Amendment 0004 – September 30, 2025

NRL BAA Announcement #N00173-24-S-BA01
Long Range Broad Agency Announcement (BAA) for Basic and Applied Scientific Research

The purpose of this amendment is to extend the due date for acceptance of White Papers and revise Appendix 1 in it's entirety as follows:

APPENDIX 1 – RESEARCH DESCRIPTION - SUMMARY TOPICS

II. Detailed information about the funding opportunity

The Naval Research Laboratory (NRL) is the Navy's corporate laboratory. NRL conducts basic and applied research for the Navy in a variety of scientific and technical disciplines. The basic research program is driven by perceptions about future requirements of the Navy.

The Navy's operational effectiveness depends on its ability to keep pace with rapidly developing technologies. NRL contributes to this requirement by conducting research in the following areas, organized into NRL'S three research directorates and Naval Center for Space Technology:

Systems Directorate Code 5000
Materials Science and Component Technology Directorate Code 6000
Ocean and Atmospheric Science and Technology Directorate Code 7000
Naval Center for Space Technology Code 8000

A. SYSTEMS DIRECTORATE - CODE 5000

53-24-01 - HIGH FREQUENCY RADAR

The Systems Section of the Advanced Radar Branch of the Naval Research Laboratory (NRL) conducts research and development in concepts and techniques for using high frequency (3 MHz to 30 MHz) radar to meet U.S. Navy mission requirements. Focus is on high frequency electromagnetic wave propagation and scattering (sky-wave and surface wave), radar system performance forecasting, radar system testing, radar data transfer, signal processing methodologies, spread Doppler clutter mitigation and use of the radar return to classify targets. Additional information on this new type of radar is available in the "Radar Handbook", 3rd edition, edited by M. I. Skolnik, pp. 20.1 – 20.83, McGraw-Hill, 2008 and in "Applications of high-frequency radar," Radio Science, Vol. 33, No. 4, Pages 1045-1054, July-August 1998.

Address White Papers (WP) to nrl_5324_baa@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

53-24-01C - HIGH FREQUENCY RADAR (CLASSIFIED)

The Systems Section of the Advanced Radar Branch of the Naval Research Laboratory (NRL) conducts research and development in concepts and techniques for using high frequency (3 MHz to 30 MHz) radar to meet U.S. Navy mission requirements. Focus is on high frequency electromagnetic wave propagation and scattering (sky-wave and surface wave), radar system performance forecasting, radar system testing, radar data transfer, signal processing methodologies, spread Doppler clutter mitigation and use of the radar return to classify targets. Additional information on this new type of radar is available in Chapter 20 of the "Radar Handbook", edited by M. I. Skolnik, McGraw-Hill, 2008 and in "Applications of high-frequency radar," Radio Science, Vol. 33, No. 4, Pages 1045-1054, July-August 1998.

In order to provide a clear understanding of all aspects of the proposed program, classified proposals are acceptable. If the offeror is proposing to perform research in a classified area, indicate the level of classification of the organization, the Principal Investigator and all the proposed personnel, and the agency that issued the clearance; if a formal (classified) proposal is requested by NRL, an unclassified executive summary should accompany the proposal.

CLASSIFIED SUBMISSIONS

Contact nrl_proposals@us.navy.mil for instructions on how to submit classified white papers and Proposals.

53-24-02 - LOW-COST WIDEBAND ANTENNA ARRAY TECHNOLOGIES

The RADAR Division of the Naval Research Laboratory (NRL) is interested in research which will help reduce the cost of ultra-wide bandwidth multi-functional phased array antennas for communication and radar systems. To this end, NRL welcomes proposals that address the following areas:

1) New element design concepts, array architectures, feed components and construction processes that make it more affordable to manufacture large array apertures by a factor of 5 or more.

2) Techniques that reduce the number of radiating elements and/or feeding components while maintaining ultra-wide bandwidth, i.e. thinning, interleaving, or element scaling techniques.

3) Low-profile ultra-wide bandwidth array designs. This could include abstracted element types or apertures that are on the order of one-half a wavelength thick at the highest frequency of operation and/or can be printed on a single layer such as a thin substrate or potentially the (curved) surface of vehicle.

Proposals should address the value added by contrasting the proposed approach with conventional techniques and technology. This may be done by direct comparison or by a parametric analysis of sufficient depth to assess the benefits of the proposed approach.

Address White Papers (WP) to nrl_5300_baa@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

53-24-03 - ADVANCED COMPUTATIONAL ELECTROMAGNETICS

The Radar Division of the Naval Research Laboratory (NRL) is interested in research that will lead to the accurate and timely analysis of CEM problems that are beyond the capability of the current state of the art computational methods to solve. The emphasis is on simulation of RADAR and antenna systems, but can be generalized to large electromagnetic structures that are multi-scale in nature – i.e. sub-wavelength features within systems that are many thousands of wavelengths in size. Proposals should address the following topics:

1) The ability to model with high-fidelity as well as visualize/manipulate electromagnetic objects having details on the order of fractions of a wavelength within composite systems that are several hundred to many thousands of wavelengths in size.

   Emphasis on innovative techniques for high-fidelity simulations and visualizations of RF circuits, antennas, antenna arrays and large EMI/EMC sensitive systems.

2) Techniques/algorithms that reduce the condition number of very large systems of

equations.

3) Methods to reduce the number of data points needed for full/accurate characterization of a system over broad frequency ranges or scan/incidence angles.

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55-24-01 - INFORMATION AND DECISION SCIENCES

The Information and Decision Sciences Branch of the Naval Research Laboratory (NRL) is seeking proposals for innovative research and development in information technology. Current and anticipated areas of research focus include:

1) Virtual simulations and mixed reality systems that support operational uses, situational awareness, and training, for both kinetic and non-kinetic missions. Application areas include mobile augmented reality, virtual or mixed training environments, and interactive and automated dismounted infantry simulation and training. Research topics include information visualization techniques, adaptive user interfaces, avatar control, distributed collaboration, training effectiveness evaluation, novel assessment techniques, adaptive training, and simulation fidelity. In all cases, NRL is interested in human factors evaluations, usability-based methodologies to quantify the costs and benefits of design choices, understanding how system fidelity and training objectives interact, and expressing results in terms of improvements in the field or in live exercises.

2) Systems to support comprehension assessment and complexity analysis of visual data representations. Current work focuses on validation of queries and measuring the contribution of graph components to complexity and their effect on comprehension. Other research topics include multi-variate representations, statistical analysis techniques, and coordinated data views. In all cases, NRL is interested in human factors evaluations, new visualization metaphors, and measuring or assessing information overload.

3) Human Systems Integration research involving the following topics: real time physiological and behavioral measures of warfighter cognitive workload; new interfaces and interaction techniques for supervising unmanned systems; methods for training small unit decision making; new approaches for predicting and scheduling team member's tasking to enhance performance; evaluating different strategies for cross-culture trust generation.

4) Information management technologies that maximize the effectiveness of an enterprise (e.g., military operations) by improving its ability to act upon information that is produced and consumed within the enterprise and/or externally. Technologies that are of particular interest include: data management and exploitation technologies that apply

emerging mathematics and machine learning techniques to improve processing of large amounts of data. Of particular interest is the optimization of the collection and processing of multimodal sensor data in real-time at the tactical edge. Also of interest are assistive technologies that aid decision makers in the understanding of information and how it impacts expected mission outcomes in terms of cost, risk, and expected outcomes. Furthermore, tools that reduce barriers to effective information use by providing intelligent notifications, mediation, access control, and persistence services; tools to assess information quality and suitability; tools that support autonomous information discovery from both open systems and DoD infrastructure to provide decision makers with the most comprehensive and up-to-date situational awareness on the battlefield. The topic is interested in decision sciences research that supports understanding, modeling, prototyping and evaluating effective systems that discover, process, disseminate, visualize and present information in support of military decision making. The following topics are also of interest: identification and assessment of the essential characteristics of decision-making processes within the C4I application domain; identification of techniques/methods and related tools for improving the decision processes.

5) Research and applications of multi-agent and multi-robot systems, reinforcement learning, game theory, and related technologies for enhancing decision support capabilities in adversarial environments. Areas of interest include, but are not limited to, new techniques for multi-agent decision making, coordination and teamwork to perform tasks in contested, denied, asymmetric and unstructured environments, reinforcement learning in multi-player games and real-time strategy games, multi-agent cooperation and teamwork in ad-hoc, dynamic and open environments, and mixed-initiative interactions (e.g., human-agent collaboration). Operational domains of interest include, but not limited to, improving maritime domain awareness, improving human interaction with autonomous systems, and threat detection mitigation and response for cyber security and cyber-warfare applications. Applications of generative AI and large multi-model models (LMMs) for solving problems related to the aforementioned topics is also an area of interest.

6) Parallel and distributed simulation technology. The emphasis is on advanced Modeling and Simulation (M&S) architectures, particularly for distributed systems. The latter includes classical cluster and shared memory architectures, as well as geographically distributed large-scale simulations. Areas of current interest include the formal description of math and physics-based models for building “composable” systems, natural environmental effects servers for M&S architectures, and web-based DoD technology.

7) Human Performance Research involving the following topics: basic cognition (e.g., memory, attention); human factors and applied cognition (e.g., human-computer interaction, automation, physiological assessment); manpower and personnel (e.g., selection, classification, assessment); training and education; data science, psychometrics, and measurement (e.g., data modeling, advanced analytic tools).

Address White Papers (WP) to nrl_code_5580_baa@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

55-24-02 - MATHEMATICAL FOUNDATIONS OF HIGH ASSURANCE COMPUTING

(This may require a DD 254 at the TS level due to investigation requirements – depending on access required, duties and deliverables.)

The Formal Methods Section (Code 5543) of the Naval Research Laboratory's Center for High Assurance Computer Systems is seeking white papers for innovative research in the mathematics underlying security and high assurance computing.

Current and anticipated areas of research focus include:

1) Cryptographic Protocol Design and Analysis – We are interested in the analysis of security protocols for security and performance. Design of new protocols, together with their analysis, is also of interest. Analysis techniques may include formal methods, mathematical analysis, simulation, and experimental evaluation.

2) Traffic security – We are interested in the design and analysis of traffic-secure communications. One challenge of interest is metadata protection, including protecting the source and recipient identities, the type and purpose of communications, traffic volume, and the existence of certain communications. Another problem of interest is the authentication of network data, including of addresses, routes, and keys. A third issue of concern is evading communication blocking. Approaches of interest include network protocols, distributed systems, applied cryptography, and machine learning. Key criteria for proposed solutions are security, performance, and usability. Techniques can be based on mathematical analysis, simulation, experimentation, and measurement. Measurement efforts to provide datasets for designing and evaluating solutions are of particular interest..

3) Hidden Communication – We are interested in the design and analysis of hidden and covert means of communication. Emphasis will be placed on means for accomplishing, detecting, and preventing such hidden communication, and metrics and methods for the evaluating their effectiveness. Techniques can be based on mathematical and/or logical analysis, simulation, and/or experimentation.

4) Mathematical and Logical Analysis of Distributed Systems – We are interested in mathematics and logics, which are integrated with design methodologies for producing secure distributed systems. Emphasis will be placed on hardware-software codesign, distributed architectures, and programming methodologies. The formal apparatus will include non-standard logics (modal, substructural, etc.), category theory, domain theory,

Shannon information theory, and structures that relate these elements in an elegant and coherent manner.

Address White Papers (WP) to nrl_5543_info@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

55-24-03 - HIGH ASSURANCE ENGINEERING AND COMPUTING

(This may require a DD 254 at the TS level due to investigation requirements – depending on access required, duties and deliverables.)

The Center for High Assurance Computer Systems of the Naval Research Laboratory (NRL) is seeking white papers for innovative research, advanced system concepts and security architectures, and the development of prototypes, new analysis tools and techniques in the areas of information assurance (IA), cyber security, software engineering, mobile system security, and real-time systems. Current and anticipated areas of research focus include:

1) Cryptographic Technologies – We are interested in the development of advanced cryptographic technologies for the Cryptographic Modernization Initiative (CMI). This includes software-based cryptography, FPGA-based cryptography, interoperability specifications for cryptographic waveforms, authentication algorithms, software defined radio architectures, dispensable cryptographic devices for the tactical edge, and modeling and emulation of high speed cryptographic techniques.
2) Key Distribution Technologies – We are interested in the research and development of net-centric key distribution systems (e.g., Key Management Infrastructure). We are additionally interested in novel key management architectures and techniques, such as key net broadcast, group key concepts, quantum cryptography for COMSEC and key distribution, and integrated key/mission planning.
3) IA Enabling Technologies – We are interested in innovative solutions and technologies that include network threat visualization, secure BIOS, secure hardware platforms, secure root of trust, trusted execution flow and data filtering frameworks, security enhanced and trusted Operating System development (e.g., SELinux policy development), and design, verification, and analysis of secure network protocols as well as the study of their effects on computer systems and network traffic.
4) Guarding Solutions – We are interested in the research and development of high assurance Cross Domain guards to support assured information sharing and security policy enforcement across disparate enclaves or domains. We are additionally interested in the research and development of secure gateway technology and new analysis tools and techniques for enabling remote monitoring, administration, and configuration of such security devices.
5) Security Architectures – We are interested in the design and development of security architectures for enterprise and tactical systems, with a particular interest in identity management and access control solutions. We are additionally interested in data protection mechanisms and vulnerability assessment methods.

6) Software Security – We are interested in innovative solutions and developing practical approaches that apply and enhance security to software execution environments. Emphasis will be placed on security monitoring and flexible software configuration to enhance survivability. Techniques, tools, and solutions for autonomous cyber responses and automated testing methods are also of interest.
7) Cyber Defense - We are interested in the research and development of high assurance network security architectures and solutions (e.g., components, toolkits, equipment, software, and systems). We are interested in the development of tools and solutions for security orchestration, automation, and response. Of particular interest is emphasis on providing a holistic view of network health and status across enterprise, tactical, and industrial control domains; aggregating data feeds from diverse sources; and optimization of monitoring and response in software defined networks. Additionally, we are interested in development of tools, techniques, and solutions for network intrusion detection, as well as visualization capabilities to display situational awareness dynamically and visually. We are interested in the development of machine learning models of operator and adversary behaviors leading to improved situational awareness and automated course of action analysis. Emphasis on making model-based behavioral anomaly detection actionable by human network defenders is of particular interest.
8) Malicious Code Analysis - We are interested in developing methods, tools, solutions for malicious code analysis, reverse code engineering, and other anti-forensic/anti-reversing techniques. The customization and maintenance of malware analysis tools, the application of knowledge of malicious code trends and concepts, and diverse reporting capabilities, such as compilation of malware research findings and identification of unique malware characteristics are also of interest. Additionally, we are interested in approaches for scrutinizing of coding techniques, language usage/proficiency, and file format properties to identify the level of code sophistication and potential origin. We are interested in the development of machine learning models of executable software that recognize indicators of threat, vulnerability, and compromise.
9) Cyber Assured Missions – We are interested in research and development of tools and techniques to identify mission workflows, milestones, artifacts, and requirements through observation of cyber activities. Emphasis is placed on enabling mission continuity across the contested cyber battlespace. We are interested in the development of tools, techniques, and solutions including cyber deception, resilience, and maneuver. Additionally, we are interested in development of machine learning models of mission requirements, resources, and risks. Emphasis on cyber battle damage assessment and course of action selection is of particular interest.
10) Software Assurance – We are interested in the development of mathematically based methods, models, algorithms, and theories for assuring software system properties such as safety, security, functional correctness, timing, and fault-tolerance. Emphasis will be placed on formal modeling and formal verification techniques for cyber-physical systems, assurance of systems using machine learning (ML) and other AI approaches, binary analysis, requirements elicitation, and run-time verification.
11) Assured Autonomy – We are interested in techniques for assuring the correct and safe operation of autonomous platforms. We are particularly interested in novel security concepts and security architectures for assuring the behavior of software throughout the platform life-cycle.

12) Tactical Zero Trust – We are interested in technologies that, in part or in whole, enable a zero-trust methodology for tactical network environments. Important characteristics of tactical networks that should be accounted for include non-Internet Protocol-based communication protocols, decentralized control and data flows, and low size, weight, and power constraints.
13) Autonomous Cyber Operations – We are interested in research and enabling technologies for automating the planning, coordination, execution, and assessment of cyberspace operations.

Address White Papers (WP) to nrl_5540_info@us.navy.mil . Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

55-24-04 - ADVANCED NAVAL NETWORK SOLUTIONS

(This may require a DD 254 at the TS level due to investigation requirements – depending on access required, duties and deliverables.)

The Networks and Communications Systems Branch of the Naval Research Laboratory (NRL) is seeking White Papers for innovative research and development in information technology; specifically, relatively mature technology (TRL 6 and higher) for Naval Network and Communications Solutions. Current areas of research focus include:

1) Software Waveforms. Implementation of complex waveforms (such as TTNT, HNW, SDA T0, and unmanned platform Control Station Algorithms)) hosted on CPCI/CMOSS cards, as part of a systems level, heterogeneous networking capability. Ensure linkage to ONR funded Enabling Capabilities (EC's) in Advanced Tactical Data Links (ATDLES) and SATCOM mitigation. Solutions may be IP or non-IP based.

2) Advanced Tactical Edge Solutions. Demonstrate candidate technologies for next generation Tactical Communications Links. Integrated, systems level solutions to Ad-Hoc Naval Tactical Edge Mobile Area Networks and candidate protocol stacks/application layer toolkits, with connectivity of up to 30 nodes, including air, ground and sea platforms.

3) Spectrum Diversity. Identify integrated, wireless, heterogeneous solutions for network connectivity between afloat and airborne platforms (e.g., ships, aircraft, and UAV's), to include Line of Sight (LOS) solutions. Also, identify and implement advanced waveforms to maximize bandwidth at various ranges to achieve the best signal surpluses, and include in possible solutions improved apertures, maximized efficiency of legacy communications links, UAV communications relays, and wireless connectivity for tactical users. Optical as well as RF solutions at a variety of frequency bands are encouraged.

4) SATCOM Mitigation. Integrate technological solutions for overcoming the loss or over-subscription of SATCOM connectivity between (a) deployed units in an Expeditionary or Carrier Strike groups (ESG or CSG; respectively), and (b) connectivity reachback ashore from deployed ESG/CSG in any given geographic area of responsibility. Solutions must be exportable, scalable, and relevant in any geographic maritime environment in which an ESG or CSG might operate, and must include compatible, tactical edge connectivity and services. Particular interest exists in solutions that can be hosted on small- to medium-UAVs, and in other airborne relays.

5) PODs. Integrate candidate communications, Optical and/or RF, payloads (e.g., Sea Lancet, SRP, etc.) into small airborne PODs, using currently available airframe modifications and POR technology, for both unmanned and manned platforms, conforming to NAVAIR standards and size, weight and power (SWAP) requirements. Include receivers, apertures, and payload.

Address White Papers to NRL_Code_5520_BAA@us.navy.mil. Allow one month before requesting confirmation of receipt of White Paper, if confirmation is desired. Substantive contact should not take place prior to evaluation of a White Paper by NRL. If necessary, NRL will initiate substantive contact.

55-24-05 - FEDERATED, DISTRIBUTED COMPUTING/NETWORK INFRASTRUCTURE

(This may require a DD 254 at the TS level due to investigation requirements – depending on access required, duties and deliverables.)

The Center for Computational Science of the Naval Research Laboratory (NRL) is interested in receiving proposals in emerging scalable leading edge technologies relevant to high performance (HP) distributed supercomputing, wide area networking and visualization, and data collaboration technology for High End Computing (HEC). Research involves work in scaling single-image large memory supercomputer processing for scientific problems undertaken as part of the NRL, ONR and High Performance Computing Modernization Office programs; research is ongoing in the areas of exascale computing, infrastructure virtualization, collaboratory and conferencing environments; streaming multi-gigabit multimedia network technology while providing E2E QoS guarantees; federated, distributed technology for multi-petabyte scale file systems; prototype environments for the design of scalable, object oriented multimedia databases for near-realtime access, archival and retrieval; and stream and compression technology for transmission of progressive motion and/or high resolution imagery.

Sensors and Processing Algorithms: Recent advances in very high resolution sensors with collocated energy-efficient processors continue to mount challenges to various dynamic metrics of agile, adaptive and comprehensive processing of sensor data across C4ISR networks with embedded computing distributed across these networks: at the sensor, at the archives and near the end-user. Large scale data-analytic solutions in the areas multisource information fusion,

persistent video analytics, content characterization and retrieval based on dynamic content features are now being recast from the perspective of near-real-time high performance computing networks. Algorithm development aimed at C4ISR networks using adaptively taskable sensors in size weight and power (SWAP) constrained computing environments are also of interest. Innovative sensing inside latency- and bandwidth-challenged degraded, actively contested and/or urban environments requires new approaches. Video analytics that extract content dynamics, situation awareness, 3D structure of rich scenes, and exploit geospatial information including 3D point clouds, terrain maps, multi-sensor motion imagery, etc. are of interest.

High End Computing and Communications: The research objective is to investigate and develop innovative approaches and techniques that have the potential to create superior revolutionary rather than evolutionary advances in computing, communications, display and information infrastructures and tools. In addition to software and emerging hardware advances, NRL seeks new methodologies for interconnecting energy-efficient heterogeneous systems through high speed network technologies that over time have the potential to scale to terabit flows; all-optical amplified wavelength division networking and optical burst switching technology; high performance stream access to remote assets over commercial networks; leading edge flow routing architectures capable of end-to-end streams with QoS guarantees; and information assurance and encryption technologies and tools for the above. Alternatives to von Neumann architectures are of interest.

Advanced Resilient Networks: Computer networks have become ubiquitous with the requirements for resiliency ever increasing. Advancements in survivable, reconfigurable and self-repairable network protocols in adverse and unreliable environments is critical to the Department of Defense (DoD). This includes land-based communications, line-of-sight wireless (LOS RF and Optical) communications and beyond line-of-sight (BLOS RF and Optical), and seaborne/airborne/space-borne communications nodes/relays. Of interest are both reliable and deterministic traditional networks, along with ad-hoc tactical edge networks with 10's to 100's of nodes.

Address White Papers (WP) to baa@cmf.nrl.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

56-24-01 - OPTICAL SCIENCES R&D

Optical Science Division of the Naval Research Laboratory (NRL) is seeking proposals for innovative research supporting ongoing programs within the Optical Sciences Division related to a wide variety of topics in the following areas:

1) The development of innovative new techniques which support laser countermeasures against laser guided or laser aided threats, such as laser beamrider missiles, laser designators, and laser rangefinders.

2) The development of countermeasure technology and countermeasure techniques against advanced anti-air and anti-ship imaging infrared seekers. Offerors must also have background in the use of modeling and simulation tools for imaging seekers to conduct countermeasure research.

3) Fabrication of optical fibers that transmit infrared (IR) radiation, especially chalcogenide and heavy-metal oxide glass fibers; processing techniques for making IR fibers; purification of glass starting materials; novel crucible fiber drawing techniques; specialty fibers for chemical sensor applications and techniques for making chemical sensors. Development of ruggedized, vibration-resistant and athermal cables and connectors for middle wavelength IR (MWIR) fibers for use with high power mid-IR lasers. New technologies for making IR fiber switches to work with mid-IR lasers as well as technology for fabrication of IR fiber couplers, filters and splitters.

4) Fabrication of domes, aspherical optics and large (≥ 20 inch) diameter windows with high transmission across UV-Visible and infrared wavelengths. Technologies are sought that utilize environmentally rugged materials (glasses, ceramics or poly/single crystals) and produce defect-free optics with wide band anti-reflection coatings.

5) Development and fabrication of specialty thin film structures leveraging plasmonics, metamaterials and waveguide technology to enable novel devices including non-mechanical beam steering from the UV to LWIR. Fiber optic sensors for detecting acoustic, magnetic and electric fields, rotation rate, strain, temperature, pressure, chemical, and other parameters. Novel interrogation, multiplexing, demultiplexing and modulation/demodulation techniques using frequency, wavelength and time division, or other techniques to increase sensor count per fiber, decrease electronic demodulation power requirements, and provide all-optical signal processing, and lower total system cost are desired. In addition, methods are sought for improving fiber sensor performance, packaging, deployment, and survivability of these systems in a variety of environments. Low phase noise laser sources that feature very good isolation from ambient effects to improve overall optical system performance are desired. Low power, high bandwidth, signal-processing components with automatic signal detection to fill current technology gaps for autonomous sensors are of interest. Robust, agile, advanced automation tools that are able to detect, classify and track selected targets of interest acoustically, using data from fixed and mobile arrays and generate automated contact reports are desired to reduce manpower requirements associated with sonar operator tasks.

6) High frequency data transfer networks using fiber optics; signal processing in fiber optic links; optical-microwave delay lines for gigahertz signal transmission, high frequency directly modulated diodes and external modulators, and high-speed detectors. Fiber devices such as amplifiers, fiber lasers, super-luminescent fibers, and phase shifters; laser diodes that meet military specifications and can operate in the multigigabit/s range; harmonic generation and mixing using laser diodes; nonlinear effects that impact fiber optic links such as soliton propagation, Brillouin scattering, and four-wave mixing.

Integrated optical devices for sensors, optical-microwave delay lines, signal processing, networks, digital or analog communication links.

7) Glass and processing techniques for nanochannel glass technology and holey fibers; specialty glasses and fibers for sensor applications and nuclear radiation hardness; optical fibers with high mechanical strength, survivable coatings, and low bending loss.

8) Novel optical particles or nanorods that exhibit unique optical properties (transmission, absorption, chirality, spectral signature, etc.) in VIS, SWIR, MWIR and/or LWIR.

9) Narrow linewidth lasers for coherent detection; multi-spectral lidar technology; single-photon lidar technology; pulsed solid state blue-green lasers

10) Algorithms for wavefront sensing phase and/or image reconstruction; compressive sensing algorithms for electro-optic applications; computational imaging algorithms to design optical hardware.

11) Photonic band-gap materials; optical properties of materials and coatings; narrow band gap superlattices; quantum wells, wires and dots; bioconjugated quantum dots to probe cellular and environmental behavior; novel nanostructures; the interaction of light with single microdroplets; development of real-time in-situ optical instrumentation to detect bioaerosols, including single particles on-the-fly; novel materials or concepts to protect eyes and sensors against intense laser radiation;

12) Development of type II "W" mid-IR lasers and quantum cascade lasers; other MWIR laser and amplifier devices that increase brightness and power; organic light emitting sources and optoelectronics; slow light studies; nonlinear optical probes such as Fast CARS; and development of condition-based sensors for fluid monitoring.

13) Electro-optical, visible, infrared, multi spectral and hyperspectral technologies used in systems for reconnaissance and surveillance of air, ocean, and ground targets, from space, air, surface and subsurface platforms; high-speed digital optical/RF communications in a tactical environment, including architectural issues; algorithmic development, including digital image and signal processing algorithms for target detection and tracking; the measurement and theory of optical signatures of air and ocean targets; the acquisition, and characterization and simulation of large-area background imagery; atmospheric propagation effects relevant to missile warning, laser countermeasures, and imaging; electro-optical sensor technology including efficient high-speed photo-detectors, focal plane arrays and signal processing; electro-optical components; digital holography and electronic shutters; signal processing and data compression for multi-color electro-optical and infrared sensors; multi sensor/data fusion and exploitation; neural network processing and electronics particularly applicable to electro-optical sensors; advanced data compression techniques and electronics for very large area visible, infrared, and multi spectral.

Address White Papers (WP) to NRL_OptSci_BAA@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should

not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

57-24-01 - ELECTROMAGNETIC TECHNIQUES AND TECHNOLOGY RESEARCH AND DEVELOPMENT

The U.S. Navy is interested in exploring the use of High Power Electromagnetic techniques and technologies for purposes including anti-ship missile defense (ASMD), engine stopping, counter improvised explosive devices, and command and control warfare (C2W). Proposals that incorporate NRL capabilities are encouraged. Proposals for research and development into High Power Electromagnetic techniques and technologies may include, but are not be limited to:

1) Wideband (narrow-pulse) HPM sources. The sources of interest range from compact, lightweight devices that may be conventionally or explosively driven to larger, higher power devices that are suitable for shipboard installation.

2) Narrowband HPM sources. The sources of interest are generally high duty, relatively long pulse transmitters. Very high peak power, high average power, and high efficiency are all desirable.

3) Innovative conventional and non-conventional HPM based electronic attack (EA) techniques and systems including anti-missile defense applications, special operations, engine stopping, counter improvised explosive devices, command applications and C2W applications.

4) The use of RF transmission and backscatter to identify, determine properties, and/or locate potential threat devices.

5) Interactions of lasers with materials and electronics. Particular interest in femtosecond laser technology and atmospheric propagation.

6) Methods and technology for defending Naval systems from high power Electromagnetic attack.

7) RF countermeasure techniques and technologies for anti-ship missile defense.

8) Modeling and simulation ranging from device level simulation to campaign models that explore the utility of high power electromagnetic weapons.

9) Nearfield effects, sources, and antennas.

10) Ultrashort pulse technologies.

11) Directed Energy Prototype development.

12) Synergisms between Directed Energy, Conventional Electronic Warfare, and Kinetic defense systems for land and sea.

13) Electromagnetic energy effects on cells and organisms.

14) RF effects on biological materials

NRL more favorably will consider proposals offering initial increments comprised of short term studies (6-8 man-months) which then can be used to decide if the research deserves further investment.

NRL is also is interested in proposals for work leading towards prototype development.

Address White Papers (WP) to nrl_5745_baa_hpem@us.navy.mil. Any specific security questions should be addressed in advance of proposal submission via separate discussion. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

57-24-02 - SHIPBOARD ELECTRONIC WARFARE

The Surface Electronic Warfare Systems Branch (SEWS) of the Naval Research Laboratory (NRL) conducts research and development of Electronic Warfare (EW) systems directed toward the protection of Navy ships. The Branch mission includes the development of EW system and subsystem requirements; development, analysis and evaluation of shipboard ECM systems, subsystems with and components; threat assessments; and development of EW operational tactics and concepts.

The Surface EW Systems Branch is interested in receiving proposals for research and development into all of its mission areas. Specific areas of interest include, but are not limited to:

1) Signal Detection and Processing

The trend in threat emitter characteristics is toward lower power emitters with highly agile parameters, including pulse to pulse frequency variation and random or semi random pulse repetition frequency (PRF). These emitter characteristics may include parameter variations using identifiable sequences or random parameter variations. EW systems must be able to detect, de-interleave, sort, and measure intra-pulse and pulse-train parameters to classify and associate EA techniques with these agile emitters in a dense electromagnetic (EM) environment. Key research areas include:

- Detection and direction finding of LPI signals in a complex EM environment, including associated microwave receiver, antenna component, and system technologies that provide wide bandwidth and high sensitivity.
- Sorting and deinterleaving of frequency and PRI agile emitters in a complex EM environment.
- Pulse-to-pulse feature extraction for real time signal processing.
- Pulse and emitter measurements and derived pulse train measurements that provide parameters to improve emitter classification with minimal ambiguities.

2) Electronic Attack (EA) Technique Generation

Countering advanced threat systems will require innovative conventional and non-conventional ECM techniques and EA technique generators for application in all phases of the battle timeline including surveillance, targeting, acquisition, and terminal phases. In addition countering advanced threats requires a coherent technique generation which includes the ability to capture, store, and process threat pulses received in a complex EM environment. Key research areas include:

- Broadband, high dynamic range Digital Radio Frequency Memories (DRFMs).
- Finite Impulse Response (FIR) Filters.
- ECM techniques against Low Probability of Intercept (LPI) radars.
- Counter-targeting ECM techniques systems for battle force defense.

3) Advanced ECM transmitters

Increased threat capability and increasing threat density will require the development of new transmitter technology with expanded frequency coverage and multiple threat handling capability. Key research areas include:

- Millimeter-wave EW transmitter concepts and technologies.
- Broadband, multiple-simultaneous-beam antenna technology.
- Multifunction aperture designs and technology.
- Very wideband electronic countermeasures (ECM) technologies and components, including amplifiers (tubes, solid state, and hybrids), power combiners, filters, and other discrete devices.

4) Sensor Integration

Future EW systems will need to operate in a distributed, networked environment in order to provide effective capability against advanced threats in complex EM environment. Key research areas include:

- Shipboard sensor fusion techniques;
- Intra-ship information fusion/association techniques;
- Timely/near real-time EW effectiveness measurement technology.
- Distributed, networked battle force concepts, techniques and systems.

5) System Concept & Embarkable Prototype development and demonstration

The effective transition from research to operational use requires the demonstration of advanced technology in an operationally relevant environment in a manner that is consistent with how it would be deployed. The Surface EW Systems Branch has developed a standard interface that can rapidly and easily support the demonstration of advanced EW capability in a relevant shipboard environment. It allows for the integration and demonstration of signal detection and process technologies, EA Technique Generation technologies, Advanced ECM transmitter technologies, and Sensor Integration technologies into a field demonstrable (i.e. Embarkable Prototype) system. Key research areas include:

- Analysis tools for developing and assessing EW Concepts
- Methodologies/tools for assessing and quantifying countermeasure capability/effectiveness against current and projected threats.
- Technologies that facilitate rapid deployment, upgrade, and support of Advanced EW capability on Naval combatants.

NRL more favorably will consider proposals offering initial increments comprised of short-term studies (6-8man-months) which then can be used to decide if the research deserves further investment.

Address White Papers (WP) to nrl_5740_proposals@us.navy.mil. Allow one month before requesting confirmation of receipt of Initial Proposal, if confirmation is desired. Substantive contact should not take place prior to evaluation of an Initial Proposal by NRL. If necessary, NRL will initiate substantive contact.

B. MATERIALS SCIENCE AND COMPONENT TECHNOLOGY DIRECTORATE CODE 6000

60-24-01 - HIGH PERFORMANCE COMPUTING ON MASSIVELY PARALLEL ARCHITECTURES

The Laboratories for Computational Physics and Fluid Dynamics (LCP&FD) of the Naval Research Laboratory (NRL) conduct research and development supporting the national initiative in high performance computing. Advanced algorithms, codes and licensable software are developed for commodity systems and for the newest massively parallel architectures.

Research is pursued in the fields of compressible and incompressible fluid dynamics, reactive flows, fluid/structure interaction including submarine and aerospace applications, atmospheric and solar geophysics, magneto-plasma dynamics, fire modeling, engine modeling and molecular dynamics. We are interested in receiving proposals for basic scientific research and development directed toward increasing knowledge or understanding pertaining to our on-going programs in the following topics:

1) Novel modeling and simulation of complex combustion systems involving multi-phase

fuel (including alternate and synthetic fuels) injection such as droplets, sprays and particulate matter in a gaseous background. Also innovative development, integration and maintenance of an environment for efficient approaches to the massively parallel processing of detailed chemical kinetics mechanisms and the development of simplified chemistry models (for conventional and alternate fuels) for inclusion in multidimensional simulations of flames, fire and detonations.

2) Innovative characterization of sound generation and investigation of methods to increase fuel-air mixing, reduce noise and pollution from jet engines burning current and future alternate fuels (including bio-derived and synthetic fuels) using direct and large eddy simulation techniques and supporting data for validation.

3) Novel numerical modeling for large scale studies with general boundary conditions, modeling of local phenomena in multidimensional magnetofluids, innovative many-body simulation models for plasma phenomena.

4) New radiation transport and equation of state models for inclusion in highly parallelized and vectorized hydrodynamic simulation codes which address astrophysical and laboratory plasmas, in which the effects of radiation transport and non-ideal equations of state are relevant.

5) Novel techniques for structured and unstructured grid-based unsteady flow solvers for complex, three-dimensional flows. This research would also address parallel load balancing and adaptive refinement and re-meshing for unsteady flows. CAD interfaces with grid generators and unsteady flow solvers for multiple moving surfaces and bodies in relative motion, bodies in and near a free surface, and bodies in turbulent separating flows are also sought.

6) Development and application of efficient Flux Corrected Transport (FCT) methods for Graphical Processing Units and other computational coprocessors.

7) Development, validation and application of techniques for complex multi-phase flows and development of innovative techniques for the simulation of low Reynolds number flows through complex geometries.

8) Innovative modeling of elastic-plastic flows and flow interactions with solid deformable boundaries. This includes shock loading in sand and/or explosive effects on deformable bodies.

9) Development of innovative and efficient numerical techniques, analysis and experiments for the simulation and validation of the performance and operation of continuous and pulsed detonation engines.

10) Development, application, validation, and accreditation of numerical simulation models needed to support decisions in protection of buildings, facilities, cities and/or military platforms from the threat of chemical/biological incidents and blasts.

11) Development and application of scalable methodologies for urban geometry and feature extraction from LIDAR and remote sensing data.

12) Development and application of numerical simulation models, including visualization techniques, to investigate complex unsteady viscous flows associated with bio-fluidic systems and devices as well as artificial bio-mimetic vehicles and systems.

Address White Papers (WP) to Code 6040, by email to 6040whitepapers@nrl.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

61-24-01 - ELECTROCHEMICAL ENERGY STORAGE, CONVERSION AND COMMAND/CONTROL

The Alternative Energy Section (Code 6113) of the Chemical Dynamics and Diagnostics Branch of the Naval Research Laboratory (NRL) is interested in receiving proposals for the improvement of power/energy sources for U.S. military missions, with a focus on electrochemical energy storage and conversion systems such as batteries and fuel cells. The NRL seeks innovate concepts to promote electrification, command & control energy, and supply chain resilience of emerging energy technologies. Proposals will be considered on topics ranging from materials discovery and development through systems integration. Energy storage and conversion materials, components, cells and system level developments and advancement are requested.

Address White Papers (WP) to NRL_6100_PowerEnergyBAA@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

61-24-02 - CORROSION PROCESSES, CONTROL, MITIGATION, AND TECHNOLOGY

The Naval Research Laboratory (NRL) is interested in receiving proposals for research and development in materials performance, environmental effects, corrosion processes, corrosion control and marine coatings technology. These efforts may include studies from basic corrosion mechanistic studies through applied technology and corrosion control initiatives. The areas of research and development activities of interest to NRL include, but are not limited to the following:

1) Develop computational modeling techniques for the development of predictive equations of state for materials, mechanistic prediction and prognostics, which could greatly reduce costs, techniques, methodology and processes for developing new materials with improved corrosion resistance and structural performance attributes. These may include fundamental composition modification, forming processes, treatments, processing and augmentation that permit optimization of properties, including corrosion resistance, cathodic protection requirements, reduction in localized effects, stress corrosion cracking resistance, reduced hydrogen embrittlement, etc.

2) Improved properties of materials, inhibitors, surface modification and passivation, property enhancement related to materials physical property improvements, improved galvanic compatibility, minimize microbial influenced corrosion (MIC), electrochemical enhancement, plating, hardening, carburization and low temperature carburization, surface coatings, welding techniques, annealing, reduced susceptibility to stress corrosion cracking and hydrogen effects, novel methods for metal extraction, ionic liquids, rapid prototyping methods, oxidation/reduction effects. Materials efforts may contribute toward Navy vessels and may include but are not limited to: steels, HSLA steels, stainless steels, nickel alloys, aluminum alloys, titanium, copper/bronze, magnesium alloys, composites, polymers, anode materials, and novel materials, such as nano-based, amorphous, implanted, flame/plasma spray, novel microstructure and unique technology.

3) Design of marine coatings technology that contribute to improved corrosion performance, new resin/formulation properties, coatings durability, reduced total life cycle cost, dual-use, improved inspection capability, reduced/marginal surface preparation requirements, advanced application technology, rapid cure/single coat cure, self-inspecting, radar adsorption, acoustic damping, improved special hull treatment/mold in place, antifoulant technology, cavitation/erosion resistance, reduced maintenance and condition based maintenance (CBM). These efforts may pertain to all ship and submarine platform technologies and includes applications for aircraft, remotely operated vehicles, autonomous vehicles, Marine Corps vehicles, component parts and developing technology.

4) Development of: sensor technology, corrosion control systems, cathodic protection technology, electrochemical techniques, integrated components, biological materials, novel electronic circuits, smart materials and structures, dual-use systems, control algorithms, computational techniques, physical scale modeling, devices, components, bioremediation techniques, chlorination/dechlorination methods/equipment, descaling/fouling removal applications, electrical isolation, improved grounding, power systems, fuel cell technology, catalysts, membrane technology, materials extraction, novel manufacturing processes – including interstitial hardening and other surface modification processes that improve the corrosion resistance of materials, diamond materials, surface enhancements/detection methods, improved concrete processes/durability, and diver safety technology.

5) Development of materials, coatings, devices, components, product and systems that address crucial Naval and DoD requirements for corrosion prevention, control,

remediation, maintenance, life-cycle extension, cost reduction, platform sustainment, sea basing, technical insertion, advanced ship design, propulsion systems, equipment design/specification, system engineering and unique naval applications.

Address White Papers (WP) to NRL_6130_BAA@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

61-24-03 - APPLICATIONS OF MOLECULAR BIOLOGY, BIOCHEMISTRY, ANALYTICAL CHEMISTRY AND ADVANCED LASER TECHNIQUES

The Naval Research Laboratory (NRL) Chemistry Division conducts research in a number of areas related to detection of biological, chemical and other hazardous materials or conditions. In addition, the Division conducts research in developing tools and methods to transfer, preserve and characterize and optimize the performance of chemical and biological based materials.

Areas of primary interest include:

1) Characterization of environmental processes and their application to remediation and restoration technologies;
2) Detection, sampling and characterization of chemical and biological agents, toxic metal ions and explosives;
3) Unique analytical chemistry tools for more efficient and cost effective sample processing;
4) Genetic- and molecular biological-based tools; (4a) techniques for the preservation and characterization of cells, tissue and biomaterials; (4b) methods for printing environmental biological and chemical material;
5) Improved and alternative fuel sources that include hydrogen fuel cells, solid oxide fuel cells and microbial fuel cells;
6) Atmospheric propagation of femptosecond pulses;
7) Electromagnetic induction sensors and analysis for detection and classification of unexploded ordinance;
8) Advanced laser and optical techniques, including novel plasmonic systems, optical diagnostics, remote sensing, and materials-based optical signatures;
9) Microfluidic structures with application to microchip separations, sampling, detection and pumping;
10) Chemometrics;
11) Volume sensing through image analysis and machine vision; 12) Reactive multi-functional coatings;
12) High throughput culturing of unculturable and/or environmentally derived microorganisms;
13) Lithium ion battery safety diagnostics; and
14) Advanced power system analysis and optimization

Key words describing these research interests include, but are not limited to: chemical sensors, biosensors, biosurfactants, gene probe technology, biofilms, freeze-drying, lyophilization, cryopreservation, contaminated sediments, corrosion and biofouling, remote sensing, methane hydrates, carbon cycling, laser pressure, optical techniques, biocollector, MTADS, capillary electrophoresis, microchip, laboratory-on-a-chip microfabrication, microfluidics, video-based detection, machine vision, workspace monitoring, damage control, multivariate analysis, mobility fuels, thermal stability, antioxidants, and metal catalysis. NRL is interested in receiving proposals which address innovative technologies or fundamental approaches related to these research areas.

Address White Papers to NRL_6101_BAA@us.navy.mil. Allow one month before requesting confirmation of receipt of White Paper, if confirmation is desired. Substantive contact should not take place prior to evaluation of a White Paper by NRL. If necessary, NRL will initiate substantive contact.

61-24-04 - MULTIECHELON DIAGNOSTICS (MEDx) TECHNOLOGY DEVELOPMENT AND TIERED EVALUATION

Recent advances in diagnostic technologies are blurring the standard definitions of Echelons of Care *[see below for definitions]*. As smaller, faster, more sensitive, and easier to perform become superlatives of emerging technologies, those technologies may now be applicable to more than one Echelon of Care. For example, complex genomic analysis for alleles, SNPs, or other unique genomic markers may have started out as an Echelon 4 activity, but can now be performed on a portable thermocycler device that has the operational characteristics to be successfully deployed at Echelons 1 or 2. Additionally, DNA/RNA numerous isothermal amplification schemes even remove the need for thermal cycling and that added instrumentation. Therefore, the community has never been more empowered to introduce new technologies across the battlespace, specifically the same technology with multiple concepts of operation.

The Naval Research Laboratory (NRL) is seeking Research & Development partners to advance technology developed for *in vitro* diagnostic devices that are amenable to military hardening and integration with communication capabilities to support the medical diagnostic and epidemiological detection and biosurveillance needs of the US military across multiple Echelons of Care and specifically for field deployment at Echelons 1 or 2.

Desired Design and Performance Capabilities
The Government is interested in proposals offering innovative, high functioning approaches for *in vitro* diagnostic devices that can operate at Echelon 1; however, superlative diagnostic technologies that operate at Echelon 2 will be considered. Offered technologies must be mature enough to enter into the Tiered Evaluation Model.
Proposals for both genomic and immuno-analysis technologies are sought. Desired performance capabilities for the two use cases are:

Genomic Analysis Platforms: Devices capable of detecting specific nucleic acid targets and/or examining molecular sequences at clinically relevant concentrations in complex clinical sample matrices, to include whole blood, serum/plasma, urine, and nasal swabs. An integrated or very simple method to nucleic acid sample preparation/purification is needed to operate without any complex external sample manipulation. Specifically DNA and/or RNA pathogen genomic signatures and/or host response biomarker targets must be measured, to provide positive identification of the causative agent of illness on a hand-held or man portable diagnostics system. Analysis should be multiplexed (minimum of four; preferred more than five, including internal positive controls. Sample adequacy/processing controls and negative template controls are also encouraged) to provide a syndromic approach to disease identification; including sub-typing for diseases as appropriate (*e.g.,* dengue virus serotypes, phylogenetic differentiation of Ebola strains, etc.).

High Performance Non-Nucleic Acid Analysis Platforms: Devices capable of identification of affinity ligand binding antigen capture (*e.g.,* immunoassay target platforms that promote identification of the causative agent of illness. Analysis should be multiplexed (minimum of three, preferred more than four) to provide a syndromic approach to disease identification; including sub-classification for diseases as appropriate. Assays for immunological targets that indicate acute infections are preferred, particularly for deployment in endemic areas.

In either use case, the Device and Assay must have the following characteristics: The device must be a low-complexity diagnostic device usable by personnel following minimal training. A total sample to answer timeframe of one hour or less is preferred. The final technology package should be for use in field forward, often austere environments with limited resources. Important assumptions for these environments include that they have no surgical and limited patient holding capability, are manned by a Physician, Physician Assistant (PA), or Medic, with the mission of providing triage, and treatment to return military personnel to duty, or stabilizing them for evacuation to the next level care facility. The device must have communications ability or can be easily integrated with a communication capability. The base requirement is that the communication of the resulting analytical data is possible via electronic means (*e.g.,* text message, email, image, PDF, et cetera). The device should have battery capability that assures no disruption in assay completion should field conditions change abruptly. Full battery operation with periodic battery charging is preferred. It is not required that the device is handheld, but the physical parameters of weight and footprint will be evaluated. It would be desirable that the device could test multiple matrices such as blood, urine, saliva, tears, sweat, and environmental matrices with as little preprocessing of the sample. For example, testing whole blood from a finger prick is preferable to serum from venous blood.

Devices should demonstrate sufficient analytical sensitivity, specificity and total (positive and negative) predictive value for infectious disease diagnostic applications. The Devices and Assays should be designed to diagnosis diseases whose origin is an infectious agent, pathogen, or toxin (organized as panels by syndromic presentation or pathogen class), and/or biomarkers of

exposure to said agents. Analytes of interest include both pathogen and host-related exposure class-differential diagnostic markers. The ability to differentiate between pathogens that cause non-specific febrile systemic disease that needs to be differentially ruled in (and preferably ruled out) such as Malaria (specifically *P. falciparum*), Arboviral diseases (e.g. dengue, chikungunya, etc.), Typhoid, Arenaviral diseases, Rickettsial diseases, Viral hemorrhagic fevers (specifically Lassa fever and Ebola), Plague, Tularemia (*Francisella tularensis*), and melioidosis (*Burkholderia pseudomallei*) is desirable. The Government is also highly interested in capabilities for the rapid analysis of Antimicrobial/Multi-drug resistance (AMR/MDR) sensitivity. Detection should be possible out of the appropriate sample matrix (*e.g.,* whole blood, serum, urine, saliva) with sample collection occurring at similar environmental conditions to the device operation. Sample preparation should be minimal or preferably automated. It is not a requirement that the device technology fulfilling the requirements outlined above be specifically designed for these pathogens/diseases, but the technology must be easily adaptable to such pathogens/diseases. A full use scenario from sample collection, through sample preparation, to answer must be offered with preference given to fully automated and user-friendly solutions.

NRL will work cooperatively with the Offeror to test and verify performance of the devices and to assist in the integration of the diagnostic devices with communication and device hardening for Echelon 1 application. The offeror must demonstrate manufacturing capability, or partnerships for manufacturing, that assure prototype Devices and Assays will be available for field deployment and testing at the end of the performance period.

Any potential International Traffic in Arms Regulations (ITAR) restrictions, including any anticipated restrictions likely to be generated by the proposed work plan, must be listed.

Tiered evaluation model

It is anticipated that the MEDx program will provide up to two years of funding for research and development through competitive prototyping. The timeline will be divided into three Tiers. The first Tier will be no more than 5 months and include time for NRL to independently benchmark the performance of the offerors technology with the current assay that best matches the stated diagnostic needs; note that not every need must be met by the technology at the time of proposal, but a clear path towards meeting those needs within the overall span of the program options must be described. Technologies of sufficient merit will be advanced to an optional second Tier that engages the offeror in research and development of the technology to meet all needs outlined with a performance period up to 12 months. Following the performance period, the developed technology will be again be independently benchmarked by NRL. Finally, an optional third Tier of 3-9 months can be activated for the field deployment of the developed technology. The offeror will need to manufacture enough devices to supply the field study. Exact number of devices will depend on the offered technology, but anticipated requirements are for 500-5000 devices. These three Tiers include device development, testing and demonstration, evaluation, reporting, and selection activities. Selection of device candidates to be advanced into Tier 2 and Tier 3 will be based on specific parameters and metrics being successfully met in demonstration exercises. The

Government shall provide technical data and support for demonstrations, as well as facilitate interaction with relevant DoD and Interagency stakeholders.

Address White Papers (WP) toNRL_6170_MEDX@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a White Paper by NRL. If necessary, NRL will initiate substantive contact.

Appendix A: Echelons of Care Definitions. Information taken from:
Cubano, M.A.; Lenhart, M.K. *Emergency War Surgery*; US Army, Office of the Surgeon General; eBook; 2014; pp 410; ISBN: 016092197X.

Chapter 2

Levels of Medical Care

Military doctrine supports an integrated health services support system to triage, treat, evacuate, and return soldiers to duty in the most time efficient manner. It begins with the soldier on the battlefield and ends in hospitals located within the continental United States (CONUS). Care begins with first aid (self-aid/buddy aid, and combat lifesaver), rapidly progresses through emergency medical care (EMT) and advanced trauma management (ATM) to stabilizing surgery, and is followed by critical care transport to a level where more sophisticated treatment can be rendered.

There are **five levels of care (also known as "roles")**, previously referred to as echelons by NATO and ABCA (USA, Britain, Canada, Australia) countries. Levels should **not to be confused with American College of Surgeons use of the term in US trauma centers**. Different levels denote differences in capability, rather than the quality of care. Each level has the capability of the level forward of it and expands on that capability. Soldiers with minor injuries can be returned to duty after simple treatments at forward locations, all others are prepared for evacuation with medical care while en route to a higher level.

Level I

- Immediate first aid delivered at the scene.
  - First aid and immediate life-saving measures provided by self-aid, buddy aid, or a **combat lifesaver** (nonmedical team/squad member trained in enhanced first aid).
  - Care by the trauma specialist (91W) (**combat medic**), assigned to the medical platoon, trained as an Emergency Medical Technician-Basic (EMT-B). Some other primary

care providers, with various levels of training, include the Special Forces Medical Sergeant 18D, Special Operations Combat Medic 91W, SEAL Independent Duty Corpsman, Special Boat Corpsman, Pararescueman, and Special Operations Medical Technician.
    - Initial treatment of nuclear, biological, and chemical casualties, treatment of toxic industrial material casualties, primary disease prevention, combat stress control measures, and nonbattle injury prevention.
- Level I medical treatment facility (MTF) (commonly referred to as the Battalion Aid Station [BAS]).
    - Provides triage, treatment, and evacuation.
    - Physician, Physician Assistant (PA), and medics.
    - Return to duty, or stabilize and evacuate to the next level.
    - Can be chem/bio protected.
    - No surgical or patient holding capability.
- US Marine Corps (USMC): Shock Trauma Platoon (STP).
    - Small forward unit supports the Marine Expeditionary Force (MEF).
    - Stabilization and collecting/clearing companies.
    - 2 physicians.
    - No surgical capability.
    - Patient holding time limited to 3 hours.

Level II

- Increased medical capability and limited inpatient bed space.
- Includes basic primary care, optometry, combat operational stress control and mental health, dental, laboratory, surgical (when augmented) and X-ray capability.
- 100% mobile.
- Each service has a slightly different unit at this level.

- **Army.**
    - **Level II MTFs** operated by the treatment platoon of divisional/nondivisional medical companies/troops.
        - Basic/emergency treatment is continued.
        - Packed RBCs (Type 0, Rh positive and negative), limited X-ray, laboratory, and dental.
        - 20–40 cots with 72-hour holding.

- Can be chem/bio protected.
- No surgical capability.

- **Forward Surgical Team (FST).**
  - Continuous operations for up to 72 hours.
  - Life-saving resuscitative surgery, including general, orthopedic, and limited neurosurgical procedures.
  - 20-person team with 1 orthopedic and 3 general surgeons, 2 nurse anesthetists, critical care nurses and technicians.
  - The supporting medical company must provide logistical support and security. (Doctrinally, the FST is collocated with a Medical Company.)
  - ~1,000 sq ft surgical area.
  - Can be chem/bio protected.
  - Operational within 1 hour of arrival at the supported company.
  - May be transported by ground, fixed wing, or helicopter; some fleet surgical teams (FSTs) are airborne deployable.
  - 2 operating tables for a maximum of 10 cases per day and for a total of 30 operations within 72 hours.
  - Post-op intensive care for up to 8 patients for up to 6 hours.
  - X-ray, laboratory, and patient administrative support provided by the supporting medical company.
  - Requires additional electricity, water, and fuel from the supporting medical company.
  - The FST is not designed, staffed, or equipped for stand alone operations or conducting sick-call operations. Augmentation requirements are discussed in FM 4-02.25.

- **Air Force.**
  - **Mobile Field Surgical Team (MFST).**
    - 5-person team (general surgeon, orthopedist, anesthetist, emergency medicine physician, and OR nurse/tech).
    - 10 life/limb saving procedures in 24–48 hours from five backpacks (350 lb total gear).
    - Designed to augment an aid station or flight line clinic.
    - Not stand alone, requires water, shelter of opportunity, communications, among other things.

- Integral to remainder of Air Force (AF) Theater Hospital System.

- **Small Portable Expeditionary Aeromedical Rapid Response (SPEARR) team.**
  - 10-person team: 5-person MFST, 3-person CCATT (see Chapter 4, Aeromedical Evacuation) and a 2-person preventive medicine (PM) team (flight surgeon, public health officer).
  - Stand alone capable for 7 days, 600 sq ft tent.
  - 10 life/limb saving procedures in 24–48 hours.
  - Designed to provide surgical support, basic primary care, post-op critical care, and PM for early phase of deployment.
  - Highly mobile unit, with all equipment fitting in a one-pallet–sized trailer.
- **Expeditionary Medical Support (EMEDS) Basic.**
  - Medical and surgical support for an airbase, providing 24-hour sick call capability, resuscitative surgery, dental care, limited laboratory and X-ray capability.
  - 25 member staff includes SPEARR team.
  - 4 holding beds, 1 OR table, 3 climate controlled tents, and 3 pallets.
  - 10 life/limb saving procedures in 24–48 hours.
  - ~2,000 sq ft.
- **EMEDS + 10.**
  - Adds 6 beds to EMEDS Basic, for total of 10.
  - No additional surgical capability.
  - 56-person staff.
  - 6 tents, 14 pallets.
  - Can be chemically hardened.

- **Navy.**
  - **Casualty Receiving & Treatment Ships (CRTS)**. CRTSs are part of an Amphibious Ready Group (ARG) and usually comprise one landing helicopter assault or amphibious (LHA) Tarawa-class or landing helicopter deck (LHD) Wasp-class ship, which are Marine amphibious

assault helicopter carriers that function as casualty receiving platforms. An ARG includes up to 6 ships with surgical capability only on the CRTS.

- 47-48 beds, 4-6 ORs, 17 ICU beds.
- 300 additional medical care beds may be available once Marines disembark.
- Fleet Surgical Teams (FSTs): 3-4 physicians, 1 surgeon, 1 CRNA or anesthesiologist and support staff.
- Usually 2 general surgeons and 2 orthopedic surgeons. OMFS (oral maxillofacial surgery) support available through the dental department. Can be substantially augmented.
- Laboratory, X-ray.
- Excellent casualty flow capability (large helicopter flight deck and landing craft units [LCU] well deck).
- Mass casualty (MASCAL) capability with triage area for 50 casualties.
- Doctrinally, holding capability is limited to 3 days.

- **Aircraft Carrier (CVN) Battle Group.**
  - 1 OR, 40–60 beds, 3 ICU beds.
  - 1 surgeon, 5 other medical officers.
  - Up to 9 ships, but usually only the CVN has physicians. Medical assets aboard aircraft carriers are intended for use by the aircraft carrier and its task force. Aircraft carriers are NOT casualty receiving ships and are not figured into medical assets for support to ground forces.
- **USMC.**
  - **Surgical Company**.
    - Provides surgical care for a MEF (Marine Expeditionary Force). Basis of allocation is 1 per infantry regiment.
    - 3 ORs, 60-bed capability.
    - Patient holding time up to 72 hours.
    - Stabilizing surgical procedures.
  - **Forward Resuscitative Surgical System (FRSS)**.
    - Embedded organically as part of the TO&E of the surgical company, if employed reduces the capability of its parent surgical company.

- Rapid assembly, highly mobile.
- Resuscitative surgery for 18 patients within 48 hours without resupply.
- 1 OR, 2 surgeons.
- No holding capability.
- No intrinsic evacuation capability.
- Chem/bio protected.
- Stand alone capable.

Level III

Represents the highest level of medical care available within the combat zone with the bulk of inpatient beds. Most deployable hospitals are modular, allowing the commander to tailor the medical response to expected or actual demand.

- **Army.**
  - Two different Corps-level Combat Support Hospital (CSH) designs.
    - Medical Force 2000 (MF2K) CSH.
    - Medical Reengineering Initiative (MRI) CSH will replace the MF2K.
  - **Combat Support Hospital.**
    - **MF2K CSH.**
      - Resuscitation, initial surgery, post-op care, and either return to duty or stabilize for further evacuation.
      - Up to 296 patients, typically divided into 8 ICUs (96 ICU beds), and 7 Intermediate Care Wards (ICWs) (140 beds), 1 neuropsychiatric (NP) ward (20 beds), and 2 minimal care wards (40 beds).
      - 175 officers, 429 enlisted; specialty attachments may increase numbers.
      - Up to 8 OR tables for a maximum of 144 operating hours per day.
      - General, orthopedic, urologic, neurosurgical, dental and oromaxillofacial surgery.
      - Blood bank, laboratory, X-ray/computer tomography (CT); nutrition, physical therapy and NP capabilities.
      - Dependent on a number of Corps support elements for personnel, finance, mortuary, legal, laundry,

security, and enemy prisoners of war (EPW) management, support.

- ◊ Transportation support required for both incoming and outgoing patient evacuation, and to transport the hospital.
- ◊ Transported via semitrailer, railcar, air cargo, or ship.
- ◊ Fully deployed CSH (including motor pool, billeting, heliport, and other life support activities) covers 30.3 acres.
- ◊ Divided into modules, deployed as a single unit or separately as the mission dictates. The main modules are the Hospital Unit-Base (HUB) and the Hospital Unit-Surgical (HUS).
  - HUB is the infrastructure of the CSH.
    - Up to 236 patients, divided into 36 ICU, 140 intermediate, 40 minimal, and 20 NP beds.
    - Two operating modules with specialty surgical care capability.
    - HQ, administrative, personnel, chaplain, laboratory, pharmacy, X-ray, and blood bank services.
    - Part of the HUB can be chem/bio protected (FM 4-02.7).
  - HUS capabilities.
    - 60 ICU patients, 2 OR modules, X-ray.
    - Dependent on the HUB for all logistical support.
    - Can be deployed forward, separate from the HUB, for brief periods as the mission dictates.

- **MRI CSH (Corps).**
  - Provides hospitalization and outpatient services for all classes of patients in the theater, either returned to duty or stabilized for further evacuation.
  - Headquarters/headquarters detachment: 15 officers and 44 enlisted.
  - Up to 248 patients, typically divided into an 84-bed hospital company and a 164-bed hospital company, with split base operations capability.

- **84-bed hospital company.**
  - 24 ICU beds.
  - Up to 2 OR tables, maximum of 36 operating hours per day.
  - 3 ICWs (total 60 beds, including NP patients).
  - 56 officers and 112 enlisted personnel.
    - Some patient care areas can be chem/bio protected.
- **164-bed hospital company.**
  - 24 ICU beds.
  - Up to 4 OR tables, maximum of 60 operating hours per day.
  - 7 ICWs (total 140 beds, including NP patients).
  - 84 officers and 169 enlisted personnel.
    - Some patient care areas can be chem/bio protected.
- **Applicable to 84-, 164-, and 248-bed (see CSH [Echelon of Care, EAC] below) hospital companies.**
  - General, orthopedic, urologic, thoracic, OB/GYN, neurosurgical, dental and oromaxillofacial surgery.
  - Blood bank, laboratory, X-ray, nutrition, and physical therapy.
  - Dependent on EAC support elements for personnel, finance, mortuary, legal, laundry services, security and EPW support.
  - Parts can be chem/bio protected.
  - Transportation support required for both incoming and outgoing patient evacuation, and to transport the hospital.
  - Transported by semi-trailer, railcar, air cargo, or ship.
  - Fully deployed, covers 5.7 acres.
  - Minimal care wards are provided by an attached minimum care detachment.

- **Air Force.**
  - **EMEDS +25.**
    - 25-bed version of EMEDS Basic.
    - 84 personnel, 2 OR tables, 9 x 600 sq ft tents, and 20 pallets.
    - 20 operations in 48 hours.
    - Can be chemically hardened.

- Additional specialty modules can be added, including vascular/cardiothoracic, neurosurgery, OB/GYN, ear, nose and throat (ENT), ophthalmology teams; each comes with own personnel and equipment.

- **Navy.**
  - **Fleet Hospital.**
    - 500-bed hospitals, 80 ICU beds, and 6 ORs.
    - 1,000 personnel.
    - Stand alone; full ancillary services.
    - 8–10 days to be operational.
    - Large footprint — 28 acres, 450 isolation (ISO) shelters.
    - No limit on holding capability.
  - **Hospital Ships (TAH) — USNS Mercy and USNS Comfort.**
    - 1,000 beds, 100-bed ICU capability, and 12 ORs.
    - 1,000 staff, over 50 physicians.
    - Extensive laboratory and X-ray capabilities.
    - Patient holding is doctrinally limited to 5 days.

Level IV

- Definitive medical and surgical care outside the combat zone, yet within the communication zone/EAC of the theater of operations (TO).
- Patients requiring more intensive rehabilitation or special needs.
- Traditionally includes the MF2K Field Hospital (FH) and General Hospital (GH).
- In some situations, the MF2K CSH or a fixed hospital may act as a Level IV facility (eg, Landstuhl Army Regional Medical Center, Germany).
  - **Field Hospital.**
    - Semipermanent hospital that provides primarily convalescent care.
    - At least 2 OR tables for 24 OR hours per day.
    - General, orthopedics, OB/GYN, urologic, oral surgery, and dental services.
    - Up to 504 patients, with 2 ICUs (24 patients), 7 ICWs (140 patients), 1 NP ward (20 patients), 2 minimum care wards (40 patients), and 7 patient support sections (280 patients).

- **General Hospital.**
  - Usually a permanent or semipermanent facility.
  - At least 8 OR tables for 144 OR hours per day.
  - General, orthopedic, gynecologic, urologic, and oral surgery.
  - Dental and optometry services.
  - Outpatient specialty and primary care services.
  - Up to 476 patients, with 8 ICUs (96 patients), 16 ICWs (320 patients), 1 NP ward (20 patients), and 2 minimum care wards (40 patients).

The MRI CSH Echelon Above Corps (EAC) will replace the FH and GH.

- **CSH (EAC).**
  - Headquarters/headquarters detachment: 17 officers and 33 enlisted.
  - Cannot operate in a split-based mode like the CSH (Corps).
  - 248-bed hospital company.
    - 4 ICUs (total 48 ICU beds), and 10 ICWs (total 200 beds, including NP patients). A specialty clinic section that can treat NP patients. Minimal care wards are provided by attached minimum care detachments.
    - 140 officers, 244 enlisted personnel.
    - Up to 6 OR tables for 96 operating hours per day.
    - Fully deployed (including motor pool, troop billeting, heliport, and other life support activities), covers 9.3 acres.
    - See other general characteristics under MRI CSH (Corps).

Level V

This level of care is provided in the CONUS. Hospitals in the CONUS sustaining base will provide the ultimate treatment capability for patients generated within the theater. Department of Defense (DoD) hospitals (military hospitals for the tri-services) and Department of Veterans Affairs (DVA) hospitals will be specifically designated to provide the soldier with maximum return to function through a combination of medical, surgical, rehabilitative, and convalescent care. Under the

National Disaster Medical System, patients overflowing DoD and DVA hospitals will be cared for in designated civilian hospitals.

63-24-01 - MATERIALS PERFORMANCE, PROCESSING, AND MODELING

The Materials Science & Technology Division (MSTD) of the Naval Research Laboratory (NRL) is interested in receiving proposals for research and development in materials, their joining, and their processing, including modeling of materials performance and joining and forming processes to achieve cost- effectiveness. The areas of research and development activities of interest to NRL include, but are not limited to the following:

1) Modeling - Microstructural/continuum modeling for the development of predictive equations of state for materials which could greatly reduce costs of developing new alloys and forming processes as well as permit optimization of properties and plant weldable aluminum and iron alloys of high strength, toughness, stress corrosion cracking resistance, reduced hydrogen embrittlement, etc.

2) Forming/Machining - Forming and machining of hard-to-form and/or machine alloys by the application of high fields. This may include the application, singly or in combination, of electric, magnetic, ultrasonic, and microwave fields and address the casting and/or forming to near-net-shape by rolling, drawing, or forging and the machining by point cutting or grinding of any low ductility materials such as tungsten alloys, aluminides, etc.

3) Processes for Lower Life Cycle Costs/Simulations - Design of manufacturing processes that achieve desired product attributes at lowest total life cycle cost. This may include the integration of several unit forming processes and the simulation of such processes to account for geometric effects and the effects of evolving material microstructure and temperature and stress fields. Total life cycle spans issues from the initial material synthesis to the final disposition of components including all costs of acquisition and ownership.

4) Smart Materials - Demonstrate the application of "smart materials and structures" (SM&S), in military and dual-use systems. Generically, SM&S should have the capability to sense environmental stimuli, process the acquired data, and actively respond in a controlled manner to achieve a desired goal. This includes a wide range of materials (e.g., shape memory alloys, electrostrictive ceramics, ionic/conductive polymers, and polymer fibers and films, etc.), control algorithms and signal processors, and their assembly into devices that can be made to perform battle-related actions robotically (e.g., swim, fly, walk, etc.).

5) Superconductivity - Development of superconducting materials, devices, components, and systems that address crucial Naval and DoD requirements. Although the principal area of interest is in superconductors with transition temperatures above 30K, unusually sound proposals for research and development devices, components, and circuits fabricated from materials with superconducting transition temperatures below 30K will be considered if deemed suitable for potential Naval applications.

Address White Papers (WP) to Code 6300, by email to mstdbaa@nrl.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

67-24-01 - BASIC AND APPLIED RESEARCH IN PLASMA SCIENCE

The Naval Research Laboratory (NRL) is interested in receiving proposals that address basic and applied experimental, theoretical and computational research to advance fundamental knowledge in high temperature plasmas.

Specific areas of interest include:

1) Theoretical and experimental studies of krypton-fluoride and argon-fluoride laser systems, both single pulse and repetitively pulsed, includes pulsed power, optics and electron beam generation, propagation and transport. Study of laser-matter interactions and strongly-coupled plasmas for high energy density science. Theory and experimental studies of laser-plasma instability at high intensity and materials at extreme conditions..

2) High energy pulsed power systems employing capacitive and inductive energy storage. Production of pulsed plasma and intense high-power, charged particle beams including single pulse and high average (rep-rated) power systems. Modeling and simulation of pulsed power devices and applications. Pulsed-power-driven radiation and acoustic shock generation sources. Primary energy storage and thermal management for pulsed power systems.

3) Theoretical and large-scale computational modeling of ionospheric, magnetospheric, solar and space plasmas.

4) Theoretical studies and computer simulations of nonlinear dynamic phenomena and novel nonlinear algorithms for use in applications such as nonlinear time series analysis, analysis of complex data sets, study of adaptive networks, analysis and control of coupled systems, and emergent structures in stochastic dynamics.

5) Theoretical and experimental research in the areas of coherent radiation sources, systems, and propagation, including microwave and millimeter-wave sources, high energy lasers, and ultrashort pulse lasers. Research includes beam control, secondary radiation generation, interaction with materials, sources of mid and long wavelength infrared pulses, and laser acceleration of particles.

6) Diagnostic and data handling/analysis techniques applicable to pulsed or dc measurements for remote sensing and laser-matter interactions, including real time diagnostics and post-interaction analysis.

7) Theoretical and experimental research into the production of plasmas in neutral gas

backgrounds using RF excitation, plasma discharges, beam ionization, or other techniques. Development, testing, and analysis of advanced plasma diagnostics for partially ionized gas distributions. Investigations of the interaction of plasmas with gas distributions, surfaces, or coatings on surfaces. Development or utilization of specialized diagnostics to analyze plasma effects. Analysis of experimental results and comparison with theoretical predictions.

8) Theoretical and experimental research on microwave, millimeter-wave, low temperature plasma or pulsed electron beam processing or synthesis of materials, including ceramics, metals, liquids, or gas mixtures.

9) Experimental research in high-velocity electromagnetic launchers. Design of launcher barrels and armatures. Diagnostics of launcher performance. Pulsed power systems for electromagnetic launch. Novel applications of electromagnetic launchers, including laboratory studies of shock generation in materials.

10) Theoretical and experimental research on high-energy-density plasma (HEDP) physics, including atomic processes and advanced plasma diagnostics. Physics and simulation of high-energy-density plasmas produced by electron beams, lasers, or Z-pinches. Computational tools to understand the coupling of ionization, radiation transport, and plasma dynamics in HEDP environments.

11) Development of novel and robust detection systems suitable for high-power pulsed environments, consisting of temporally-, spatially-, and/or spectrally-resolved detectors for x-ray, high-energy gamma, or neutron (both fast and thermal) emissions and mode-differentiating data acquisition electronics.

12) Theoretical and experimental research on the generation and diagnosis of space plasmas. Developmental research of advanced plasma diagnostics for space plasmas using ground-based simulation chambers or space-based platforms. Integration of advanced diagnostics into space platforms. Interfacing of experimental hardware with space craft. Acquisition of data, analysis, and comparison with theoretical models or other data.

13) Theoretical research on hypersonic plasmas generated by air-breathing and reentry vehicles or guided projectiles. The emphasis is on the plasma chemistry in the interface layer between the vehicle/projectile surface and ambient environment that is in contact with that surface, known as hypersonic shock wave boundary layer. Shocks, thermal heating, plasma formation, and energy exchange between the surface and plasma are modeled.

Address White Papers (WP) to nrl6701@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

68-24-01 - RADIATION EFFECTS RESEARCH

The Solid State Devices Branch of the Electronics Science and Technology Division of the Naval Research Laboratory (NRL) is interested in receiving proposals to investigate the effects of radiation on advanced solid state devices, developing methods to mitigate these effects, and detecting radiation. The radiation of interest includes the natural radiation environment of space (trapped particles, cosmic ray ions, solar protons, etc.) and non-natural sources (gamma rays, neutrons, pulses of energy, etc.). The effects include total dose and displacement damage and single event effects including upset, latchup, gate rupture, etc. The devices of interest include, but are not limited to, advanced technology memory devices, gate arrays, microprocessors, imagers, solar arrays and energy storage devices such as batteries. Mitigation effects include hardening by processing or design or shielding techniques especially using novel and innovative ideas not previously investigated.

Address White Papers (WP) to nrl_Quantum_Optoelectronics@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

68-24-02 - PHOTOVOLTAICS FOR PORTABLE POWER

The Optoelectronics and Radiation Effects Branch of the Electronics Science and Technology Division of the Naval Research Laboratory (NRL) is interested in receiving proposals to investigate photovoltaic (PV) technologies that enable portable power sources. These power sources are intended for man-portable applications as wells as powering unattended, remote systems. PV devices that provide high photon to electric conversion efficiency and can be produced on flexible substrates are of particular interest for forming flexible PV blankets. PV devices that can be directly integrated into a system for remote powering are also of interest. Proposals ranging from basic device development to system demonstration are encouraged.

The Quantum and Optoelectronics Branch of the Electronics Science and Technology Division of the Naval Research Laboratory (NRL) is seeking proposals to investigate optical wireless power transfer technologies that can power unattended, remote systems via ground-to-ground, ground-to-air, air-to-ground, or ship-to-shore transmission. Of particular interest is the ability to convert at least 1 kW of power at a distance of at least 3 km. The system must be capable of automatically shutting off to prevent damage/injury in the event that an asset (ground, air, or satellite) crosses the transmission path. Safety system must be capable of operation both day and night, as well as in inclement weather or in the event of GPS failure. Photovoltaic receive aperture must be less than one square meter in diameter, and the transmitter should be a modular laser with variable output power up to 5 kW (optical) and capable of continuous operation. Desirable photovoltaic receiver attributes include high conversion efficiency, scalability, and the

ability to manage substantial thermal loads imposed by the incident laser. System-level demonstration should show ability of long-range wireless power transfer for charging military batteries. Proposals ranging from basic device development to system-level demonstrations are encouraged.

The Quantum and Optoelectronics Branch of the Electronics Science and Technology Division of the Naval Research Laboratory (NRL) is seeking proposals to investigate modeling, simulation, and analysis (MS&A) to supply quantitative insights into the first, second, and third order operational effects that can be realized when advanced optical wireless power transfer technology is brought to the battlefield. MS&A must involve purpose-built models and apply data from separate experimental demonstrations (experimental technology demonstrations outside the scope of MS&A proposal) to both calibrate modeled inputs and supply a trajectory for optical wireless power transfer capability development as well as its associated operational impact.

Address White Papers (WP) to nrl_Quantum_Optoelectronics@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

C. OCEAN AND ATMOSPHERIC SCIENCE AND TECHNOLOGY DIRECTORATE CODE 7000

71-24-01 - ACOUSTIC SIMULATION AND TACTICS

The Naval Research Laboratory (NRL) conducts broad-based research in ocean acoustics to better understand the effects of the ocean environment on underwater acoustics, and to assess and predict how these environmental effects will impact the performance of Naval systems, operations, and missions. The "ocean environment" includes three-dimensional, time-evolving features such as rough air-sea interfaces, sub-surface bubbles and plumes, volume effects (e.g., internal waves, solitons, fluctuating media, biologics, pollutants, fronts, eddies), rough sea-floor interfaces, and ocean bottom and sub-bottom regions. "Underwater acoustics" includes all acoustic processes and interactions that can occur within the ocean environment (e.g., propagation, scatter, attenuation, dispersion, mode conversion, coherence, ambient noise and sediment penetration). "Naval systems, operations, and missions" include, but are not limited to, sonar systems, Anti-Submarine Warfare (ASW), Mine Counter Measures (MCM), warfare effectiveness, and strategy and tactics optimization. Numerical techniques and computer codes are developed as required to support the Navy's need for improved ocean acoustics models and data bases and to provide supporting analysis for operational and tactical application of computer models.

Current major areas of research interest include:

1) Acoustic Simulation and Modeling (e.g., theoretical formulations, computational acoustics, numerical modeling, inverse methods, stochastic methods, visualization, and scalable computer and supercomputer code development);

2) Warfare Effectiveness (i.e., research in advanced methods of assessing environmental impact on Naval missions and strategy optimization);

3) Mid to High-Frequency Acoustics efforts related to the effect of the environment on the performance of Navy sonar systems, including the effects of the medium coherence, bottom roughness, sediment composition, clutter and their effects on advanced imaging techniques;

4) The application of sophisticated signal processing methodologies (e.g., matched field processing and high-order spectral techniques), to determine the limits and variability of harsh environments on the performance of Navy sonar systems;

5) Novel optimization, physics-informed machine learning, and advanced, modern techniques for acoustic applications;

6) The combination of acoustics with other sensing techniques, such as optics, magnetics, electromagnetics, hydrodynamics, geophysics and others for both ASW and MCM applications;
   a. Acoustic environmental characterizations, data base modeling, and analysis of those aspects of the marine environment relevant to acoustic propagation; and
   b. Coupled target-waveguide modeling and target recognition, classification, and discrimination.

Proposals for evolutionary improvements are inappropriate under BAA authority and are not desired.

Address White Papers (WP) to NRL_Code7180_BAA@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

72-24-01 - LOW FREQUENCY RADIO INTERFEROMETRY

The Remote Sensing Division of the Naval Research Laboratory is developing and deploying imaging HF/VHF radio interferometers for use in developing, demonstrating, and exploiting interferometric imaging through the ionosphere at low frequencies. NRL is interested in proposals for innovative basic and applied research leading to the development of new capabilities and applications for these instruments; the development of new techniques for wide-

field interferometric imaging, ionospheric phase correction, or interference excision; or for other innovative science or technical development related to long wavelength radio interferometry.

Proposers may respond to one or more areas of interest or may propose clearly related investigations; however, each area requires an individual and complete proposal which will be separately evaluated.

Research may be conducted at the unclassified level and proposals must be unclassified.

Address White Papers (WP) to nrl_7200_baa@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

72-24-02 - OPTICAL REMOTE SENSING OF THE COASTAL REGIME

The Remote Sensing Division of the Naval Research Laboratory (NRL) is developing methods and instrumentation for the remote sensing of coastal waters, near shore areas and adjacent lands, and other coastal regions by means of optical sensors working throughout the electromagnetic spectrum – both active and passive – and the algorithms associated with sensor data. NRL is interested in innovative proposals for basic and applied research which will lead to improved retrieval of environmental parameters be that from novel or improved instrumentation or algorithms. Additionally, the ability to model the performance of instruments and methods in various situations is desirable.

Proposers may respond to one or more areas of interest or may propose clearly related investigations; however, each area requires an individual and complete proposal which will be separately evaluated.

Address White Papers (WP) to nrl_7200_baa@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

72-24-03 - REMOTE SENSORS AND IMAGING SYSTEMS

The Remote Sensing Division conducts a program of basic research, science, and applications aimed at the development of new concepts for sensors and imaging systems for objects and targets on the Earth and in the near-Earth environment, as well as deep space. The research focuses on the discovery and understanding of the basic physical principles and mechanisms that give rise to the background environmental emission and targets of interest and to absorption and emission mechanisms of the intervening medium. The development effort includes active and passive sensor systems to be used for the study and analysis of the physical characteristics of phenomena that give rise to naturally occurring background radiation, such as that due to the

Earth's atmosphere and oceans, as well as man-made or induced phenomena such as ship/submarine hydrographic effects. The research includes theoretical, laboratory, and field experiments leading to ground based, airborne and space systems for use in such areas as remote sensing, astrometry, astrophysics, surveillance, environment and improved operational support systems for the Navy. Areas of interest include all levels of the atmosphere (lower, middle, and upper) and space environment, air/sea interface and oceanography. Special emphasis is given to developing space-based sensors and improving the exploitation of existing space systems. Innovative research is desired in areas of interest including, but not limited to, the following:

1) The impact of the physics of atmosphere and ocean interaction on physical and biological sea surface characteristics, from the viewpoint of global surveillance systems.

2) Research attempting breakthrough advancements in imaging data compression methodology, scene classification, and coherent/non-coherent sensor exploitation.

3) Atmospheric gases and aerosol measurements. Research in this area is wide ranging: propagation effects, pollutant monitoring, global climate change, and cloud physics.

4) Development of instruments, models, and retrieval algorithms for passive remote sensing of the oceans, atmosphere, and land.

Address White Papers (WP) to nrl_7200_baa@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

72-24-04 - AIRBORNE, SHIPBOARD, AND OVERHEAD DATA ACQUISITION AND ANALYSIS

The Coastal and Ocean Remote Sensing Branch of the Naval Research Laboratory (NRL) is interested in receiving proposals for research and development in the areas of sensor technology, data acquisition, and data analysis in the field of fixed sensor, airborne and shipboard remote sensing.

The primary areas of interest are synthetic aperture radar, GPS navigation, multi- and hyper-spectral imaging, and radar/laser profilometry. The proposed research would address methods and techniques in data acquisition, analysis, and modeling for all of these sensors, with particular interest in ultra-wide-band SAR and hyperspectral sensors. The research may address issues in surveying and analysis of natural materials - i.e. sediment, water, snow, and ice-surface and sub-surface layers, vegetation, including multi-layered canopies, as well as man-made object and materials property evaluation using all remote sensing modalities from the entire electro-magnetic spectrum range.

The research may involve new and innovative research in long-range kinematic differential GPS navigation with a goal of producing decimeter level positioning of aircraft for baseline lengths of

up to 1,000 kilometers. The research may also involve new methods of acoustic and non-acoustic modeling combining the water column with bottom and sub-bottom acoustic and non-acoustic characteristics in both shallow and deep-water regions. The research may also address issues in seafloor sediment characterization using novel contact and non-contact methods and instruments as well as modeling of sediment behavior in the wide range of deformation and rates-of-deformation regimes – both in situ and in laboratory environments. Furthermore, the research may involve small-SWAP and edge-processing of hyperspectral, multispectral optical data and SAR/RF data for drone applications, including calibrations, positioning and ortho-rectification, radiometric corrections, and other calibration and rectification components.

The Coastal and Ocean Remote Sensing Branch particularly desires proposals on innovative techniques for:

1) Real-time acquisition and storage of data at high rates from numerous sensor channels;

2) Real-time high-speed data analysis and display; and

3) Optimal combined processing of multi-sensor data.

Address White Papers (WP) to nrl_7200_baa@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

73-24-01 - OCEAN DYNAMICS AND PREDICTION OCEANOGRAPHY

The Oceanography Division of the Naval Research Laboratory (NRL) is interested in proposals of basic and applied research in its mission areas of ocean dynamics and prediction, and of ocean feature and process analysis using remote and in situ data. Ocean dynamics and prediction includes basic and applied research in computer modeling of ocean hydro/thermodynamics (i.e., ocean circulation and density structure), modeling of ice dynamics, coupled ocean/acoustic, ocean/atmosphere, ocean/sediment, and ocean/biological model development, computational numerical techniques, visualization of ocean features and dynamical processes, data assimilation and the analysis of satellite oceanographic data as related to the development of modeling and data assimilation capabilities. Deep ocean basins, marginal and semi-enclosed seas, coastal regions harbors and rivers are of interest. Expanded ocean physics included in such systems and areas for future research and development include ocean tide and wave and surf modeling as well as upper ocean processes. Research in computational techniques includes the study of efficient solutions to partial differential equations arising in oceanography with a special focus on efficient utilization of massive parallel processing technology. Ocean feature and process analysis includes development of sensor systems that acquire the in-situ spatial and temporal properties of oceanographic environmental parameters including wave height, wave direction, currents, temperature, salinity, wind speed, and wind direction. Innovative ideas, trawl resistant

designs, real-time data access, and covert operations are of high interest. Development of algorithms and techniques for processing remotely sensed ocean data, with special application to determining ocean features and properties from multispectral, hyperspectral, and optical data is of high interest. Application of ocean data and analysis to systems performance models for emerging and operational Navy sensors and systems is also of interest. The ocean nowcast/forecast and simulation systems have broad and direct application to issues related to Naval operations (ASW, Search & Rescue, Amphibious landing, Mine and Special Warfare, Mission Planning, etc.). These systems also are directly applicable to the simulation and design of global, regional and coastal observing systems.

Address White Papers (WP) to NRL_7302@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

73-24-02 - SEAFLOOR SCIENCES

The Naval Research Laboratory's (NRL) Seafloor Sciences Branch conducts biogeochemical, geophysical, geoacoustic and geotechnical research of marine sediments, which advances the development, and/or performance of naval sensors and systems. Research conducted includes investigation and modeling of the fundamental micro to macro-structural processes which control sediment behavior and seafloor properties. This includes biological, geological, geochemical, historical, and subsequent diagenetic processes that control the distribution, range, and variability of sediment physical properties including bathymetry, roughness, and subseafloor morphology. NRL is responsible for developing, assessing, and improving models and databases for all seafloor properties of interest to the Navy and utilizes state-of-the-art laboratory, in situ, and remote sensing techniques.

Address White Papers (WP) to NRL_7302@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

73-24-03 - GEOSPATIAL SCIENCES AND TECHNOLOGY

The research focus is on development and exploitation of new technology and techniques to support all aspects of geospatial sciences and technology. Current research interest areas are:

1) Geospatial Enterprise Solutions. Web service approaches to service oriented architecture enterprise solutions that promote interoperability and leveraging of community-of-interest content and services for optimized inter agency solutions.

2) Automated Reasoning for Distributed Surveillance and Data Fusion. Approaches to allow advanced reasoning based on multiple, disparate sensor inputs.

3) Open Source Content Exploitation. Techniques to leverage and harness the rapidly expanding structured and unstructured content on open networks.

4) Uncertainty Management. Approaches to allow improved fusion of various sensors with accommodation for propagated uncertainty.

5) Precise Positioning. Techniques for more precisely positioning undersea sensors in the absence of GPS.

6) Acoustic Image Processing. Innovative approaches to exploit acoustic imagery given its complexities inherent in the ocean medium, especially in the area of feature detection and classification.

Address White Papers (WP) to NRL_7302@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

75-24-01 - ATMOSPHERIC EFFECTS, ANALYSIS, AND PREDICTION

The Marine Meteorology Division of the Naval Research Laboratory (NRL) is interested in proposals for innovative basic and applied research in atmospheric sciences to increase our understanding of atmospheric processes and to advance the state-of-the-art in numerical analysis and prediction techniques, from short-term local-scales (microscale and mesoscale) to global-scale phenomena. Areas of active interest include numerical methods; parameterization and explicit prediction of physical processes; assimilation of remotely sensed and other non-conventional data including radar data and data collected by autonomous vehicles; dynamic initialization; variational assimilation and adjoint techniques; predictability, sensitivity, and targeted observation studies; ensemble data assimilation and prediction methods; data assimilation; including coupled air-land-ocean-ice-land-aerosol-clouds; middle-atmosphere prediction; tropical cyclone prediction; air-sea interaction and boundary layer dynamics; large eddy simulations; aerosol and cloud modeling and observations; urban and land surface parameterizations; coupled air-land-ocean-ice-hydrology-wave models; computationally efficient methods for environmental prediction on next-generation architectures; and stream processing and big data analytics for environmental information.

We are also interested in proposals that provide new and novel methods for providing environmental support directly to the warfighter especially using tactical through-the-sensor data. Areas of particular interest include exploitation of atmospheric information from observations and numerical models to derive tactical weather parameters (including the quality control of such information), and research that increases our knowledge of the effects of the atmospheric environment on ship and air platforms as well as on shipboard, airborne, and land-based communications, sensors and weapons systems. Examples of specific research topics

include meteorological applications of remotely sensed and non-conventional data; satellite data interpretation and imagery analysis; atmospheric acoustic propagation prediction; tropical cyclone forecast aids; artificial intelligence techniques and expert system development; model post-processing techniques; nowcasting including combined model, satellite and radar data; weather impact on piloted aircraft and UAV operations; aerosol measurement, characterization, and electro-optical effects; ducting, refractivity, and electro-magnetic effects; and atmospheric dispersion of chemical and biological agents.

Address White Papers (WP) to NRL_7500_BAA@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.

76-24-01 - RESEARCH INTO SPACE, BACKGROUNDS, IMAGING AND MODELING

The Naval Research Laboratory (NRL) is interested in receiving proposals that address basic and applied experimental, theoretical and computational research to advance fundamental knowledge of high-energy space, heliospace, and geospace. The results are of importance to electromagnetic wave propagation, communications, and navigation that affect the operation of ships and aircraft; specification, forecasting, and utilization of the near-space and space environment of the earth; homeland defense; and, the fundamental understanding of natural radiation and geophysical phenomena.

The Space Science Division is interested in receiving proposals for research related to the above research interests.

Address White Papers (WP) to nrl_7600_baa@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact

D. NAVAL CENTER FOR SPACE TECHNOLOGY CODE 8000

82-24-01 - SPACECRAFT & SPACE SYSTEMS TECHNOLOGY

The Spacecraft Engineering Division (SED) at the Naval Research Laboratory (NRL) performs research and development by applying advanced technologies and techniques to provide new space capabilities that address critical Navy, DoD, and national needs. The emphasis at the NRL's SED is incubating critical technologies and assembling them into systems that provide relevant and often revolutionary new space capabilities. Past examples include first flight of solar cells, atomic precision clocks leading to the NAVSTAR Global Positioning System (GPS), and

the first tactical downlink of space data and on-board processed products to Tactical Receive Equipment (TRE). Each of these systems radically improved operational capability and each was enabled by innovative, system application of new technologies. Therefore, NRL's SED seeks a broad range of innovative space systems technologies included associated and enabling ground systems technologies.

NRL's SED performs research and exploratory development in, but not limited to, the following areas: spacecraft payloads; spacecraft structures; spacecraft mechanisms; spacecraft guidance, navigation, and control; spacecraft robotics; spacecraft thermal control; spacecraft power systems; spacecraft propulsion systems; advanced materials for spaceflight use; on-orbit environment monitoring sensors; ground and flight software; spacecraft electronics; spacecraft ground systems; integration and testing; operational user interfaces; space integration into operational tiered systems; and hypersonic systems. SED projects range from basic theory and component technology development to full space systems development and operations.

Address White Papers (WP) to nrl_8200_baa@us.navy.mil. Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.