STATEMENT OF WORK
ESM Engineering and Technical Work

1.0 INTRODUCTION

This Statement of Work describes the engineering and technical work to be provided to the Electronic Warfare Support Measures (ESM) Branch of the Tactical Electronic Warfare Division (TEWD) of the Naval Research Laboratory (NRL), Washington, D.C.

2.0 BACKGROUND

The Electronic Support Measures (ESM) Branch of the Naval Research Lab (NRL) has developed advanced EW modeling and simulation capabilities to support NRL research and development (R&D), as well as US Navy training activities. Simulation work at NRL focuses on the ability to generate Electronic Warfare (EW) pulse level environments through specialized hardware and software tools within a user scripted scenario. The simulation outputs serve to stimulate state-of-the-art EW receivers, and signal processors, as well as software models of those subsystems for thorough test and evaluation. Simulator outputs are either actual pulsed or continuous wave RF signals, or digital or software descriptions of the pulse or signal descriptor words (PDW or SDW). The ESM Branch supports multiple Electronic Support Measures Environment Simulator (ESMES) systems. The earliest version of an ESMES was the Tactical Electronic Warfare Environment Simulator (TEWES) system. This system advanced the simulation technology to the point where an environment simulator could simulate up to 1000 radar signals simultaneously into an ESM receiver being tested. NRL developed the Portable TEWES (PTEWES) as a mobile RF simulator capable of running scenarios. NRL also has the capability to use software only scenarios to generate pulse descriptor words to drive ESM receiver simulations. NRL developed software packages such as Builder and the PTEWES software (SimEdit) to create these pulse descriptor words. Continued research at NRL is expected to focus on the continuing improvement of hardware and software simulation capabilities to simulate the current state of the art deployed radar systems for research into ESM exploitation techniques. Continued research at NRL is expected to encompass simulated environments with hardware in the loop, as well as distributed simulations employing the High Level Architecture Run-Time Infrastructure (HLA/RTI).

Modeling work focuses on creating software characterizations of existing and developmental EW systems and subsystems. These models are used in concert with simulated EW environments to characterize system and subsystem performance, capabilities, and limitations.

The ESM Branch of the Naval Research Lab conducts research into advanced ESM collection and processing techniques – typically including ESM system design and prototype development. Work spans the spectrum of ESM system design and

development including RF, digital and analog signal processing, and software.

3.0 SCOPE

The engineering and technical work includes a number of interrelated tasks that vary in both their technical dimensions and deliverable product. A high degree of inter-task coordination is a requirement of this specification. These tasks include software and hardware systems development, systems engineering (hardware and software), systems analysis (hardware and software), test and evaluation. The uniqueness of data availability, availability of necessary processing equipment, and security requirements dictates that a portion of the tasks will be performed at NRL.

The contractor shall provide engineering and technical expertise in support of NRL developed ESMES systems and software by providing systems analysis and systems engineering of hardware concepts and software programs, designing, developing, testing, and maintaining hardware and software programs in scenario construction problems in the task areas outlined below.

The contractor shall provide engineering and technical expertise in support of the design, development, test, and evaluation of prototype ESM systems as covered under the task items.

3.1 TASKS:

3.1.1 TASK I ESMES and ESM system and subsystem analysis and design.

3.1.2 TASK II Software development and support

3.1.3 TASK III Custom hardware design, development, and repair.

3.1.4 TASK IV Engineering Assistant

3.2 All work, travel and material purchases associated with these tasks are subject to prior written Contracting Officer Representative (COR) approval. Work under the tasks shall be proposed in writing for COR approval showing estimated time to complete as well as estimated labor and material costs. Prior to any travel, contractor shall submit a travel plan showing itinerary, estimated travel and estimated material purchase costs.

3.3 All work performed under this task will be fully documented. A required deliverable for this task will be a detailed document set describing the work performed. Document set to include, but not limited to, hardware design documentation and software design documentation, and performance analysis reports. Additional deliverables for this task will be technical reports, trip reports, monthly progress reports and monthly fiscal reports.

4.0 DEFINITIONS:

Electronic Warfare: Any military action involving the use of electromagnetic and directed energy to control the electromagnetic spectrum or to attack the enemy. The three major subdivisions within electronic warfare are electronic attack, electronic protection and electronic warfare support.

Electronic Warfare Support: That division of electronic warfare involving actions tasked by, or under direct control of, an operational commander to search for, intercept, identify and locate sources of intentional and unintentional radiated electromagnetic energy for the purpose of immediate threat recognition. Thus, electronic warfare support provides information required for immediate decisions involving electronic warfare operations, threat avoidance, targeting and other tactical actions. Also called ES.

Electronic Warfare Support Measures: That division of electronic warfare involving actions taken under direct control of an operational commander to search for, intercept, identify and locate sources of radiated electromagnetic energy for the purpose of immediate threat recognition. Thus, electronic warfare support measures provide a source of information required for immediate decisions involving ECM, ECCM, avoidance, targeting and other tactical employment of forces. Also called ESM.

ESMES: Electronic Support Measures Environment Simulator. A system used to provide a simulated radar signal environment for ESM receiver testing. The TEWES system is one type of ESMES system.

ESM Receiver: A receiver used to scan the microwave electromagnetic spectrum looking for activity. When a signal is detected, it could be from a radar or from a communication data link. The ESM receivers discussed in this SOW are being tested for radar signal detection only. An ESM receiver is composed of (1) an RF front end that converts the RF pulses in the environment into an intermediate pulse format (IF, analog, or digital), (2) a preprocessor that converts the intermediate pulse format environment into a digital pulse format, and (3) the processor that converts the digital pulse format of the environment into a signal level description of the environment.

ESM System and ESM Subsystem: ESM system refers to the entire hardware and software suite that comprises the ESM system, to include antennas, RF distribution, RF receivers, signal processors (to include signal conditioning and analog to digital conversion), computers and display. An ESM subsystem is one of those components that comprise the ESM system.

TEWES: Tactical Electronic Warfare Environment Simulator. A system developed by NRL that is used to provide a simulated radar signal environment

that is composed of many simultaneous radar signals. This resulting environment is then fed into an ESM receiver either as a RF signal as it would be seen in a real environment, or as it is seen after being detected by the ESM receiver RF front end (in a analog or digital form). A typical TEWES system is composed of (1) a Intel-based computer that uses special software and a scenario data file to generate a radar signal level simulation of the environment, (2) a Digital Generator Subsystem that converts a radar signal level simulation into a digital radar pulse level simulation, and (3) a RF Generation Subsystem that converts a digital radar pulse level simulation into a radio frequency (RF) simulation of the environment.

PTEWES: Portable Tactical Electronic Warfare Environment Simulator. A portable system developed by NRL that is used to provide a simulated radar signal environment that is composed of many simultaneous radar signals. This resulting environment is then fed into an ESM receiver either as a RF signal as it would be seen in a real environment, or as it is seen after being detected by the ESM receiver RF front end (in a analog or digital form). A PTEWES system is composed of (1) a Intel-based laptop computer that uses special software and a scenario data file to generate a radar signal level simulation of the environment, (2) a chassis that converts a radar signal level simulation into a digital radar pulse level simulation, then converts the digital radar pulse level simulation into a radio frequency (RF) simulation of the environment.

RF: Radio Frequency. In this context, RF is loosely defined as electromagnetic energy having a frequency anywhere from 400 MHz up through 110 GHz.

Scenario: A description of the movements and emissions of radiating and moving platforms over a defined period of time. A scenario is typically defined for a specific geographical location. For purposes of this SOW, the ESMES must work at the pulse level using the information from a scenario. Typically a data file is used by the ESMES system that describes the time, location, and movement of radar and ESM platforms within a geographical lay-down.

5.0 WORK REQUIREMENTS
5.1 TECHNICAL REQUIREMENTS

5.1.1 TASK I -- ESMES and ESM SYSTEM AND SUBSYSTEM ANALYSIS AND DESIGN

The contractor shall provide technical expertise in the areas of system and subsystem design, analysis, and development activities for NRL ESMES, ESM system and subsystem modeling, and NRL ESM R&D projects.

For ESMES related work, the contractor shall be active in all aspects of EW simulator design and prototype development. The contractor shall provide analysis of current and projected Threat Emitter signal environments. The contractor shall work with NRL engineers to develop system technical requirements associated with new or modified ESMES systems and generate a specification summarizing the results.

The contractor shall be required to design and develop both hardware (RF, digital) and software simulation capabilities to meet NRL simulation needs (details of the hardware and software tasking are included in sections 5.1.2, 5.1.3).

For ESM system and subsystem modeling related work, the contractor shall provide analysis of ESM systems and subsystems inner workings. The contractor shall work with NRL engineers to design and develop software models of the ESM systems and subsystems. The contractor shall work with NRL engineers to design and develop these models to operate with NRL simulation capabilities to allow for system and subsystem test, evaluation, and analysis.

The contractor shall provide hardware and software support for NRL legacy simulation capabilities, including the ATEWES and PTEWES systems. The contractor shall be responsible for evaluating system simulations capabilities, recommend and design system improvements to meet evolving NRL and Navy simulation needs. The contractor shall support training of NRL and Navy personnel on the system software.

The contractor shall provide engineering expertise to NRL ESM R&D projects and prototype system development. The contractor shall be responsible for evaluating project requirements and proposing analytical, software and hardware system designs to satisfy project requirements. Top-level software and hardware designs, as well as the hardware platforms, operating systems and programming languages to be used will be selected or approved by the NRL COR.

Estimated level of effort per year for this task will be one (1) man-year principal engineer.

5.1.2 TASK 2 SOFTWARE DEVELOPEMENT AND SUPPORT

The contractor shall provide software design and development for NRL ESMES, NRL ES system and subsystem modeling, and NRL ESM R&D activities. ESMES software work involves maintaining and enhancing the system software for existing NRL ESMES assets, as well as creating future ESMES R&D prototype systems. ES modeling software work involves software development to emulate existing and future ES systems and subsystems. ESM system software work involves software development for NRL R&D prototype ESM systems. Task 5.1.1 personnel may participate in the top-level software system design. Top-level software designs, as well as the hardware platforms, operating systems and programming languages to be used will be selected or approved by the NRL COR.

Source code developed under this contract will be the property of the Naval Research Laboratory. Use of contractor owned software will require prior approval by the NRL COR; any such software will be made available to NRL in source code form for

its nonexclusive use. Appropriate use of third party software libraries, purchased by NRL, will be approved by the NRL COR.

The contractor shall provide software system design and development for the PTEWES, and software PDW generator ESMES systems. The present ESMES software is written in C/C++. The contractor shall provide software support to NRL developed simulation software, including the system software that runs the PTEWES systems. Software support includes debugging and system enhancements. The contractor shall support training of NRL personnel on the system software. The contractor shall be responsible for evaluating system simulations capabilities, recommending and designing system improvements to meet evolving NRL simulation needs.

The contractor shall provide software expertise to NRL modeling efforts requiring programming in the C and C++ programming languages. NRL modeling work requires development of software emulations of existing and developmental ES systems and subsystems. The task requires familiarity with the field of ESM system and subsystem processing.

The contractor shall provide software expertise to NRL R&D efforts requiring programming in the C and C++ programming languages. NRL R&D work often requires the development of prototype ESM systems, which include software for control, signal processing, and display. The task requires some familiarity with the field of radar pulse processing and realtime operating systems such as VxWorks. Support personnel will be expected to gain a thorough understanding of existing and developmental pulse processing systems and use that knowledge to create and maintain software under the direction of Branch employees.

The contractor shall be responsible for following Software Engineering procedures as established by NRL code 5720 personnel, including Version Control, Unit Testing, System Testing, and software source code documentation.

This task may require that some time be spent on-site at NRL. This requirement will vary with the specific work task. For example during times of system integration and test, this task will be performed on-site. Source code will not be transported or transmitted out of NRL building 210 without the prior approval of the COR. On site location will be at the direction of the COR.

Estimated level of effort per year for this task is two (2) man-years.

5.1.3 TASK 3 CUSTOM HARDWARE DESIGN, DEVELOPMENT, AND REPAIR.

The contractor shall provide technical expertise to the ESM Branch in the areas of design, development, calibration, test and evaluation, and repair of custom electronic hardware. This hardware includes existing ESM and ESMES systems developed at NRL,

as well as R&D prototype systems under development for both ESMES and ESM systems.

The contractor shall provide hardware design and debug services in support of radar pulse processing work currently underway in the ESM Branch. Based on a given set of requirements, the contractor shall design, build, and integrate the digital, analog, and RF hardware and software required to fulfill the requirements. This may involve the following engineering tasks: system architecture design; hardware and software development; PC board design, layout, fabrication, and testing; system level integration and testing. Detailed digital designs will encompass the field of signal processing. They will likely commence at the output of an A/D converter, then process through logic circuitry and likely encompass the areas of FPGA and DSP programming. Analog circuitry will typically involve signal conditioning, filtering, amplification, and A/D conversion. RF circuitry involves signal reception, amplification, filtering, and frequency conversion (mixing – typically downconversion to a baseband frequency). The task will require the use of the C (or C++) programming language to support the hardware being built and tested. The contractor will be expected to gain a thorough understanding of existing and developmental ESM receiver and pulse processing systems and use that knowledge to create and maintain hardware as required Branch employees.

For existing NRL ESMES systems, the contractor shall be expected to maintain digital, analog, and RF generation circuitry. Digital circuitry includes Field Programmable Gate Array (FPGA) devices, integrated circuits, programmable logic devices, digital signal processors, and microprocessors. In addition, some designs use SCSI, ethernet, and microcontroller VLSI components. Since these VLSI components are software controlled, microprocessor based designs are required. The analog circuitry will be mostly composed of high-speed operational amplifiers and digital-to-analog converters. The RF components being used are digitally controlled RF switches, attenuators, and vector modulators.

The contractor shall maintain, test and evaluate, calibrate, repair, and improve existing NRL ESM systems. NRL ESM Systems are composed of antenna systems, RF tuners, signal processors, embedded PCs, and system interfaces (serial, Ethernet, and other communications protocols). These subsystems contain highly sophisticated digital, analog, and RF collection circuitry. Digital circuitry includes Field Programmable Gate Array (FPGA) devices, integrated circuits, programmable logic devices, digital signal processors, and microprocessors. The analog circuitry will be mostly composed of high-speed operational amplifiers and digital-to-analog converters. In addition to the RF tuners, RF components typically used are digitally controlled RF switches, attenuators, and RF filters.

This task may require that some time be spent on-site at NRL. This requirement will vary with the specific work task. For example during times of system integration and test, this task will be performed on-site. On site location will be at the direction of the COR.

Estimated level of effort per year for this task is one (1) man-year.

5.1.4 TASK 4 ENGINEERING ASSISTANT

The contractor shall assist the engineers in the tasks above with low-level engineering tasks in support of their efforts on the contract. The Engineering Assistant will perform the following tasks in support of the NRL contract: order parts and maintain inventories using spreadsheets and databases; inspect and test incoming parts; build mechanical assemblies and special electrical cables; operate PROM/ PLD/ FPGA programmers to program and check parts; populate circuit boards; test assemblies; design mechanical fixtures using CAD software; serve as a point of contact to mechanical subcontractors; install and configure system software on embedded ESMES systems or computers; aid in development of technical documentation such as specifications and system documentation. There shall be continual interactions with the contractor's engineering staff.

This task will mainly be performed at the contractor's facility. This requirement will vary with the specific work task. Work at NRL will be at the direction of the COR.

Estimated level of effort per year for this task is four (4) man-months.