone Antenna is designed for installations that do not need a TACAN capability and to provide a receive-only backup capability onboard platforms with the larger AS-4127

URC-107(V) JTIDS Antenna. Authorization was received to install the JTIDS Stand-Alone Antenna (military designation applied for) to replace existing three-antenna configurations aboard DDG 72 (and up) class ships, and identification, friend or foe (IFF) antennas on all new ships. This antenna is planned for use with the AS-4127 JTIDS antenna in a receive-only mode to provide additional receive coverage, resolving multipath problems.

**C$^2$P Deliveries.** Completed the following C$^2$P deliveries: the Model 5 Version to USS *Constellation* (CV 64); Model 4 Version to USS *Abraham Lincoln* (CVN 72); and the Model 4 Low-Level NTDS Serial Interface Version to the AEGIS Test Facility at Wallops Island.

**Synthetic Theater of War (STOW).** Successfully conducted a STOW Engineering Demonstration. Metrics were collected on the integration of live, virtual, and constructive entities into a single STOW as the baseline for an upcoming major STOW demonstration. This demonstration integrated the RESA system, BBS system, and the Naval Tactical Command System-Afloat (NTCS-A) at NRaD; the Tactical Air Range Instrumentation Facility (TARIF) at China Lake; Manned Air Simulators (AIRNET) at Ft. Rucker, and Modular Semi-Automated Forces (MODSAF) and the BBS system at the Institute for Defense Analysis.

**Mobile Ashore Support Terminal (MAST)/Fleet Mobile Operational Command Center (FMOCC).** Deployed the MAST component of the FMOCC to COMUSNAVCENT Bahrain.

**Joint Maritime Command Information System (JMCIS).** Installed the JMCIS 2.1.0.1 (with the Theater Ballistic Missile Defense JMCIS 2.1.1 functionality) on USS *Dwight D. Eisenhower* (CVN 69) (this latest JMCIS configuration is based on TAC-3 hardware and includes more than 30 separate software functional components); installed JMCIS 2.1.2 on USS *LaSalle* (AGF 3), the COMSIXTHFLT replacement flagship; and provided a wide range of operational and technical support.

**Contingency Theater Automated Planning System (CTAPS).** Installed CTAPS Version 5.06 software on the JMCIS on USS *Dwight D. Eisenhower* (CVN 69) and USS *Mount Whitney* (LCC 20), giving both ships a complete Joint Forces Air Component Commander (JFACC) afloat capability; installed CTAPS 5.0 on USS *Blue Ridge* (LCC 19). This was the first 5.0 afloat installation, using Air Force software on Navy hardware, and gives C7F a JFACC afloat capability.

**Tomahawk Strike Coordination Module (TSCM).** Installed the main components of the TSCM onboard the COMSECONDFLT flagship USS *Mount Whitney* (LCC 20); installed TSCM software v1.06 beta with Tactical Aircraft Mission Planning System (TAMPS) tape interface on USS *Kitty Hawk* (CV 63). System, Central Data Base Server (CDBS) pull, and local-area network (LAN) tests were performed and TAMPS missions were transferred to TSCM.

**Map Generator Prototype.** Installed, tested, and evaluated the Map Generator Prototype and the Ampro 2600 color large-screen display on USS *Constellation* (CV 64). The Map Generator provides high-resolution World Vector Shoreline maps and Digital Aeronautical Flight Information File (air corridors) as color graphical underlays to tactical situation displays on six UYQ-21 consoles, one PT-525 monochrome large-screen display, and the new Ampro color large-screen display.

**Navy Tactical Command System-Afloat (NTCS-A).** Completed integration and test facility setup and management preparations for production of USS *Dwight D. Eisenhower* (CVN 64) JMCIS 2.1 build. JMCIS 2.1 will ultimately include all NTCS-A applications plus OSS applications.

**NTCS-A.** Completed (with NISE East and West) USS *Constellation* (CV 64) 2.0.10.5 installation. The NTCS-A team loaded software and conducted the certification testing of the SCI system, helped

solve remaining hardware problems, and provided parts to complete the installation. NRaD also installed software, tested the hardware, and conducted the certification test on the stand-alone SCI Correlator. This is the first shipboard installation of a system that will allow retirement of the HP 9020 based Advanced Tracker Prototype.

**NTCS-A.** Supported the Office of Naval Intelligence in the certification of the Joint Deployable Intelligence Support System (JDISS) as a segment on the JMCIS 2.1 software. This will be installed first on USS *Dwight D. Eisenhower* (CVN 69) in JMCIS Phase 3. This JDISS segment moves JDISS functionality from a separate SPARC 10 to JMCIS SCI hardware. Besides eliminating an external computer, it is the first phase of a planned JDISS integration program that will merge JDISS databases ashore with JMCIS databases afloat.

**NTCS-A.** Completed installation of six Contingency Theater Automated Planning System (CTAPS) servers and three TACs on USS *Kitty Hawk* (CV 63). The software was configured for WESTPAC, and all six communication paths were verified operational.

**Tactical Data Link Gateway.** The Joint Interoperability Test Command recommended that the NRaD TADIL Gateway be used for testing by all participating services and agencies.

**SIMNET Integration Project.** Successfully demonstrated the Brigade/Battalion Battle Simulation System for STOW-E in Hohenfels, Germany, and Ft. Rucher, AL, in Atlantic Resolve 94 Exercises.

**High-Performance Computing.** The NRaD HPC team won first place in the Heterogeneous Computing Challenge at Supercomputing 94.

**Link-16 Acquisition Review Board**. The JTIDS/C$^2$P program received authorization to be briefed to DASN R&D for the Navy Program Decision Memorandum.

**JTIDS/C$^2$P.** Operational Test and Evaluation Force (OPTEVFOR) recommended JTIDS and C$^2$P as operationally effective and suitable with no deficiencies.

**RESA.** Supported the Ulchi Focus Lens 94 exercise that was described by VADM A. Clemins, COMSEVENTHFLT, as "the best Joint Training Exercise that he has ever been involved with." RESA provides naval simulated forces to 14 command centers in Korea and 10 command centers in Japan as well as the Joint Operational Tactical System (JOTS) picture to COMSEVENTHFLT's flag ship.

**OSIS Baseline Upgrade.** Installed the OBU version 20.14 at Kamiseya, Japan, and received full accreditation.

**Joint Intelligence Center, Pacific (JICPAC) Support.** Provided technical support to JICPAC during the testing of a dial-up connection over an INMARSAT-STU III-router data link between a remotely located JDISS and JICPAC's GENSER LAN. This capability can be set up quickly and provides intelligence support to a Joint Task Force Commander during the initial hours of a contingency deployment before SHF SATCOM can be established. Future testing includes the use of communication servers that provide bandwidth-on-demand over STU-III hookups.

**C$^4$I Assist for COMNAVAIRPAC.** NRaD provided a C$^4$I Assist for COMNAVAIRPAC supporting USS *Constellation* (CV 64) battle group (BG) carrier qualification (CQ) and training. Dual Link-16 and Link-11 data-forwarding operations between USS *Abraham Lincoln* (CVN 72) and USS *Constellation* (CV 64) went well, with a good and consistently solid picture.

**Haiti Operations Support.** Provided technical support and C$^3$I system grooming for USS *Dwight D. Eisenhower* (CVN 69) and USS *America* (CV 66); recreated the Joint Warrior Interoperability Demonstration (JWID) Common Tactical Picture (CTP) capability for Commander, Task Force (CTF) 180 (CG 18TH Airborne Corps

embarked on USS *Mount Whitney* [LCC 20]); provided connectivity to the National Military Command Center (NMCC); reestablished a "mini" Network Operations Center (NOC) at USACOM to support the Commander, Joint Task Force (CJTF); provided round-the-clock support to the Global Command and Control System (GCCS)/Common Tactical Picture (which is essentially the JMCIS 2.1 software) effort at U.S. Atlantic Command (USACOM).

## COMMUNICATIONS

*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 Communications Support System. 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. FY 94 program accomplishments in communications included the following.*

**Automatic Link Establishment (ALE) Tests.** Participated with National Telecommunications Information Administration (NTIA) personnel in over-the-air HF ALE tests in support of National Communication Systems (NCS) compatibility test.

**GTE Cooperative Research and Development Agreement (CRADA).** Conducted a successful Video Teleconference (VTC) demonstration between NRaD, San Diego and GTE, Needham, MA. The VTC link was established via satellite with ATM switches at both terminals. As part of the GTE CRADA First Experiment, various voice, video, and data applications were demonstrated over a DS3 link operating at 44.7 Mbps.

**$(IC)^2$.** Participated in a successful demonstration of the $(IC)^2$ at Wallops Island. NRaD was responsible for the backbone network and the administrative network.

**Low-Light Serial Switch (LLSS).** Assisted with the total check out and integration of the third LLSS in support of AEGIS programs. All three switches were trunked together and controlled successfully with the new software program.

**High Data Rate (HIDAR).** Successfully deployed the High Data Rate (HIDAR) mode as an Enhanced VERDIN System software upgrade version. HIDAR is a strategic communications mode that provides greatly reduced delivery times for Emergency Action Messages while maintaining excellent performance in stressed communications environments. HIDAR combines state-of-the-art coding and signal processing to provide rapid, reliable, communications on the Strategic Connectivity System.

**Modified Miniature Receive Terminal (MMRT).** Provided system engineering and software engineering support to the U.S. Air Force for the implementation of the HIDAR strategic communications mode and nonlinear adaptive processing (NONAP) into a Modified Miniature Receive Terminal (MMRT) multichannel scanning receiver. The MMRT will be deployed in the JCS National Airborne Operations Center (NAOC) and the E6B.

**TRIDENT Integrated Radio Room (IRR) Test and Evaluation.** Transitioned four Land-Based Evaluation Facility on-site representative positions from SPAWAR to NRaD. This team, augmented by the NRaD San Diego project office, certified the sixteenth shipset of the Integrated Radio Room (IRR) that was subsequently installed in the hull of USS *Maine* (SSBN 741).

**TRIDENT Direct Fleet Support.** Successfully responded to three requests for Direct Fleet Support by Commander, Submarine

Squadron 20 at Submarine Base, Kings Bay, GA. Accomplished the upgrade to the radio room of USS *Rhode Island* (SSBN 740), prior to her deployment on sea trials. With the concurrence and support of the Strategic Systems Program Office (SSPO), NRaD implemented Submerged Launch Ballistic Missile (SLBM) retargeting prior to weapons qualification tests.

**TRIDENT Integrated Radio Room (IRR) Upgrades.** Deployed a new firmware release for TRIDENT that resolved five Submarine Satellite Information Exchange (SSIXS) problems unique to the IRR. Deployment of the Enhanced VERDIN System (EVS) upgrade that implemented HIDAR was smoothly accomplished in all TRIDENT hulls.

**NATO Interoperable Submarine Broadcast System (NISBS).** Successfully completed and installed Software Version 2.2 that supports fault transfer between primary and alternate circuits and makes the remote single channel broadcast independent of the U.S. Navy Broadcast. Additionally, this software release allows one channel of a VERDIN broadcast to be formatted in accordance with NATO STANAG 5030. The user interface was enhanced to facilitate operator functions. Also completed was Formatter Software Version 3.1 that adds the capability to support NATO STANAG 5030 MODES N2 through N6. This capability is scheduled for deployment in FY 95.

**TACAMO Message Processing System (TMPS).** Deployed Software Version 9.0 with concurrent training onboard the E-6A TACAMO aircraft. This software upgrade implements National Emergency Airborne Command Post (NEACP) and Airborne Command Post (ABNCP) Emergency Action Message (EAM) processing, transmission via the Air Force SATCOM in the bypass mode, HIDAR transmit and receive via EVS, and improved system level diagnostics.

**MILSTAR Message Processing System (MMPS).** Successfully installed Software Version 2.4 onboard the E-6A Avionics Block Upgrade TACAMO Aircraft prior to the start of scheduled developmental and operational testing. This software release enables MILSTAR Transmit Terminal interface with multicopy capability and HIDAR transmit and receive via EVS.

**Integrated Submarine Automated Broadcast Processing System (ISABPS).** Completed installation and training at NCTS Sigonella, Italy, for the ISABPS Phase 2 upgrade of the Phased Improvement Program (PIP). This installation completed the deployment of Software Release 7.2 and Rev. E hardware changes. Also completed installation, lead site testing, and training of the ISABPS Phase 3 upgrade for the PIP.

**VERDIN.** Completed and deployed Software Version 8.2 and Royal Australian Navy Version 2.0, which provides NATO STANAG 5030 capabilities. Deployed an upgrade to the VERDIN Magnetic Tape Unit programming equipment. Developed and submitted to SPAWAR a proposal to restructure the worldwide Very Low Frequency Broadcast Keying Sites architecture to save in labor and connectivity costs.

**Fixed Very Low Frequency (FVLF).** Designed, installed, and tested a prototype driver for a saturable reactor at Naval Radio Transmitting Facility, Cutler, ME. The on-the-air test demonstrated the improved performance and power savings that could be achieved.

**Enhanced VERDIN System (EVS).** Deployed Software Version 7.4 to airborne and shipboard platforms. This revised software represents the first implementation of the High Data Rate Very Low Frequency/Low Frequency communications mode for the Strategic Connectivity System.

**Circuit Mayflower Shore Automation System (CMSAS).** Successfully completed installation of "early" Phase II of CMSAS at Elmendorf AFB in Anchorage, AK, and at Special Communications Division (SPECOMMDIV), Honolulu, HI. Early Phase II was the installation of Automated Remote Workstation (ARWS) and Automated Local Workstation (ALWS) Software Version 1.1. Completed the installation of CMSAS Phase I at six SPECOMM-DIV receive sites around the world. Phase I was the installation of Master Workstation Software Version 1.2 and hardware modifications that are connected over a 1-Mbps local-area network (LAN).

**Small Talk**. Developed subminiaturized, solid-state, audio recorder to meet critical requirements of several government agencies.

**Millimeter and Microwave Integrated Circuit (MIMIC) Program.** Disseminated vendor product information in compact disk format and provided on-site seminars and training for application of MIMIC products.

**Early Operational Capability Phase II.** Demonstrated a radio frequency (RF) network supporting multiple applications. The network used multiple RF subnetworks. Supported LEDS, JOTS, and TCP/IP applications. Data were routed over HF line of sight (LOS), UHF LOS, and VHF SATCOM subnets. The system was demonstrated at sea using a ship, submarine, and two land sites.

**MILSTAR Satellite.** Supported the Air Force (AF) testing of the MILSTAR satellite. NRaD participated in the writing of the orbit test plan and supported SPAWAR PMW141 in the in-orbit testing of the EHF package of the UFO/E satellite.

**Direct Broadcast Satellite.** Demonstrated the capability of using a high-power, transmitter-equipped satellite to broadcast various data types at high data rates to a user equipped with a small satellite receiver terminal antenna.

**HF Standards.** Supported over-the-air tests of FED-STD-1052 proof-of-concept developmental modems. These modems are identical to the MIL-STD-188-110A single-tone serial modems but also incorporate powerful ARQ algorithms for error-free data delivery.

**Link-16 Training.** Provided Link-16 Communications Planning Training to Fleet Combat Training Center Atlantic instructor personnel. NRaD provided developmental training support on JTIDS through OPEVAL and was tasked with developing computer-based training for multilink operations.

**VVFD Demonstration.** Demonstrated the Voice, Video, Fax, and Data (VVFD) over full-duplex HF radios at 4800 baud. A full-duplex 9600-baud link will be completed and will incorporate a code-combining processor to allow 9600-baud full-duplex connectivity between ships for various data applications.

**HF Communications Demonstration.** Established a two-ISB (Independent Sideband) full-duplex HF link supporting 9600 bps between two NRaD buildings. This link was used to demonstrate operation of code-combining ARQ packet software. Error-free throughputs of 2000 to 8100 bps for large files (300 Kbits) were demonstrated.

**Submarine Satellite Information Exchange System (SSIXS).** Successfully completed certification of the Royal Navy SSIXS Rehost Unit. This system contains the UYK-20 emulator that replicates a UYK-20 and is hosted on a VME board in a DTC-2 chassis.

**High-Speed HF.** Operated a 4800-bps full-duplex channel over existing shipboard high-frequency radio equipment between USS *Duluth* (LPD 6) and USS *Peleliu* (LHA 5). This channel supported VVFD terminal text and image exchanges using Harris 5254C single-tone serial modems and KG-84s at ground wave distances out to 75 miles. The feasibility of extending this full-duplex link to shore was tested and verified using standard Marine Corps HF radios.

**High-Data-Rate (HDR) LAMPS MK III Communication System.** Conducted a successful test ship-to-ship encrypted video teleconferencing (VTC). During the test, T-1 (1.544 Mbps) full-duplex links were established and maintained between the two ships for a 5-hour test interval. Solid video teleconferencing was achieved on each ship, requiring only 128 Kbps of the T-1 capacity. Generally, the remaining capacity (1.416 Mbps) was used by a Firebird BER (bit error rate) link tester. The test started at 15 nmi and went out to a 20-nmi separation.

**Demonstration of UAV Target Data.** Successfully passed imagery to our Fleet Imagery Satellite Terminal (FIST) terminal, forecasting successful transfer of UAV target data and imagery from a UAV to NTCS-A, and sharing of that data with other subscribers in the Navy's UHF satellite network.

**Naval EHF Communications Controller (NECC).** Successfully demonstrated NECC. The demonstration used two subscribers (JOTS and CCMail) and one resource (EHF SATCOM). Three sites were used: NRaD, NISE West Vallejo, and Petersen AFB. A gateway functionality was also demonstrated by having electronic mail sent from Petersen AFB to NRaD via a gateway (using CCMail automatic forwarding) at NISE West Vallejo.

**Electro-Optic Electromagnetic Environment Monitoring Systems (EO-EME).** Completed (with NISE West) Phase I in-port testing of an NRaD-developed EO-EME monitoring system aboard USS *Rushmore* (LSD 47). The prototype system is based on EM field induced modulation of a laser signal coupled to an interferometric waveguide modulator. Tests indicate that a single probe, mounted near the mast, can detect and classify emissions from every topside emitter.

**Circuit Mayflower (CMF) Phase I Shore Automation.** Successfully installed Master Workstation Software Version 1.1 and made hardware modifications to the local-area network at the DMF Northwest, VA.

**Joint Air Defense Operation/Joint Engagement Zone (JADO/JEZ).** Supported JADO/JEZ near-land testing. Provided additional training in Link-16 terminal initialization and operation to support the combined Navy, Air Force, Army, and Marine multi-data link operations.

**Link-16.** Provided changes to Link-16 Network 11 loads to support video exchange between submarines and surface ships. The modified links were successfully tested aboard USS *Minneapolis/St. Paul* (SSN 708) and USS *Ticonderoga* (CG 47).

**NATO Interoperable Submarine Broadcast System (NISBS).** Successfully completed installation and testing at NCS HE Holt, Australia. The site is now operational, and the Royal Australian Navy (RAN) channel of information is completely independent from U.S. channels.

**NISBS.** Successfully installed and tested NISBS at Naval Radiating Station Aguada, Puerto Rico. NRaD delivered NISBS Software Version 2.2, provided training, and participated in site validation testing and training. The site is now operational. The site can retransmit three channels of U.S. information and one channel of NATO STANAG 5030 information simultaneously.

**Topside Antenna Placement.** Obtained an accurate numerical wire grid model–a first in the numerical modeling history of the past 20 years. The model was created with the beta version of the NEEDS 3.0 workstation developed at NRaD to calculate antenna-to-antenna coupling. The PC 1 numerical wire grid model, consisting of 1600 elements, was extracted from a 3-D solid drawing.

**Ship/Shore Connectivity.** Supported COMNAVSURFPAC and COMDESRON 33 with the installation of a fiber-optic local-area network (LAN) on USS *Rentz* (FFG 46) and subsequent wide-area network (WAN) demonstrations. The LAN will enable the ship to be a learning site in port or underway. The LAN is the medium for

transfer of documents, training, maintenance information, and remote medical expertise aboard ship. Multimedia voice, data, and video teleconferencing (VTC) was demonstrated from the ship (in port) via a fiber-optic WAN to COMDESRON 33 headquarters and then to several VTC sites connected to the Defense Commercial Telecommunications Network (DCTN).

**Tactical TCP/IP.** Successfully demonstrated a Tactical TCP/IP WAN using the Red Backbone Architecture. This multilevel security WAN is being used as the communications backbone for most of the Navy JWID demonstrations. The Common Tactical Picture was demonstrated successfully.

**Geolocation.** Installed and tested the "geolocation of RFI workstation" at the NAVAPACE Space Defense Operations Center. The system determines the source of radio frequency interference (RFI) on FLTSAT and is used for housekeeping on the UHF SATCOM network.

**POWERR.** Developed and installed the analysis system software for the Prototype Operational Workstation for EW/RFI Resolution (POWERR) at the Space Defense Operations Center at Cheyenne Mountain, SD. The system was developed to aid USSPACECOM in making hostile/friendly determinations on RFI on satellite communications.

**Multimission Antennas.** Successfully demonstrated an optically switched dipole antenna. The optically controlled switches were indium phosphide depletion mode JFETs with the gates being controlled by a photovoltaic cell. The required light power to perform switching is only 1 mW, which is considerably less than the unrealistic 500 mW for comparable photoconductive switches. This antenna could serve as the "unit cell" of a phased-array antenna supporting multiple radiation bands.

**Optoelectronics.** Demonstrated a reconfigurable antenna using optically activated field-effect transistors as the switching elements. A single antenna was shown to resonate at two different frequencies in the range from 4 to 6 GHz when an optical signal was directed onto the photo-activated switches. This program is expected to result in a significant reduction in the size, weight, and cost of multifrequency shipboard antenna systems.

**Charged-Coupled Devices (CCDs) Laser.** Received initial test results from the National Aeronautics and Space Administration's (NASA's) Jet Propulsion Lab (JPL) on CCDs laser-processed by NRaD that show a quantum efficiency (QE) of 65% at 600 nm. This exceeds that of conventional self-accumulated CCDs and those fabricated using molecular beam epitaxy techniques. Increased QE was measured over a wide range of wavelengths from 400 nm to 1000 nm. The NRaD laser process was developed for the Trident program and is being considered for use in the advanced solid-state camera for the upgraded Hubble telescope and other JPL programs.

**Integrated VERDIN Transmit Terminal (IVTT) (AN/URT-30B).** Successfully deployed IVTT system to ISABPS shore sites for VLF communications. IVTT combines commercial off-the-shelf (COTS), government off-the-shelf (GOTS), and an electrical enclosure shelf designed and fabricated at NRaD to replace the AN/URT-30 VERDIN transmit set, which is becoming unsupportable.

## OCEAN 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. FY 94 program accomplishments in ocean surveillance included the following.*

**Multimission Advanced Tactical Terminal (MATT).** VAQ-209 installed a MATT in one squadron aircraft and participated in the Radiant Oak Concept Demonstration. VAQ-209 successfully launched the first operational improved warhead High-Speed Anti-Radiation Missile (HARM) against a ship at sea using over-the-horizon targeting data from national systems delivered directly to the AE-6B cockpit in near real time (NRT).

**Spinnaker Arrays.** Recovered Spinnaker lightweight, low-power, demonstration arrays (deployed for the Site Specific Experiment) in fully operational, "live" (fully functional status) after the experiment. A digital recorder designed by the Marine Physical Laboratory (MPL) was interfaced to the arrays in the NRaD laboratories, and the arrays were tested in the laboratory to identify the source of any problems seen during the experiment. The technology and techniques developed open new possibilities in ocean array deployment and use.

**CERCIS (NSA).** Completed delivery of CERCIS 30. Software was transmitted to NSA using GCS connectivity from NRaD. The 3.0 release provides full functional replacement for the NRaD-developed SCORE/SURF systems currently in operational use. Provided on-site training.

**dB MASTER.** Released dB MASTER. This analytical reference tool, portable to SUN Sparc workstations, provides on-line access to a variety of intelligence reference material. dB MASTER is operational at JICPAC, SOCPAC, USSOCOM, USACOM JIC, and additional shore sites.

**Cryptologic Unified Build (CUB) 1.1.** Performed formal integration for the CUB 1.1 Release. This release is a major milestone in the development of an open systems architecture for afloat cryptologic applications that is JMCIS Unified Build compliant.

**CUB 1.2.** Successfully completed TECHEVAL Development Test (DT) of CUB 1.2 software developed by NRaD, with support from NRaD Det Philadelphia, NISE East, and several support contractors.

**SURTASS T-AGOS 21 Certification Test.** Conducted a successful At-Sea Certification Test aboard USNS *Effective* (T-AGOS 21). NRaD served as the Test Director and the Acoustic Principal Investigator. T-AGOS 21 was recommended to be certified for IOC.

**TRAP Data Dissemination System Source Input Installation.** Completed installation and testing of a source input capability for Joint INTEL Center, Pacific (JICPAC). This capability allows JICPAC to directly inject its data onto the TRAP broadcast. It now takes under 30 seconds for the data to be sent by TRAP vice up to and exceeding 10 minutes via the previously used method.

**Ocean Temperature Sensor Array.** Fabricated a lightweight, low-power, ocean temperature vertical sensor array using Spinnaker technology. The array was suspended from the Floating Instrument Platform (FLIP) for the Shallow-Water Environmental Cell Experiment-3 (SWEllEx-3); the array continuously measured ocean temperatures through the water column to monitor ocean climactic conditions during SWEllEx-3, an ocean surveillance validation experiment.

**Mobile Detection Assessment Response System (MDARS).** Completed Category II system tests at Camp Elliott; more than 50 individual tests were successfully completed.

**Trident Stellar Sensor Arrays.** Demonstrated good functional yields in two recent lots of Trident stellar sensor arrays following major changes in processing parameters. A significant reduction in gate oxide thickness (from 100 nm to 50 nm) was introduced to reduce radiation sensitivity and to reduce the cost of the sensor array by eliminating a troublesome yield-limiting problem.

**Shallow-Water Environmental Cell Experiment-3 (SWEllEx-3).** Completed SWEllEx-3. The experiment gathered acoustic and environmental data to validate NRaD shallow-water surveillance techniques, including arrays, models, and signal processing. The experiment included over 100 source tows, over 300 full-water-column envirnomental profiles, and included such novel tests as aircraft-to-water acoustic coupling, mine laying acoustic detection, "croaker" (fish) noise chorus background characterization, and broadband matched-field processing detection.

**3-D Acoustic Simulations.** Employed Dr. Homer Bucker's 3-D Gaussian Beam model in a series of acoustic simulations of Advanced Deployable System (ADS) array concepts, using a topographically complex Mediterranean site. Dr. Bucker's model is the only acoustic model in the world to fully incorporate 3-D topography effects in a manner computationally efficient enough for extended studies. Including 3-D effects had a clear impact on the simulation results.

**Man-Transportable Special (MTS) Operations Command Research, Analysis, Threat Evaluation System (SOCRATES) .** Successfully demonstrated MTS at the Joint Warrior Interoperability Demonstration. The demonstration included establishing connectivity to the Atlantic Intelligence Center (AIC) in Norfolk, VA, via the Special Operating Forces-Intelligence Van (SOF-IV), which uses secure UHF communications.

**MAGELLAN II.** Conducted Magellan II, a highly successful multiple platform passive and active multistatics exercise, off the California coast. Air, surface, and submarine platforms operated as bistatic receivers in conjunction with SURTASS/LFA. With the addition of a passive towed array and the TX processing upgrade to the LFA transmit system on Cory Chouest, this was the first fielding of SURTASS/LFA active and passive systems integrated on the same platform.

**SURTASS Block Upgrade (SBU) TECHEVAL.** Conducted SBU TECHEVAL aboard USNS *Able* (T-AGOS 20). End-to-end system performance was verified and SBU was certified ready for Operational Evaluation (OPEVAL). The SBU improvements include the Reduced Diameter Array, providing greater array gain, and processing upgrades hosted on COTS hardware.

**ADS Milestone I.** Successfully completed Advanced Deployable System (ADS) Milestone I. The efforts of four prime contractors, NRaD, and SPAWAR culminated in four concept designs. LORAL Federal Systems, teamed with Alliant Tech Systems, was selected to continue into the demonstration/validation phase with the development of a prototype. ADS will provide the Fleet a quickly deployable surveillance system that will be integrated into joint operations.

**Advanced Deployable Array (AdDA).** Fielded the AdDA Acoustic Measurement System, developed and built at NRaD, in the Mediterranean Sea as part of the Office of Naval Research's (ONR's) Shallow Water Active Classification (SWAC) experiment. Bistatic active and passive wideband submarine signature data and environmental data were collected. High-fidelity data recordings were produced for various 6.2 exploratory development projects and assessment of detection and classification algorithms. The SWAC exercise series will develop and coordinate a series of shallow water, multistatic data collection and technology development demonstration opportunities in cooperation with associated 6.2 and 6.3 projects at several Navy laboratories and the Strategic Air Command Atlantic (SACLANT) Center.

**Expeditionary Warfare Support.** Conducted a near-shore surveillance experiment off Camp Pendleton using full-scale models of U.S. and foreign bottomed mines. Acoustic, seismic, and electromagnetic sensors were used to characterize the minelaying vessel and operation. Recorded minelaying event data will be used to design and assess future littoral surveillance systems.

**Non-Acoustic Distributed Systems Components (NDSC).** Developed a Laser Intra-Cavity Magnetometer using innovative magneto-optic technology that has the potential to be smaller, more sensitive, and less costly than existing magnetometers. Electromagnetic and acoustic data fusion algorithms were demonstrated that provide a precise target track using a single sensor.

**MERLIN.** Began Project MERLIN. The goal is to develop an architecture and mature the technology to support a network of autonomous sensors in a seamless web in coastal waters and extending onto shore.

**Relocatable-Over-The-Horizon Radar (ROTHR).** Monitored the ROTHR-Texas installation/system integration and functioned as Test Director during acceptance testing. Specific responsibilities included coordinating/acquiring flight services, final approval for all test plans/procedures, collecting performance data, and conducting analysis to determine performance acceptance criteria. At testing conclusion, NRaD was responsible for reviewing and approving all acceptance test reports and providing an acceptance recommendation to the Commanding Officer, Fleet Surveillance Support Command.

**Integrated Undersea Surveillance System (IUSS).** Supported the FDS SSIPS and SDS deployment to an operational site. In addition to technical review and systems engineering support of the development contractor, the current software (build 4) will undergo IV&V by the NRaD team in the STIC.

**Fixed Distributed System (FDS).** Successfully tested a deployable version of FDS in the Mediterranean Sea. The 2-month exercise demonstrated the performance of a distributed field of acoustic sensors operating in a littoral region.

**Theater Acoustic Warfare (ThAW).** Conducted a sensor data study to describe the many sensor types in a theater and the parameters that each can measure. Two classification methods have been in development: a Pearl tree connected to the ORCA tracker and a fuzzy-conditioned-Dempster-Shaffer algorithm. These will be tested and documented in July 1995; development for theater applications will be completed.

## MARINE SCIENCES AND TECHNOLOGY

*NRaD provides ocean engineering expertise in the areas of undersea research, survey, 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. Such work has also resulted in improved diagnostic and treatment techniques for marine mammals.*

*FY 94 program accomplishments in marine sciences and technology included the following.*

**Unmanned Aerial Vehicle (UAV).** Supported the first demonstration of the Army Short-Range UAV aboard a Navy ship. The test demonstrated the physical compatibility of the UAV with the ship. The demonstration consisted of repeated launches, fly-bys, touch-and-gos, and landings.

**Mobile Detection Assessment and Response System.** Installed a K2A robotic platform along with the latest Multiple Robot Host

Architecture software, officially marking the beginning of Category II software field development.

**Waterside Security System (WSS) $C^3$ Display.** Successfully completed the First Article Acceptance Test on the WSS Command, Control, and Communications Display.

**WSS Sonars.** Successfully installed and tested two sonars. The sonars included the CSAS-80, a sonar developed by C-Tech of Canada for the Swedish Navy, and the AN/WQX-2, a sonar developed by ARL/UT under the Navy's Shipboard Physical Security program.

**WSS-Bangor.** Completed the non-sonar component installation at NAVSUBASE Bangor.

**Marine Mammal Training.** Completed training for all Mk 4 and Mk 7 animals in fleet systems and spares for shipboard forward deployment; passed initial certification tests in preparation for participation in RIMPAC. This training allows fleet marine mammals to be housed and worked from onboard ship as part of the Advance Force or the MCM Task Force.

**RIMPAC.** Three Marine Mammal Systems (MMS) participated in RIMPAC 94. The Mk 4 and Mk 7 MMS were deployed aboard ship where they demonstrated that they could be transported with the MCM Task Force and work from shipboard without any modifications to the ship. During RIMPAC, these MMS were fully integrated into MCM operations, employing common GPS navigation and $C^3$ systems. Both systems performed above required system specifications and showed the ability to work in high seas and high-clutter areas without significant degradation.

**Marine Mammal Program Review.** Successfully passed DoD review of marine mammal program and facilities. A Congressional mandate required DoD to review every program, project, or activity using live animals in research to ensure and certify humane use. All aspects of the program were reviewed including facilities, medical capabilities, marine mammal training and work, research, and documentation.

**Sensory System Evaluation.** Conducted a sensory system medical evaluation on a stranded pygmy sperm whale to determine if the whale was suitable for return to the wild. This was the first time sensory capabilities of this species of whale were evaluated. Also, this was the first time auditory information was collected on this species and only the second time sonar pulses were recorded.

**Ceramics Pressure Housings.** Completed a successful pressure test of a 25-inch-diameter alumina ceramic hemispherical end closure. Testing included a single pressurization to 10,000 psi with a 1-hour hold, followed by 500 cycles to 9000 psi. The assembly survived the test with no structural degradation.

**Missile Motor Railcar Transporter (MMRT) Environmental Controller.** Completed successful initial testing of MMRT Global Positioning System (GPS)/Cellular tracking prototype at Magna, UT. Preliminary test results indicate that automatic dial-up and transmission of position data to the San Diego prototype base station were successfully achieved.

**Marine Aerosol Properties and Thermal Imager Performance (MAPTIP).** Cooperated with laboratory representatives from seven other NATO nations in a month-long effort collecting meteorological and infrared transmission data off the coast of the Netherlands. Initial analyses have yielded insights to processes in the coastal region affecting electro-optical propagation. A successor experiment in Electro-Optical Propagation Assessment in Coastal Environments (EOPACE) is in the planning stage to focus more specifically on effects in the littoral.

**Variability of Coastal Atmospheric Refractivity (VOCAR).** Completed experiment (with Naval Air Warfare Center [NAWC] Weapons Division, NRL, and NPS) to examine variability of radio refractivity in the southern California coastal area. Radio and meteorological data were collected for almost a year, with an intensive field measurement period for 2 weeks in August and September 1993. Subsequent analyses of these data are providing validation of propagation models, improvements to data assimilation and numerical weather prediction models, and refinements to conventional meteorological analysis.

**Advanced Unmanned Search System (AUSS).** Successfully delivered the AUSS, an untethered, computer-controlled underwater vehicle, to the Navy Supervisor of Salvage in late FY 94. AUSS is designed to locate, identify, and inspect objects on the ocean bottom at depths from 2000 feet to 20,000 feet. AUSS provides a rapid search and survey capability covering all but the ocean's deepest trenches. AUSS significantly improves overall deep-water search rates by eliminating the greatest operational problem that exists with state-of-the-art deep-depth search systems, the tether or umbilical cable.

**Flying Plug.** Successfully performed autonomous underwater docking procedures with the Flying Plug underwater vehicle. These docking tests were conducted in NRaD's TRANSDEC test pool from a distance of 100 feet. The vehicle docking sensor consisted of a four-quadrant photodetector and hyperfocal lens. The vehicle control system was programmed to center the image formed by a white light source located at the docking station. The optical docking sensor was miniaturized and interfaced to a single board processor that provided the docking signal detection function and output the digitized error signals to the main vehicle controller.

**Haselton Propulsion System.** Completed the fabrication of an improved, seaworthy, configuration of the omnidirectional Haselton propeller. The 40-inch-diameter, titanium and stainless steel propeller can produce thrust in any direction. The propeller and brushless DC motor assembly successfully completed performance and endurance testing and is ready for sea trials.

**Sonobuoy Quality Assurance Program.** Successfully completed 41 sonobuoy production tests during 63 test days at the San Clemente Island test range. These production tests represent over 80,000 units delivered to the Fleet. Also successfully completed 13 engineering tests and three new design qualification tests. All tests were conducted from Range Control II at San Clemente Island.

**USS *Dolphin* (AGSS 555).** The Navy's only operational, diesel-electric, deep-diving, research and development submarine returned to home port at NRaD after an extensive 2-year overhaul. *Dolphin* is now available as a cost-effective platform for both scientific research and test and evaluation programs. The submarine can be modified internally or externally to allow installation of specialized equipment. *Dolphin* may also function as a threat diesel-electric or target vehicle for the evaluation of emerging surveillance or ASW technologies.

**Ceramic Pressure Housings.** Completed a successful testing program characterizing the structural performance of four advanced ceramic compositions for use as external pressure housings. Conducted a pressure testing program for a 32-inch-diameter alumina ceramic hull, representing the largest housing of this type ever assembled. Finished publication of 15 NRaD technical reports and documents addressing all aspects of design, analysis, material selection, inspection, and assembly of ceramic pressure housings for deep-submergence applications.

**Spinnaker Arrays.** Successfully deployed temporary active arrays using Spinnaker technology in the Arctic, meeting a key milestone. The active arrays detected several local events, and an ocean-climatology beacon, operating on the opposite side of the Arctic Ocean, demonstrated the Array Element Localization subsystem; in general,

the arrays operated at or above expected performance levels. New technology made possible further improvements in Spinnaker array design and manufacture, including improved electronics and a new, superior, potting technique developed by the Spinnaker array group. The lightweight, low-power, Spinnaker acoustic array technology makes possible array deployments at sites and under conditions that would otherwise be impossible, but is also less expensive than other array technologies.

**Matched-Field Acoustic Processing (MFP).** Demonstrated advanced MFP techniques through analysis of the productive Shallow-Water Environmental Cell Experiment-3 data. Both broadband MFP and matched-field tracking were demonstrated to be effective in enhancing signal-to-noise ratios (SNR) and in improving detect-and-classify system performance. In this pioneering approach, detection was demonstrated at an SNR of 10 dB using advanced MFP techniques in a typical, noisy, shallow-water coastal environment reflecting common conditions, not conditions optimized for detection. Further analysis was made of biological interference from fish "croaker" choruses.

**Advanced Acoustic Simulations.** Adapted the 3-D Gaussian Beam ocean acoustic propagation model for use in the global-warming acoustic tomography program, which seeks to measure possible global climate changes by acoustically monitoring average ocean temperatures. The model accurately accounts for 3-D propagation effects over acoustic paths that may reach half the global circumference. Released advanced acoustic models that predict the complex environmental noise fields encountered in littoral regions, and that account for the complex interaction of acoustic signals with range-varying viscoelastic bottoms.

**Ultra-Lightweight Array Technology.** Initiated a new project to develop ultra-lightweight ocean acoustic array technology optimized for covert deployment, extreme forward deployment, acoustic barrier monitoring, and other potential uses as part of a suite of acoustic surveillance technology. Entire arrays could be stored in and deployed from a few cubic feet. Technological feasibility was demonstrated, and a mock-up array was used to successfully demonstrate a new surveillance-array deployment technique.

## ENVIRONMENTAL TECHNOLOGY

*NRaD 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. FY 94 program accomplishments in environmental technology included the following.*

**Site Characterization and Analysis Penetrometer System (SCAPS).** Completed SCAPS assessment work for the State of California. The operation was a success, with approximately 30 pushes (profiles) conducted to document the extent of contamination.

**SCAPS.** Deployed SCAPS EDM-1 system to NAS Alameda with significant results; the probe in use was the first NRaD product. Engineering Development Model-1 was scheduled to operate at the Marine Corps Air Station (MCAS), Yuma; potential site assessment cost savings of $1M were identified. Completed field operations, Yuma. Twenty-three pushes were made, with a 72-foot maximum depth. Pre-deployment efforts began for Marine Corps Base (MCB), Camp Pendleton.

**Community Environmental Activity.** Presented a summary of our work in San Diego Bay at a Navy-sponsored San Diego Bay Sediment Monitoring and Testing Workshop attended by many local, state, and federal agencies and environmental firms.

**PCB Detector System.** Demonstrated the NRaD-developed portable PCB Detector System at the Puget Sound Naval Shipyard. This system will save substantial analytical costs by rapidly measuring PCB contamination on decommissioned submarines prior to disposal, thus expediting cleanup procedures.

**Organotin Monitoring on USS *Leftwich* (DD 984).** Monitored organotin levels of USS *Leftwich* during removal of the ship's organotin antifouling paint. USS *Leftwich* is the last U.S. Navy ship still coated with organotin antifouling paint; this completed a 20-year history of the Navy's research and testing of these coating systems.

## MICROELECTRONICS

*NRaD conducts broad spectrum RDT&E in microelectronics science and engineering in support of Navy and NRaD mission areas. FY 94 program accomplishments in microelectronics included the following.*

**InP Transistor.** Developed a high-performance indium phosphide optoelectronic switching transistor for the Microwave Antenna Program. The transistor yields an ON resistance of less than 7 ohms and an OFF resistance in the range above 10K ohms. Such devices are expected to play a major role in the Wireless Reconfigurable Antenna.

**Sensor Arrays.** Fabricated sensor arrays with a functional yield exceeding 70%. The NRaD Microelectronics Facility used a new process designed to enhance the reliability of Trident stellar sensor arrays. This new process uses implants of an ionic species known to improve the reliability and longevity of integrated circuits that must be stored and operated in adverse environments.

**Multilayer Wafers.** Verified the structural configuration of organometallic vapor phase epitaxial (OMVPE)-grown indium phosphide (InP)/indium gallium arsenide (InGaAs) multilayer wafers produced by NRaD. Carrier concentration profiling measurements were made to verify the configuration. The NRaD power transistor group is currently using these wafers in the development of microwave/mm-wave heterojunction bipolar transistor (HBT) devices that are expected to play a major role in Navy electronic warfare, surveillance, missile guidance, and satellite communications systems.

**Polarization Independent Narrow Channel (PINC) Wavelength Division Multiplexing (WDM) Fiber-Optic Coupler.** Investigated the feasibility of compressing the wavelength channel separation of NRaD's in-house-developed PINC WDM fiber-optic coupler to 8 nanometers (nm); the channel wavelengths are in the 1550-nm region where fiber loss is a minimum and erbium-doped fiber amplifiers (EDFA) operate. Previously, NRaD demonstrated channel separations as small as 16 nm. Loss is extremely low, on the order of a few tenths of dBs, and cross-talk is less than 3%.

**Microelectronics Project.** Successfully fabricated 100x100-synapse, 100-neuron analog neural network (ANN) integrated circuit in fully depleted 100-nm thin-film silicon on sapphire (TFSOS). Preliminary characterization indicates that programming and learning have been demonstrated. The ANNs are pervasive and applicable to as varied (littoral/space/surveillance) warfare scenarios as space, antisubmarine warfare (ASW), avionics, missiles, and mines/mine countermeasures. Pattern recognition and image processing are the main military applications for implementation. Commercial applications (identification/classification and signature/speech recognition) are found in banking, perimeter surveillance, and law enforcement.

**Ion-Sensitive Field-Effect Transistor (ISFET).** Completed and delivered the first full lot of chemical sensors based on the ISFET to UNIFET, a local company specializing in silicon-based chemical and biological measurement instruments. Very high yield was obtained on devices showing excellent electrical characteristics and high chemical sensitivity. A cooperative research and development agreement (CRADA) with UNIFET will cover the joint development of new sensors and sensors integrated with on-chip electronics.

## 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. FY 94 program accomplishments in navigation included the following.*

**Standoff Land Attack Missile (SLAM) Global Positioning System (GPS).** Installed an NRaD-developed SLAM GPS initialization system aboard USS *George Washington* (CVN 73) in Norfolk, VA. Trained ship's personnel on the proper operation of the system. Nearly every carrier has had one of these systems installed.

**Precision Lightweight GPS Receivers (PLGRs).** Received the first shipment of PLGRs for fleet distribution.

**Position Locating and Reporting System (PLARS) Testing.** Successfully installed AN/WRN-6 equipment suites aboard four amphibious ships, in support of the AN/KSQ-1 (PLARS) DT IIA testing for the Naval Surface Warfare Center Coastal Systems Station, Panama City, FL. Provided technical support of large-scale, at-sea amphibious exercises to validate operation and usability. Trained ships' force personnel in the operation and maintenance of the GPS user equipment. The installation, complicated at-sea amphibious exercises, and deinstallation were successfully carried out in a very brief time frame.

**AN/WRN-6 Installation.** Delivered, installed, and verified operation of a keyed AN/WRN-6 receiver to Research Vessel RV *Knorr* in support of Woods Hole Oceanographic Institute project in Jacksonville, FL.

**Navigation Sensor System Interface (NAVSSI).** Completed development of a NAVSSI module to allow NAVSSI availability at any NTCS-A terminal. This is a major step required to fully integrate the NAVSSI into the Joint Maritime Command Information System (JMCIS) program.

**Sensor Fusion Program.** Successfully launched and tested GPS Integrated Target Spheres at Hill AFB. They were developed for testing missile targeting accuracy. Optical and GPS tracking data were combined to generate highly accurate trajectories.

**NAVSSI Surface Ship Block 0.** Received milestone IIIa approval. Thirty-five systems are now scheduled for procurement and installation on cruisers and destroyers.

**GPS Interface Unit (GPSIU).** Participated in a major 1-month Navy and Marine amphibious assault exercise at Camp Pendleton, CA, to aide in installing and testing the NRaD-developed GPSIUs. The GPSIU integrates GPS latitude and longitude information into the Position Locating and Reporting System (PLARS) for use within the AN/KSQ-1 Amphibious Assault Direction System. Results showed that the GPSIU enhanced the performance of the PLARS significantly.

**Ocean Survey System.** Successfully completed the second and final at-sea TECHEVAL of the major Ocean Survey System upgrade aboard USNS *Wyman*. This upgrade increases survey system capability and provides the Naval Oceanographic Office (NAVOCEANO) with its first multimission-capable survey platform.

**GPS/Electrically Suspended Gyro Navigator (ESGN).** Completed installation, checkout, and training on a Pacific Fleet SSN 637 Class Fast Attack Submarine at Mare Island Shipyard in Vallejo, CA. This installation consisted of the addition of GPS/ESGN and GPS/precise time interfaces to the existing AN/WRN-6 configuration on board.

**Ring Laser Gyro Navigation (RLGN).** Completed development of an RLGN system specification for U.S. Navy submarine and surface combatant platform applications.

**Data Refinement System (DRS).** Completed the installation and testing of a DRS at the United Kingdom Hydrographic Office in Taunton, England. In addition, NRaD provided training to UK personnel on operation of the system. The DRS will be used by the UK Hydrographic Office to refine the bathymetric data that will be collected and preprocessed onboard the UK Ocean Survey Vessel that will be equipped with the bathymetric survey system developed at NRaD Warminster.

## INDEPENDENT RESEARCH (IR)

*Independent Research (IR) programs support initial research in many areas of interest to the Navy, including command, control, communications, ocean surveillance, and navigation. FY 94 accomplishments in Independent Research included the following.*

**Impulse Radio Characteristics at VHF Frequencies.** Developed equipment for the investigation of impulse radio characteristics at VHF frequencies.

**Tidal Dispersion Mechanisms.** Developed a one-dimensional scaling model of enhanced dispersion mechanisms and conducted experiments in San Diego Bay to test the model.

**Matched-Field Tracking.** Developed a matched-field tracking algorithm for shallow-water acoustic applications.

**Logic of Generalizations and Exceptions.** Constructed a logic of generalizations and exceptions based on Ernest Adams' logic of conditionals and a heuristic principle.

**Variability in HF Propagation Parameters.** Obtained a variability index, based on HF data taken in San Diego, which describes the degree of variability to be expected in HF propagation parameters.

**Wavelets for Ultrabroadband Radar.** Formulated a general theory for the inversion of discrete nonorthogonal wavelets. Developed Morlet wavelet analysis software and applied it to ultrabroadband radar data.

**UV and Blue Laser Source.** Developed a high-power, efficient, multiwavelength blue laser source from ND:YAG. The multiwavelength laser was doubled to UV for laser communications.

**Large Sparse Systems of Equations.** Developed a new algorithm for solving sets of linear equations involving sparse, structurally symmetric matrices that compares favorably to the best methods currently in use.

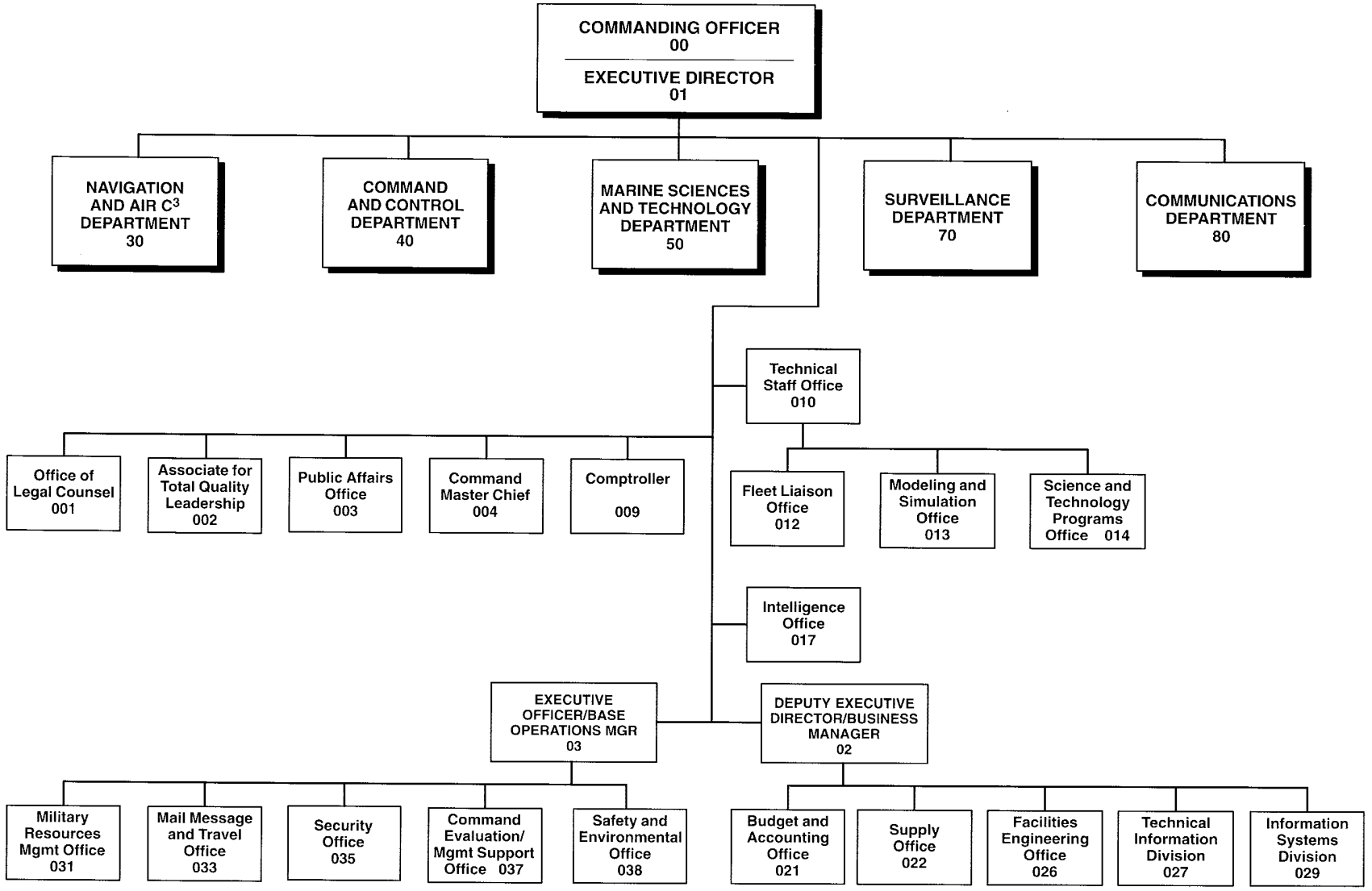
**Adaptive Equalization for High-Data-Rate Communications.** Obtained and evaluated adaptive blind equalization algorithms used in suppressing intersymbol and other additive interference in high-data-rate communications applications.

**Standard Colorimetry Equations for Color Mixing.** Showed that the standard color mixing equations lose accuracy when dealing with highly saturated laser light in the red or blue.

**Optical Ringing in Marine Water.** Demonstrated a possible link between optical ringing and the excess light that is often seen in underwater LIDAR measurements.

**Artificial Neural Network (ANN).** Demonstrated an analog 100x100-synapse, 100-neuron ANN, with parallel, onboard (i.e., on-chip) learning. This milestone alleviates difficulties and pitfalls of the past by implementing a promising ANN algorithm in hardware. This learning algorithm and the circuit designs to implement it have been developed from inception at and patented by NRaD; the architecture is that of a Multilayer Perceptron (MLP) with a modified trinary form of back-propagation learning (also patented by NRaD) that estimates posterior probabilities. This architecture is useful for generic function approximation (in deterministic and stochastic environments), acquired by supervised training.

# NCCOSC RDT&E DIVISION ORGANIZATION




95015006

# PERSONNEL DATA

| TOTAL ON BOARD | TOTAL MILITARY | TOTAL CIVILIANS | FTP[1] | TPTI[2] | FTP UNGRADED |
|---|---|---|---|---|---|
| 2879 | 95 | 2782 | 2746 | 8 | 28 |

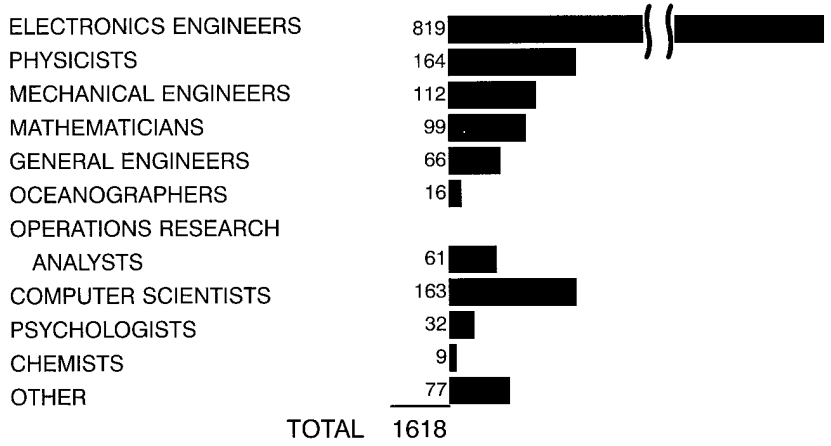
**FTP GRADED**

2746

ADMINISTRATIVE ..... 242
TECHNICIANS ..... 248
SCIENTISTS AND ENGINEERS ..... 1618
TECHNICAL SPECIALISTS ..... 282
CLERICAL ..... 356

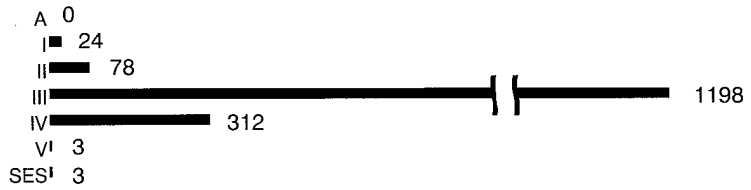
1 Full-time, permanent civilian personnel
2 Temporary, part-time, intermittent civilian personnel subject to manage-to-payroll (MTP) controls.

**FTP GRADED SCIENTISTS AND ENGINEERS**




CIVILIAN BUDGETED END-STRENGTH:
FTP AND TPTI (COMBINED) ..... 3006
MILITARY ALLOWANCE:
OFFICERS 45, ENLISTED 50 ..... 95

**SCIENTISTS AND ENGINEERS BY DEMO PROJECT LEVEL[3]**




TOTAL: 1618

3 NRaD is participating in a Demonstration Project under Title VI of the 1978 Civil Service Reform Act. The pay classification system has been restructured into five levels of classification as follows: Level I, GS 5-8; Level II, GS 9-11; Level III, GS 12 and 13; Level IV, GS 14 and 15; Level V, GS 16+.

**DEGREES — CIVILIAN FTP PERSONNEL**

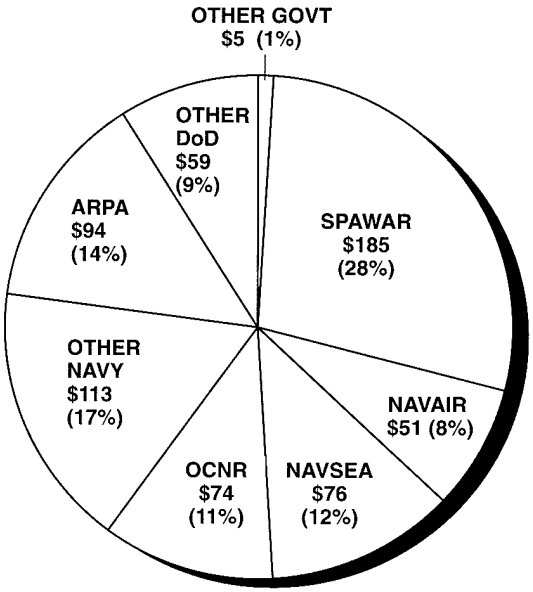
| | PhD | DVM | MS/MA | BS/BA |
|---|---|---|---|---|
| SCIENTISTS & ENGRS | 190 | 1 | 586 | 834 |
| OTHER CIVIL SERVICE | 7 | 0 | 78 | 301 |
| TOTAL | 197 | 1 | 664 | 1135 |

95015002/2

# FUNDING BY SPONSOR

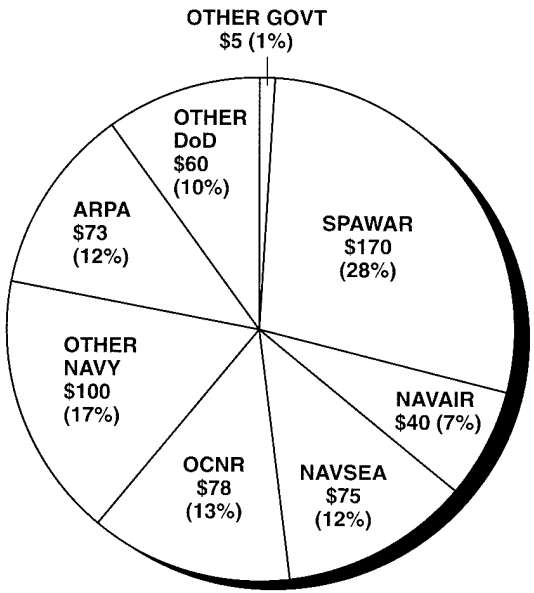
## NEW ORDERS RECEIVED ($ IN MILLIONS)

### FY 1994
ACTUAL $657*



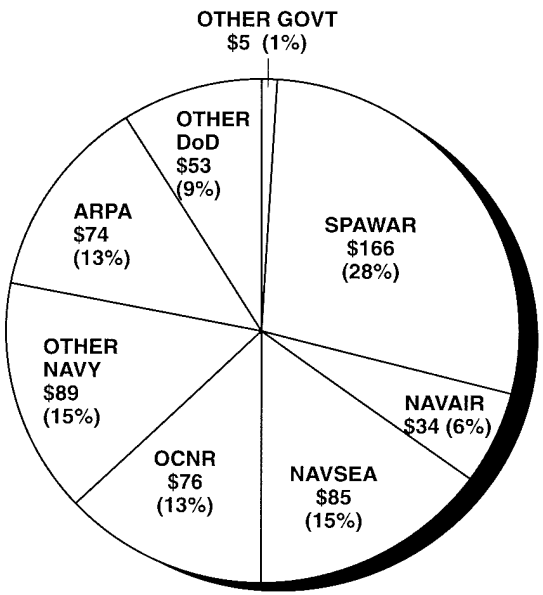

*Includes Direct Cites $207 million

### FY 1995
ESTIMATED $601*




*Includes Direct Cites $219 million

### FY 1996
ESTIMATED $582*




*Includes Direct Cites $207 million

Direct Cites - Requests for Contractual Procurements (RCPs) and Military Interdepartmental Purchase Requests (MIPRs). Financed directly by sponsor rather than NRaD Defense Business Operations Fund NIF account.

015003/2

# FUNDING BY CATEGORY AND TYPE

**NEW ORDERS RECEIVED ($ IN MILLIONS)**

| CATEGORIES & TYPE | FY 1994 | | | FY 1995 | | | FY 1996 | | |
|---|---|---|---|---|---|---|---|---|---|
| | $M ACTUAL | % of RDT&E | % of TOTAL | $M ESTIMATED | % of RDT&E | % of TOTAL | $M ESTIMATED | % of RDT&E | % of TOTAL |
| RDT&E CATEGORY | | | | | | | | | |
| 6.1 RESEARCH | 9 | 2 | 1 | 8 | 2 | 1 | 8 | 2 | 1 |
| 6.2 EXPLORATORY DEVELOPMENT | 85 | 22 | 13 | 88 | 23 | 14 | 92 | 23 | 17 |
| 6.3a/6.3 ADVANCED TECHNOLOGY DEVELOPMENT | 91 | 24 | 14 | 70 | 19 | 12 | 65 | 19 | 11 |
| SUBTOTAL | 185 | 48 | 28 | 166 | 44 | 27 | 172 | 44 | 29 |
| 6.3b/6.4 ADVANCED DEVELOPMENT | 52 | 14 | 8 | 66 | 18 | 11 | 70 | 19 | 12 |
| 6.4/6.5 ENGINEERING DEVELOPMENT | 61 | 16 | 9 | 67 | 18 | 11 | 70 | 18 | 12 |
| 6.5/6.6 MANAGEMENT AND SUPPORT | 14 | 4 | 2 | 7 | 2 | 1 | 6 | 1 | 1 |
| 6.6/6.7 OPERATIONAL SYSTEMS DEVELOPMENT | 69 | 18 | 11 | 66 | 18 | 11 | 64 | 17 | 11 |
| SUBTOTAL | 196 | 52 | 30 | 206 | 56 | 34 | 210 | 56 | 36 |
| TOTAL RDT&E | 381 | 100 | 58 | 372 | 100 | 61 | 375 | 100 | 65 |
| OPER. & MAINT., NAVY (O&MN) | 95 | | 15 | 95 | | 17 | 88 | | 15 |
| OTHER PROCUREMENT, NAVY (OPN) | 94 | | 14 | 74 | | 12 | 65 | | 11 |
| WEAPONS PROCUREMENT, NAVY (WPN) | 8 | | 1 | 7 | | 1 | 6 | | 1 |
| SHIPBUILDING & CONVER., NAVY (SCN) | 18 | | 3 | 16 | | 3 | 14 | | 2 |
| AIRCRAFT PROCUREMENT NAVY (APN) | 8 | | 1 | 7 | | 1 | 6 | | 1 |
| OTHER NAVY | 6 | | 1 | 6 | | 1 | 6 | | 1 |
| ALL OTHER | 47 | | 7 | 24 | | 4 | 22 | | 4 |
| OTHER APPROPRIATION SUBTOTAL | 181 | | 42 | 229 | | 39 | 207 | | 35 |
| TOTAL | 657 | | 100 | 601 | | 100 | 582 | | 100 |

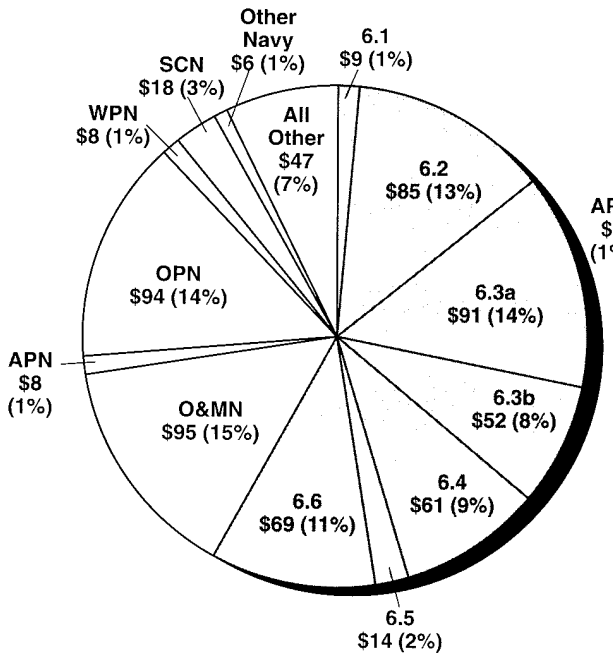
*In FY 95, 6.3a changes to 6.3, 6.3b to 6.4, 6.4 to 6.5, 6.5 to 6.6, and 6.6 to 6.7.*

# FUNDING BY APPROPRIATION

NEW ORDERS RECEIVED ($ IN MILLIONS)

## FY 1994

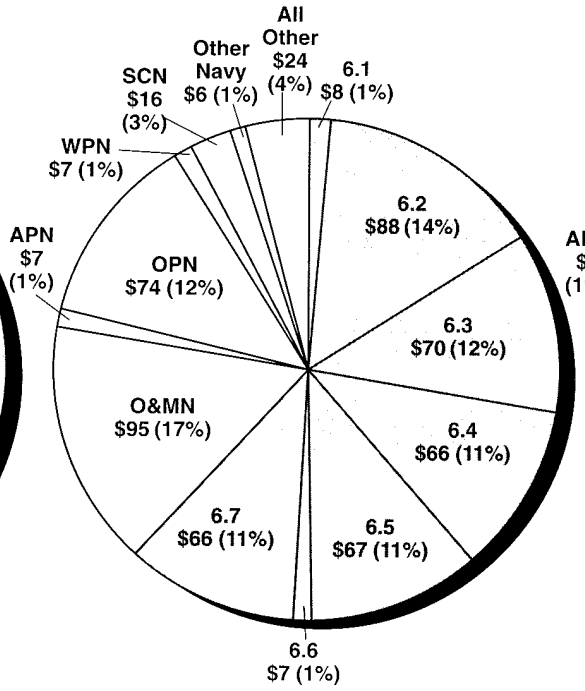
ACTUAL $657*




*Includes Direct Cites $207 million

## FY 1995

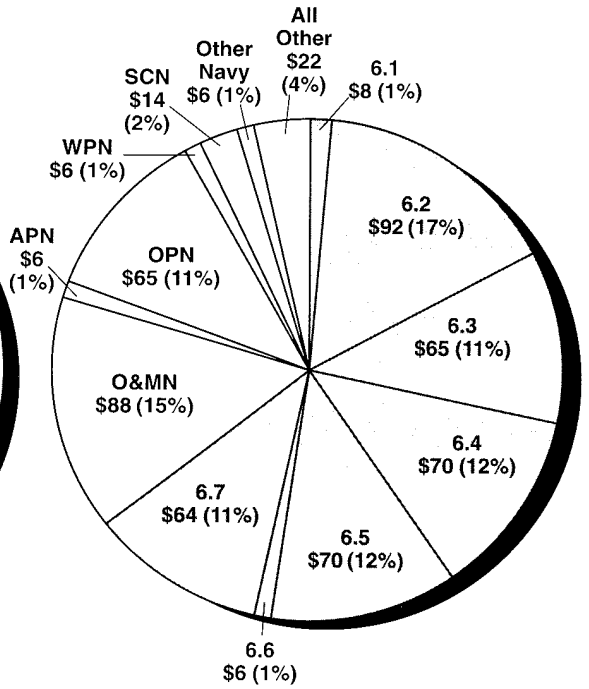
ESTIMATED $601**




**Includes Direct Cites $219 million

## FY 1996

ESTIMATED $582*




*Includes Direct Cites $207 million

*In FY 95, 6.3a changes to 6.3, 6.3b to 6.4, 6.4 to 6.5, 6.5 to 6.6, and 6.6 to 6.7.*

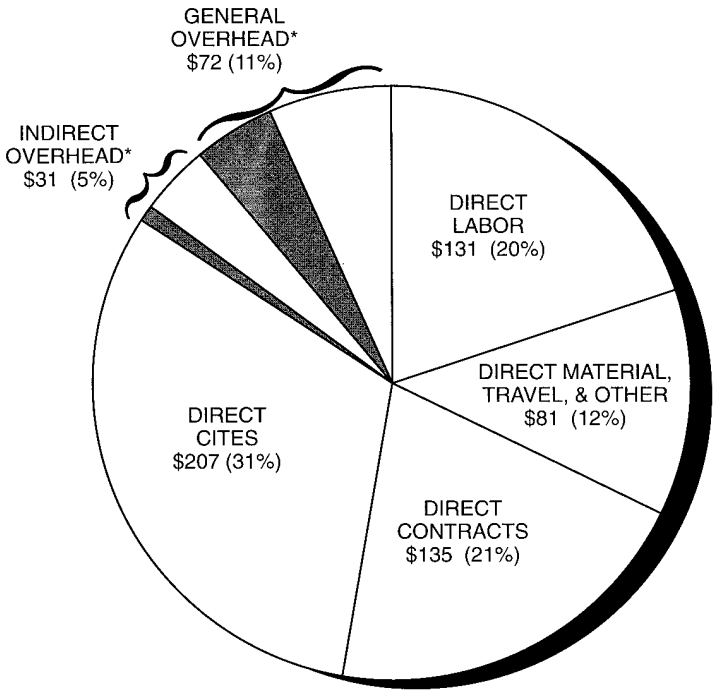
☐ RDT&E FUNDS

95015004/2

# DISTRIBUTION OF FUNDS

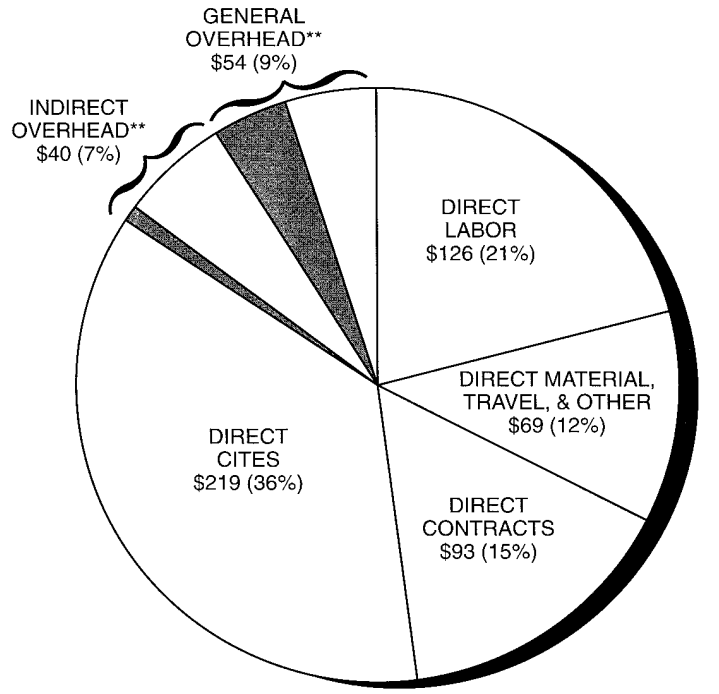
($ IN MILLIONS)

## FY 1994
ACTUAL $657




* Contracted out:
Indirect Overhead $6 (19%)
General Overhead $29 (40%)

## FY 1995
ESTIMATED $601




** Contracted out:
Indirect Overhead $5 (12%)
General Overhead $24 (44%)

95015005/1

# ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| ABNCP | Airborne Command Post |
| ACDS | Advanced Combat Direction System |
| ACMS | Automated Communications Management System |
| AdDA | Advanced Deployable Array |
| ADS | Advanced Deployable Surveillance |
| AF | Air Force |
| AFWTF | Atlantic Fleet Weapons Test Facility |
| AFWTF | Atlantic Fleet Weapons Training Facility |
| AIC | Atlantic Intelligence Center |
| AIU | Advanced Interface Unit |
| ALE | Automatic Link Establishment |
| ALSP | Aggregate Level Simulation Protocol |
| ALWS | Automated Local Workstation |
| ANN | Analog Neural Network |
| ARWS | Automated Remote Workstation |
| ASW | Antisubmarine Warfare |
| ATD | Advanced Technology Demonstration |
| ATM | Asynchronous Transfer Mode |
| ATV | Advanced Tethered Vehicle |
| AUSS | Advanced Unmanned Search System |
| AWACS | Aircraft Warning and Control System |
| BBS | Brigade/Battalion Simulation |
| BER | Bit Error Rate |
| BG | Battle Group |
| BLAC | Bottom Limited Active Classification |
| BMD | Ballistic Missile Defense |
| BMDO | Ballistic Missile Defense Organization |
| $C^2$ | Command and Control |
| $C^2P$ | Command and Control Processor |
| $C^3I$ | Command, Control, Communications, and Intelligence |
| $C^4I$ | Command, Control, Communications, Computers, and Intelligence |
| $C^4I/S$ | $C^4I$/Surveillance |
| CCD | Charged-Coupled Device |
| CDBS | Central Data Base Server |
| CDES | CDS Development and Evaluation Site |
| CDS | Combat Direction System |
| CEA | Central Engineering Activity |
| CEC | Cooperative Engagement Capability |
| CJTF | Commander, Joint Task Force |
| CLMC | Closed Liquid Metal Combustion |
| CMSA | Cruise Missile Support Activity |
| CMSAS | Circuit Mayflower Shore Automation System |
| COMINT | Communications Intelligence |
| CONUS | Continental United States |
| COTS | Commercial Off-the-Shelf |
| CQ | Carrier Qualification |
| CRADA | Cooperative Research and Development Agreement |
| CSS | Communications Support System |
| CTAPS | Contingency Theater Automated Planning System |
| CTF | Commander, Task Force |
| CTP | Common Tactical Picture |
| CUB | Cryptologic Unified Build |
| DAMA | Demand-Assigned Multiple-Access |
| DCTN | Defense Commercial Telecommunications Network |
| DIS | Distributed Interactive Simulation |
| DMSP | Defense Meteorological Satellite Program |
| DRS | Data Refinement System |
| DSI | Distributed Simulation Internet |
| DSVC | Dam Neck Systems Validation Center |

| | |
|---|---|
| DTD | Data Terminal Device |
| EAM | Emergency Action Message |
| EDFA | Erbium-Doped Fiber Amplifiers |
| EHF | Extremely High Frequency |
| EMC | Electromagnetic Compatibility |
| EMI | Electromagnetic Interference |
| EO-EME | Electro-Optic Electromagnetic Environment Monitoring Systems |
| ESGN | Electrically Suspended Gyro Navigator |
| EVS | Enhanced VERDIN System |
| FCC | Fleet Command Center |
| FCTCLANT | Fleet Combat Training Center Atlantic |
| FDS | Fixed Distributed System |
| FEWS | Follow-On Early Warning System |
| FIST | Fleet Imagery Satellite Terminal |
| FMOCC | Fleet Mobile Operational Command Center |
| FMS | Foreign Military Sales |
| FVLF | Fixed Very Low Frequency |
| GAT | Government Acceptance Test |
| GCCS | Global Command and Control System |
| GOTS | Government Off-the-Shelf |
| GPS | Global Positioning System |
| GPSIU | GPS Interface Unit |
| GSF | Gaming and Simulation Facility |
| HARM | High-Speed Anti-Radiation Missile |
| HBT | Heterojunction Bipolar Transistor |
| HF | High Frequency |
| HFSWR | High-Frequency Surface Wave Radar |
| HIDAR | High Data Rate |
| HPC | High-Performance Computing |
| HyDy | Highly Dynamic |
| IC | Integrated Circuit |
| IFF | Identification, Friend or Foe |
| INFAC | Inertial Test Facility |
| InGaAs | Indium Gallium Arsenide |
| InP | Indium Phosphide |
| INSURV | Inspection and Survey |
| IOC | Initial Operational Capability |
| IR | Independent Research |
| IRR | Integrated Radio Room |
| ISABPS | Integrated Submarine Automated Broadcast Processing System |
| ISAR | Inverse Synthetic Aperture Radar |
| ISS | Integrated Surveillance System |
| ISFET | Ion-Sensitive Field-Effect Transistor |
| ITMS | Information Transfer Management Structure |
| IUSS | Integrated Undersea Surveillance System |
| IV&V | Independent Verification and Validation |
| IVTT | Integrated VERDIN Transmit Terminal |
| JADO/JEZ | Joint Air Defense Operation/Joint Engagement Zone |
| JDISS | Joint Deployable Intelligence Support System |
| JFACC | Joint Forces Air Component Commander |
| JICPAC | Joint Intelligence Center, Pacific |
| JMCIS | Joint Maritime Command Information System |
| JMOCC | Joint Maritime Operations Command Center |
| JOTS | Joint Operational Tactical System |
| JPL | Jet Propulsion Lab |
| JTIDS | Joint Tactical Information Distribution System |
| JWID | Joint Warrior Interoperability Demonstration |
| KMS | Key Management System |

| | |
|---|---|
| LAN | Local-Area Network |
| LBTF | Land-Based Test Facility |
| LEDS | Link-11 Display System |
| LF | Low Frequency |
| LFA | Low Frequency Active |
| LLSS | Low-Light Serial Switch |
| LOS | Line of Sight |
| MAGTF | Marine Air Ground Task Force |
| MAPTIP | Maritime Aerosol Properties and Thermal Imager Performance |
| MAST | Mobile Ashore Support Terminal |
| MATT | Multimission Advanced Tactical Terminal |
| MCAS | Marine Corps Air Station |
| MCB | Marine Corps Base |
| MCM | Mine Countermeasures |
| MCS | Mission Control Segment |
| MDARS | Mobile Detection Assessment Response System |
| MerWatch | Merchant Watch |
| MFP | Matched-Field Acoustic Processing |
| MICPAC | Mobile Integrated Command Facility |
| MIDS | Multifunctional Information Distribution System |
| MIMIC | Millimeter and Microwave Integrated Circuit |
| MLP | Multilayer Perceptron |
| MMPS | MILSTAR Message Processing System |
| MMRT | Missile Motor Railcar Transporter |
| MMRT | Modified Miniature Receive Terminal |
| MMS | Marine Mammal Systems |
| MNS | Mine Neutralization System |
| MNV | Mine Neutralization Vehicle |
| MODSAF | Modular Semi-Automated Forces |
| MONET | Mobile Internet |
| MPL | Marine Physical Laboratory |
| MTS | Man-Transportable Special |
| MTWS | MAGTF Tactical Warfare Simulation |
| NASA | National Aeronautics and Space Administration |
| NAVOCEANO | Naval Oceanographic Office |
| NAVSSI | Navigation Sensor System Interface |
| NAWC | Naval Air Warfare Center |
| NCCOSC | Naval Command, Control and Ocean Surveillance Center |
| NCCS-A | Navy Command and Control System-Ashore |
| NCS | Naval Communications Station |
| NCS | National Communication Systems |
| NDSC | Non-Acoustic Distributed Systems Components |
| NEACP | National Emergency Airborne Command Post |
| NECC | Naval EHF Communications Controller |
| NISBS | NATO Interoperable Submarine Broadcast System |
| NMCC | National Military Command Center |
| nm | Nanometers |
| NOC | Network Operations Center |
| NONAP | Nonlinear Adaptive Processing |
| NRaD | NCCOSC RDT&E Division |
| NRL | Naval Research Laboratory |
| NRT | Near Real Time |
| NTCS-A | Navy Tactical Command System-Afloat |
| NTDS | Naval Tactical Data System |
| NTIA | National Telecommunications Information Administration |
| NUSTF | Navy UHF Satellite Communications Test Facility |
| OBU | OSIS Baseline Upgrade |

| | |
|---|---|
| OED | Ocean Evolutionary Development |
| OMVPE | Organometallic Vapor Phase Epitaxial |
| ONI | Office of Naval Intelligence |
| ONR | Office of Naval Research |
| OPEVAL | Operational Evaluation |
| OPTEVOR | Operational Test and Evaluation Force |
| OSIS | Ocean Surveillance Information System |
| OSP | Ocean Survey Program |
| OSP SIL | Ocean Survey Program System Integration Laboratory |
| OSS | Operation Support System |
| OTH-T | Over-the-Horizon Targeting |
| PDU | Protocol Data Unit |
| PENEX | Polar Equatorial Near-Vertical-Incidence Experiment |
| PINC | Polarization Independent Narrow Channel |
| PIP | Phased Improvement Program |
| PLARS | Position Locating and Reporting System |
| PLGR | Precision Lightweight GPS Receiver |
| PMRF | Pacific Missile Range Facility |
| POL | Petroleum, Oil, Lubricant |
| POWERR | Prototype Operational Workstation for EW/RFI Resolution |
| QE | Quantum Efficiency |
| R&D | Research and Development |
| RAN | Royal Australian Navy |
| RCS | Radar Cross Section |
| RDT&E | Research, Development, Test, and Evaluation |
| REDFIL | Reduced-Power Digital Filter |
| RELNAV | Relative Navigation Analytic Simulator |
| RESA | Research, Evaluation, and Systems Analysis |
| RF | Radio Frequency |
| RFI | Radio Frequency Interference |
| RIC | Radar Intercept Officer |
| RIMPAC | Rim of the Pacific (Annual Fleet Operation/Exercise) |
| RLBTS | Reconfigurable Land-Based Test Site |
| RLGN | Ring Laser Gyro Navigation |
| RNAS | Relative Navigation and Analytic Simulator |
| RNUS | Range NTDS Upgrade System |
| ROTHR | Relocatable Over-the-Horizon Radar |
| SACLANT | Strategic Air Command, Atlantic |
| SAFENET | Survivable Adaptable Fiber-Optic Embedded Network |
| SAT | System Acceptance Test |
| SATCOM | Satellite Communications |
| SBU | SURTASS Block Upgrade |
| SCAPS | Site Characterization and Analysis Penetrometer System |
| SCORE | SIGINT Correlation of Recognized Emitters |
| SCORSBY | Simulated Ship's Motion Facility |
| SDCAD | Surveillance Data Collection and Distribution |
| SDS | Surveillance Direction System |
| SIF | Systems Integration Facility |
| SIGINT | Signals Intelligence |
| SIGSEC | Signals Security |
| SIL | System Integration Laboratory |
| SIMNET | Simulator Network |
| SISL | Secure DSI Integration Simulation Laboratory |
| SLAM | Standoff Land Attack Missile |

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| SLBM | Submerged Launch Ballistic Missile |
| SOCRATES | Special Operations Command Research, Analysis, Threat Evaluation System |
| SOF-IV | Special Operating Forces - Intelligence Van |
| SONET | Synchronous Optical Network |
| SOSUS | Sound Surveillance System |
| SPAWAR | Space and Naval Warfare Systems Command |
| SPECOMMDIV | Special Communications Division |
| SSIXS | Submarine Satellite Information Exchange System |
| SSPO | Strategic Systems Program Office |
| SSSA | System Software Support Activity |
| STIC | Surveillance Test and Integration Center |
| STOW | Synthetic Theater of War |
| STOW-E | European Synthetic Theater of War |
| STP | Space Test Program |
| STRAP | Sonobuoy Thinned Random Array Program |
| SURF | SIGINT Universal Recognition Facility |
| SURTASS | Surveillance Towed Array Sensor System |
| SWAC | Shallow Water Active Classification |
| SWELLEx-3 | Shallow-Water Environmental Cell Experiment-3 |
| SWIFT | Signals Warfare Integrated Facilities Testbed |
| TACAMO | An Airborne VLF Transmitting Platform |
| TACTS | Tactical Air Combat Training Systems |
| TADIXS | Tactical Data Information Exchange System |
| TADIXS B | Tactical Data Information Exchange Subsystem Broadcast |
| TAMPS | Tactical Aircraft Mission Planning System |
| TARIF | Tactical Air Range Instrumentation Facility |
| TCP/IP | Transport Control Protocol/Interface Program |
| TDA | Technical Development Agent |
| TECHEVAL | Technical Evaluation |
| TFSOS | Thin-Film Silicon on Sapphire |
| ThAW | Theater Acoustic Warfare |
| TIPRS | Tomahawk In-Flight Position Reporting System |
| TMPS | TACAMO Message Processing System |
| TRANSDEC | Transducer Evaluation Center |
| TRAP | Tactical Related Applications Broadcast System |
| TRE | Tactical Receive Equipment |
| TRE/TRAP | Tactical Receive Equipment/TRE-related Applications |
| TRU | Tomahawk Receiver Unit |
| TSCM | Tomahawk Strike Coordination Module |
| TSL | Tactical Surveillance Laboratory |
| TTS | Tomahawk Transmitting Systems |
| Tx | Transmission |
| UAV | Unmanned Aerial Vehicle |
| UFO | UHF Follow-On |
| UHF | Ultrahigh Frequency |
| USACOM | U.S. Atlantic Command |
| VHF | Very High Frequency |
| VLF | Very Low Frequency |
| VOCAR | Variability of Coastal Atmospheric Refractivity |
| VTC | Video Teleconference |
| VVFD | Voice, Video, Fax, and Data |
| WDM | Wavelength Division Multiplexing |
| WSS | Waterside Security system |



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