

ONR Electronic Warfare S&T Industry Day



Revolutionary Research . . . Relevant Results

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C4ISR Department

Office of Naval Research

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Office of Naval Research Science & Technology



ONR Mission: To plan, foster, and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power, and the preservation of national security; and to manage the Navy's basic, applied, and advanced research to foster transition from science and technology to higher levels of research, development, test, and evaluation.

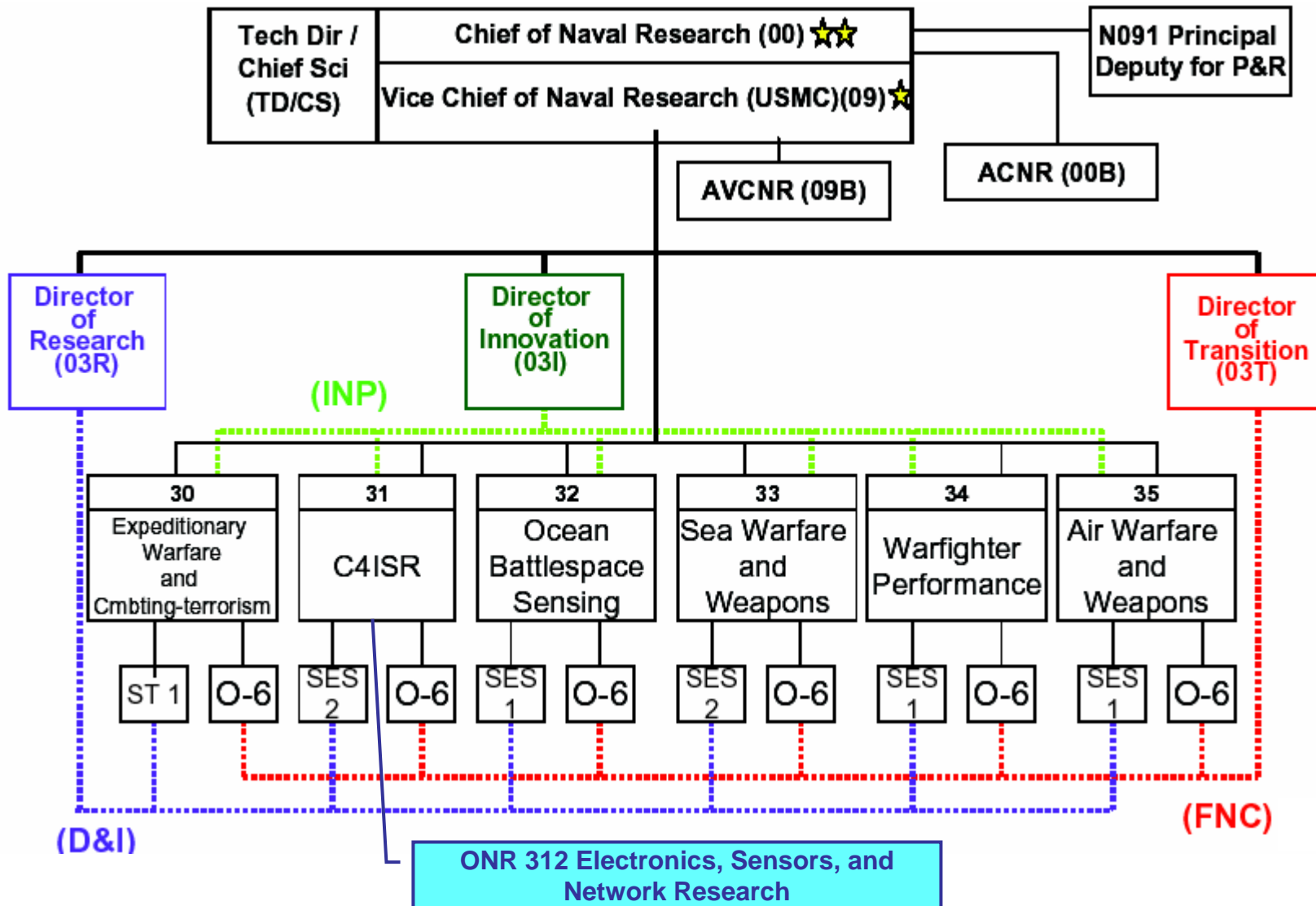
Naval S&T Vision: Sponsor scientific research and technology to:

- ***Pursue revolutionary capabilities for Naval forces of the future,***
- ***Mature and transition S&T advances to improve naval capabilities,***
- ***Respond to current critical needs,***
- ***Maintain broad technology investments to anticipate and counter potential technology surprise.***





Office of Naval Research Organization (S&T)

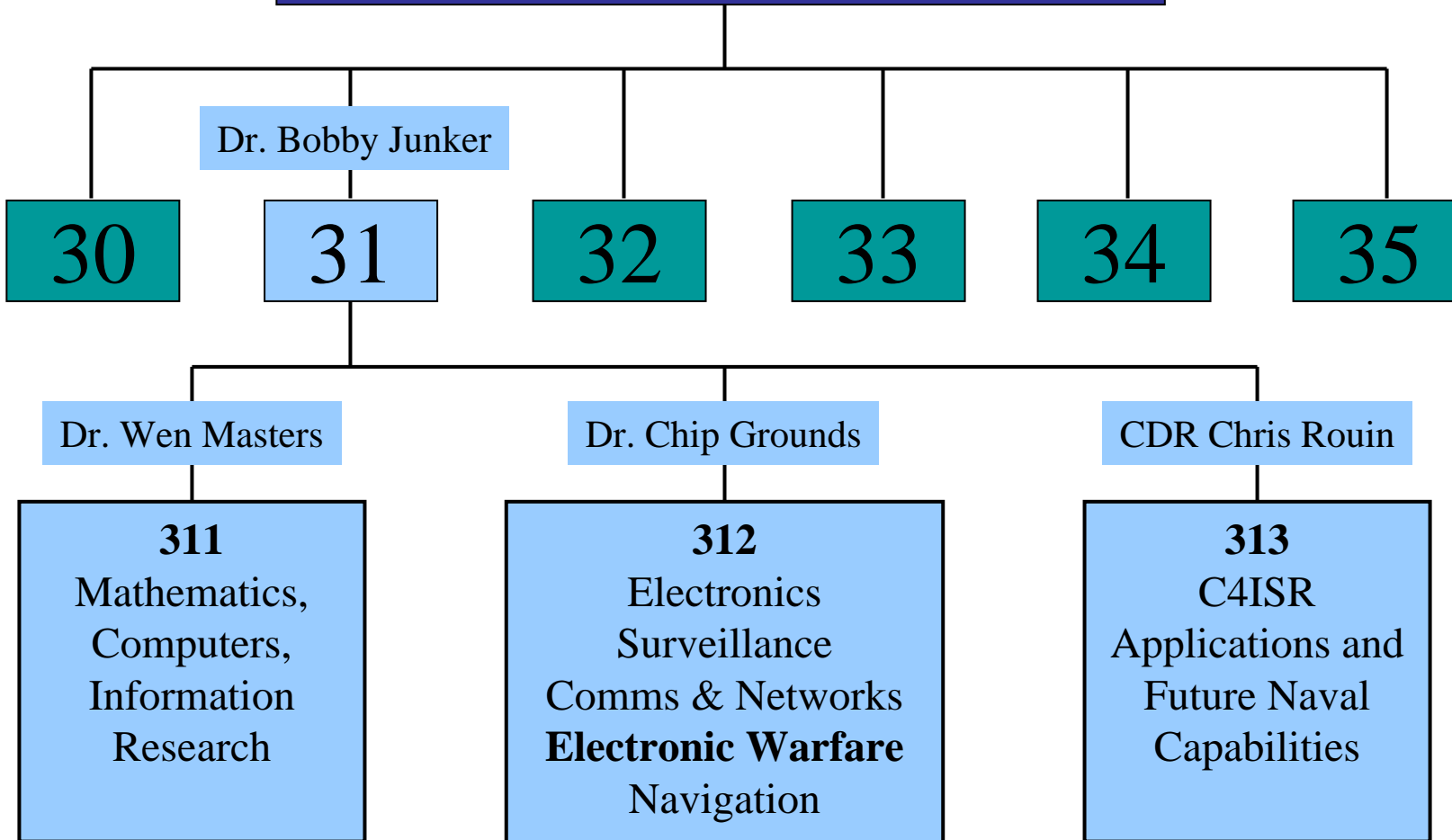




ONR Organization - S&T



Chief of Naval Research





ONR 312 Electronic Warfare



Electronic Warfare Technology Program

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EW Receivers & Transmitters
Countermeasures for Emerging Threats

6.2 Discovery & Invention

EW Signal Processing
Next Generation SEI

EW Modeling & Simulation
Network Centric EW

Future Naval Capabilities (Sea Strike & Sea Shield)

Surface/Subsurface

EA Techniques Countermeasures
Shipboard EO/IR Self Protection
Asymmetric Threat Weapon
ES Detection of LPI Radars

Air

EO/IR Protection for Rotary Wing Acft
EO/IR Laser Jammer for TACAIR
IDECM P3I
Next Generation Airborne EA

Marine Corps

EW Integrated Sys for Small Platforms
Marine Portable EW Technology

SBIR/STTR EW Technologies



Doing Business with ONR



Business Opportunities

- Broad Agency Announcements (BAA)
- Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR)
- Multidisciplinary Research Program of the University Research Initiative (MURI)
- Defense University Research Instrumentation Program (DURIP)
- DoD Experimental Program to Stimulate Competitive Research (DEPSCOR)

Detailed information can be found on the ONR website

http://www.onr.navy.mil/doing_business



What is Electronic Warfare? Joint Service Definition



Development of technologies that maximize the operational use of the electromagnetic (EM) spectrum by U.S. forces, ...while denying same from the enemy, ...by using EM means to detect and attack enemy sensor, weapon and command infrastructure systems

- Immediate battlespace recognition of hostile scenario/intent and optimized, automated response decisions**
- Electronic denial, degradation, disruption or destruction of enemy C4ISR, IADS, acquisition and associated targeting/weapon systems**
- Timely EM control over the entire battlespace: temporal, spectral, spatial**



Electronic Warfare in Perspective



The RED Kill Chain...



... and the Electronic Warfare Response Chain...



Situational Awareness/Threat Warning

Requires capability to:

- Continuously monitor all critical portions of the spectrum
- Quickly and accurately classify emitters/emitter function
- Provide specific emitter identification
- Precisely and rapidly locate platforms, events
- Conduct accurate long term monitoring/tracking
- Share key info in near real time

Counter Targeting/Jamming/ Self-Protection

Requires capability to selectively:

- Limit/deny access (jamming)
- Provide false/misleading information (countertargeting, decoys)
- Counter communications and networks
- Damage/degrade threat sensor capability



EW Networked Capabilities, Analysis & Assessment, Electronic Protection

Battlespace Awareness

Spectrum Control

Information Dominance



Electronic Warfare Terminology

DoD / JCS Definitions



Electronic Warfare (EW): “Any military action involving the use of EM radiation ... to control the EM spectrum or to attack the enemy.”

- **Electronic Support Measures (ESM):** Actions to search for, intercept, ID & locate intentional / unintentional EM sources
 - Purpose: immediate threat recognition (unlike surveillance)
 - Provides information/data for immediate decisions regarding operations & tactical actions (avoidance, targeting, cueing)
- **Electronic Attack (EA):** Use of EM ... to attack with the intent of degrading, neutralizing or destroying enemy combat capability
 - Includes jamming, EM deception



Rationale for Electronic Warfare Joint Service Planning Pubs



Enhance the survivability of the warfighters in their accomplishment of the mission/operation by:

- Providing real-time, accurate & unambiguous threat ID, location and total situation awareness**
- Executing the proper & timely EW/EM response (RF, IR, EO, UV) both on and off platform**
- Exploiting & disrupting enemy battlespace C2 infrastructure and associated targeting/intercept functions.**
 - i.e.: Levels/layers of integrated enemy defense systems and associated communications, redundancies, etc.**



Rationale for Electronic Warfare Joint Service Planning Pubs



Bottom Line: SURVIVABILITY

Platforms/Soldiers have to be in the right positions at the right times in order to achieve military objectives, or effectively contribute to military OR peacetime operations, **...OR THEY HAVE NOT DONE THEIR JOB**

- Unhindered access is required, despite anti-access environment
- Manned or Unmanned or Dismounted

EW is that key mission/task enabler, ... a “cross-cutting capability”, ... in many operations, a pre-requisite



Electronic Warfare S&T Challenges



Must remain responsive to wide array of changing, asymmetric threats ... and span of conflict / rules of engagement (ROEs)

- Peace-time transit ... “watch” operations ... urban conflict ... operations other than war (OOTW) ... to full scale conflict

Trend towards System of Systems (SoS)

- Modularity / scalability
- Multiple geometry, effective ESM/EA, when needed
- Positive command & control of assets

Distributed, self-networking of EW assets

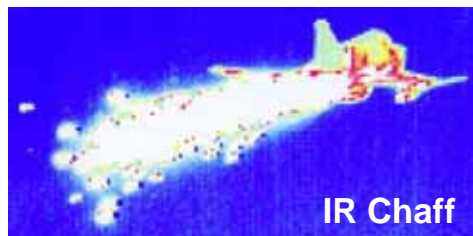
- “Distributed Survivability”
- Automated, unmanned operations (sensor management, optimized positioning, decision-making, ...)
- Larger context: Network Centric Warfare (NCW)

Transformation of EW

- Proactive: take the fight to the enemy
- Dominate & control: opens a new realm of Information Warfare (IW) opportunities



ONR 312 Electronic Warfare The ONR EW S&T Process



IR Chaff

Self-Protection / Counter Targeting

Deception Jamming
Chaff / Flares / Decoys
Lasers-DIRCM



2C-IR MWS

Threat Warning / Situation Awareness

Missile Warning Receivers
Specific Emitter ID
Situational Awareness



SEI System

Future Naval Capabilities

Sea Basing

Sea Shield

Sea Strike

FORCEnet

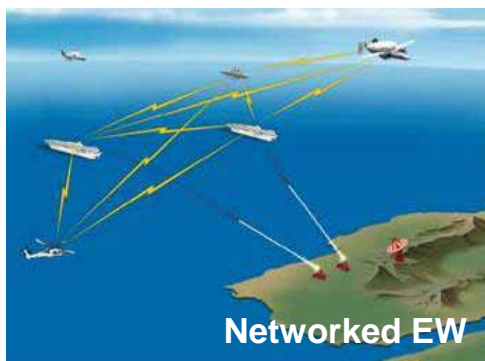
Enterprise & Platform Enablers

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NAVY EW S&T

- ONR Discovery & Invention
- ONR SBIR / STTR
- NRL EM Warfare (Base)

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Networked EW

Network Centric / Mission Support

Network-Centric EW
HK/SK Integration
Modeling & Simulation

2-10+ years

3-5 years

5-15+ years

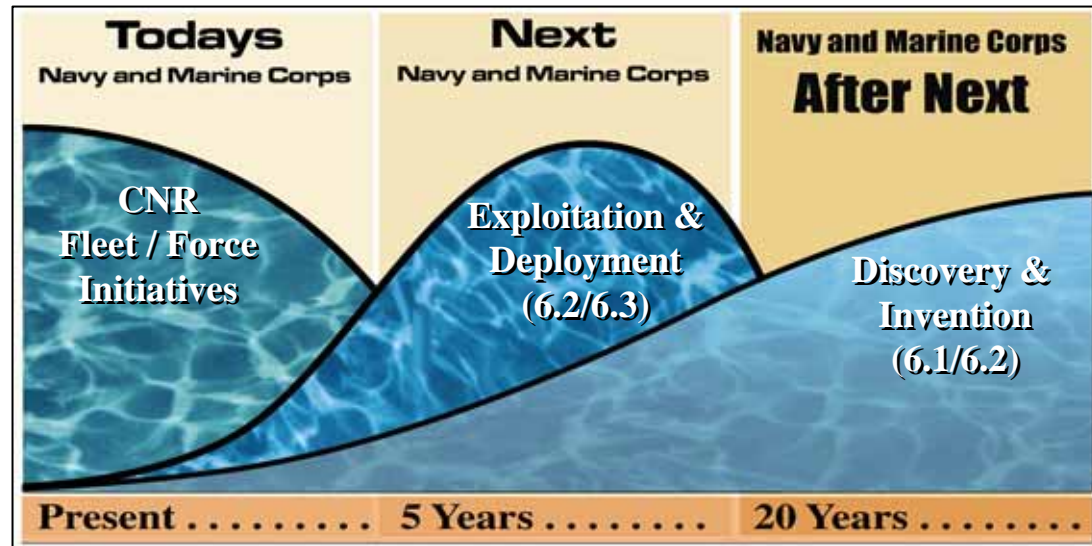
Unclassified – Distribution Unlimited



Discovery & Invention (D&I)



- **What is Discovery & Invention (D&I)?**
 - A process to focus basic research (6.1) and exploratory development (6.2) efforts to develop and mature technology to meet future Navy needs
- **Why have Discovery & Invention?**
 - Identify and investigate new and transformational concepts that could fundamentally change the way we fight
 - Mature high risk / high impact / high payoff technologies
 - Avoid technological surprise





ONR Discovery & Invention

Last year: ONR BAA 07-009



Extending the EW Spectrum

Increase Naval dominance of the EW spectrum beyond traditional RF radar and EO/IR bands.

- Low Band RF (3-1000 MHz)
- Millimeter Wave (18-40 / 75-110 GHz)
- Terahertz (300-3000 GHz)
- Long Wave IR (8-12 microns)
- Far Infrared (12-100 microns)
- Acoustics (open air transmission)

Exploiting Non-Traditional Signals

Increase Naval capability to detect, locate, track, ID, and counter RF emitters beyond traditional pulsed radar and comms.

- LPI (FMCW / Phase Coded) – (EA only)
- Spread Spectrum / Frequency Hopping
- Noise-like Waveforms
- Unintentional RF Emissions
- Optical Comms / Links
- Network Links

Countering Passive Detection

Provide Naval capabilities to detect and counter passive detection technologies, including RF Passive Coherent Location (PCL) and multi-/hyper-spectral detection.

- Methods to remotely detect and ID passive detection systems
- RF deception waveforms and techniques
- EO/IR spectral deception and obscuration

Network-Enabled Electronic Warfare

Develop modeling & simulation efforts and conduct field trials/demos to explore advantages & limitations of networked EW.

- Test scenarios and methodologies
- Determination of quantifiable metrics
- Determination of link requirements
- Coordinated vs scripted interactions
- Methods to realistically assess the effectiveness of EW employment



ONR Discovery & Invention

ONR BAA 07-009 Funded Efforts



Extending the EW Spectrum

- Cueing Receiver for Faster EA - Response Management
- Antennas from VHF to THz
- Miniature 2-70 GHz Integrated Optical Channelizer

Exploiting Non-Traditional Signals

- Exploiting Non-Traditional Signals using Photonic Based Processing
- Digital Directional Correlator

Countering Passive Detection

(No efforts funded)

Network-Enabled Electronic Warfare

(No efforts funded)



ONR Discovery & Invention

This year: ONR BAA 08-004



ONR BAA Announcement # ONR 08-004



- **Posted:** *28 December 2007*
- **Agency Name:** *Office of Naval Research*
- **Research Opportunity Title:** *Electronic Warfare Technology*
- **Program Name:** *Electronic Warfare Discovery & Invention (D&I)*
- **Response Dates:**
 - **White Papers:** *12 February 2008*
 - **Full Proposals:** *12 May 2008*



ONR Discovery & Invention

This year: ONR BAA 08-004



ONR 312 Electronic Warfare (EW) seeks white papers for efforts that shall develop and demonstrate technologies for the next generation components and systems in Electronic Warfare. Although **white papers addressing any truly innovative EW S&T will be considered, the primary emphasis of this BAA is on Advanced Radio Frequency (RF) Countermeasures Technology and Techniques. Proposed efforts should focus on development of technology and techniques to counter advanced threat radar and RF threat guidance systems employing waveform diversity, imaging techniques, passive detection/tracking, and advanced Electronic Protection (EP) features. The scope also includes multi-spectral threats and countermeasures to Integrated Air Defense Systems (IADS), as well as methods to monitor and assess the effectiveness of countermeasures on threat systems in real-time.**



ONR Discovery & Invention

ONR BAA 08-004 Research Area 1



1. Advanced Electronic Attack (EA) System Architectures

The objective is to **investigate concepts, techniques, and components of advanced RF Electronic Attack (EA) systems** to increase Naval (Navy and Marine Corps) dominance of the EW spectrum. Potential areas of investigation include:

- a. Wideband, high sensitivity receivers with embedded high-speed EA cueing capability.
- b. Dynamic technique generators with responses based on received waveform characterization rather than pre-programmed responses.
- c. RF apertures (antennas) with inherent receive/transmit capabilities that are rapidly selectable and reconfigurable.
- d. End-to-end, real-time modeling and characterization of EA system architectures to permit performance optimization analyses.



ONR Discovery & Invention

ONR BAA 08-004 Research Area 2



2. Advanced RF Countermeasures

The objective is to increase Naval (Navy and Marine Corps) capabilities to **defeat advanced RF threats which can have one or more of the following characteristics or features:**

- a. Wide bandwidth
- b. Waveform agility / diversity
- c. Wide dynamic range / power management
- d. Imaging capability (Synthetic Aperture Radar (SAR) / Inverse SAR)
- e. Passive detection / tracking capability
- f. Networked sensors
- g. Multi-spectral sensors
- h. Data fusion
- i. Advanced Electronic Protection (EP)



ONR Discovery & Invention

ONR BAA 08-004 Research Area 3



3. Countermeasures Development Methodology

The objective is to provide Naval (Navy and Marine Corps) forces with a **standardized methodology for evaluating countermeasures effectiveness**, thereby minimizing the need for costly and time consuming developmental field testing at military test ranges. This methodology should apply to all stages of development ranging from early Science and Technology (S&T) to pre-production design evaluation. Potential areas of investigation may include:

- a. Modeling and simulation
- b. Design tools
- c. Databases
- d. Measures of effectiveness



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ONR BAA 08-004 Research Area 4



4. Real-time EA Effectiveness Monitoring

The objective is to **develop methods to monitor and assess the effectiveness of Naval (Navy and Marine Corps) Electronic Attack (EA) systems in real-time** using sensors/systems onboard or under the control of the attacking asset. The goal is to determine if a technique is working, assess how well it is working, and provide feedback to permit dynamic control of EA systems to more efficiently utilize limited EW resources. Efforts in this area might include:

- a. Investigating EA artifacts and feedback mechanisms
- b. Modeling and simulation of EA system interactions and impacts
- c. Modifications to Naval sensors to exploit EA characteristics



ONR Discovery & Invention

ONR BAA 08-004 Award Info



- **ONR anticipates a budget of \$2,000,000.00 per annum for the period FY09-FY11 for this program. ONR plans to fund individual awards of \$100,000.00 to \$750,000.00 per year, using Discovery and Invention (D&I) (Budget Category 6.2) funds. However, lower and higher cost proposals will be considered.**
- **The period of performance for projects may be from one to three years, scoped as a one (1) year Base effort and up to two sequential one (1) year Option efforts. Projects will have an estimated start date of 31 October 2008, subject to date of final award and availability of new fiscal year funds.**
- **Some portion of this budget may fund research requests in this program area received from Government entities outside of this BAA.**



ONR Discovery & Invention

ONR BAA 08-004 Eligibility



- **All responsible sources from academia and industry may submit proposals under this BAA.**
- **There will be no set asides for Historically Black Colleges and Universities (HBCUs) and Minority Institutions (MIs).**
- **Some topics cover export controlled technologies. Research in these areas is limited to “U.S. persons” as defined in the International Traffic in Arms Regulations (ITAR) - 22 CFR § 1201.1 et seq.**



ONR Discovery & Invention

ONR BAA 08-004 Eligibility



- Navy laboratories and warfare centers, as well as other Department of Defense and civilian agency laboratories, and Federally Funded Research & Development Centers (FFRDCs), including Department of Energy National Laboratories, are **not eligible to receive awards under this BAA** and should not directly submit either white papers or full proposals in response to this BAA.
- **NOTE: Responses from these organizations are being solicited separately, though with the same guidance regarding research areas of interest, white paper format and deadlines.**



ONR Discovery & Invention

ONR BAA 08-004 Eligibility



- **Bottom line**: All civilian, industry, government, and military organizations are encouraged to submit white paper responses to the four ONR EW research areas as solicited.
- Once a proposed effort has been chosen for funding, ONR will determine the best method to proceed.
- If a contract is required, then the guidance, clauses, and limitations of this BAA are applicable.
- If other means are more appropriate (direct funds transfer to DoD laboratory or warfare center, use of existing contract vehicle, etc.) then separate guidance and limitations may apply.



ONR Discovery & Invention

ONR BAA 08-004 White Papers



- The due date for white papers is no later than 5:00 PM (EST) on Tuesday, 12 February 2008. **White papers received after the published due date will not be considered for funding in FY09.** Each white paper should state that it is submitted in response to this BAA.
- The only acceptable methods for submission of white papers sent in response to the BAA is via the United States Postal Service (USPS) with delivery confirmation, via a commercial carrier (FedEx, DHL, and UPS) or hand delivered to the attention of the cognizant Technical Point of Contact, Dr. Peter Craig. **NOTE: White Papers sent by fax or e-mail will not be considered.**



ONR Discovery & Invention

ONR BAA 08-004 White Papers



White Paper Format

- **Paper Size – 8.5 x 11 inch paper**
- **Margins – 1” inch**
- **Spacing – single or double-spaced**
- **Font – Times New Roman, 12 point**
- **Number of Pages – No more than two (2) single-sided pages (excluding cover page and resumes). White Papers exceeding the page limit may not be evaluated.**
- **Copies – one (1) original, seven (7) copies, and one (1) electronic copy on CD-ROM, (in Microsoft® Word or .PDF format).**



ONR Discovery & Invention

ONR BAA 08-004 White Papers



White Paper Content

White papers must address the following without exceeding the two (2) page limit:

1. Project Manager and/or Principal Investigator
2. Relevance to BAA Research Opportunity Description
3. Technical Objective
4. Technical Approach
5. Deliverables
6. Recent technical breakthroughs that will reduce risk
7. Funding plan showing requested funding per fiscal year (scoped as a one year base effort and up to 2 sequential one year option periods)



ONR Discovery & Invention

ONR BAA 08-004 Schedule



The annual ONR EW S&T Review will be held on 11-13 March, 2008 at the Executive Conference Center (ECC), Suite 600, 3601 Wilson Boulevard, Arlington, Virginia 22201. The following schedule has been established to facilitate the submission of white papers and their follow-on review and possible selection for FY 2009 funding.

12 Feb 2008	White paper responses to EW research areas due to ONR
20 Feb 2008	ONR notify selected parties to prepare briefing for EW Review
03 Mar 2008	Quad Chart due to ONR
06 Mar 2008	Briefings due to ONR
11-13 Mar 2008	EW Review @ Executive Conference Center
21 Mar 2008	ONR notify selected parties to prepare/submit proposal
12 May 2008	Full technical/cost proposal due to ONR
23 May 2008	ONR notify selected parties of intent to fund efforts
31 Oct 2008	ONR issues awards



ONR Discovery & Invention

ONR BAA 08-004 Evaluation Criteria



- A. Overall scientific and technical merits of the proposal**
 - 1. The degree of innovation**
 - 2. The soundness of technical concept**
 - 3. The Offeror's awareness of the state of the art and understanding of the scope of the problem and the technical effort needed to address it**

- B. Naval relevance, transition potential and anticipated contributions of the proposed technology to Electronic Warfare operations.**

- C. Offeror's capabilities, related experience, and past performance, including the qualifications, capabilities and experience of the proposed principal personnel**
 - 1. The quality of technical personnel proposed**
 - 2. The Offeror's experience in relevant efforts with similar resources**
 - 3. The ability to manage the proposed effort**

- D. The realism of the proposed cost**
 - 1. Total cost relative to benefit**
 - 2. Realism of cost levels for facilities and staffing**



ONR Discovery & Invention

ONR BAA 08-004 Deliverables



The following is a sample of reporting deliverables that could be required under a research effort. The following deliverables, primarily in contractor format, are anticipated as necessary. However, specific deliverables should be proposed by each Offeror and finalized with the contracting agent:

- **Detailed Technical Data**
- **Technical and Financial Progress Reports**
- **Presentation Material(s)**
- **Other Documentation or Reports, as required**
- **Final Report**

Research performed under contracts may also include the delivery of software, prototypes, and other hardware deliverables.



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ONR BAA 08-004 Facilities / GFE



- **Offerors are expected to provide all facilities (equipment and/or real property) necessary for the performance of the proposed effort. Any direct charge of facilities, not including deliverable items, must be specifically identified in the Offeror's proposal and approved by the Government prior to purchase.**
- **Any request to use Government owned facilities or Government Furnished Equipment (GFE) must be included in the Offeror's proposal and approved in advance by the cognizant Government official. After contract award, requests to use Government integration, test, and experiment facilities will be considered on a case by case basis based on availability and justification of need.**



ONR Discovery & Invention

ONR BAA 08-004 Classification



- All white papers and proposals are expected to be unclassified. However, confidential/classified white papers and proposals are permitted.
- In order to facilitate intra-program collaboration and technology transfer, the Government will attempt to enable awardees to work at the unclassified level to the maximum extent possible.
- If awardees use unclassified data in their deliveries and demonstrations regarding a potentially classified project, they should use methods and conventions consistent with those used in classified environments. Such conventions will permit the various subsystems and the final system to be more adaptable in accommodating classified data in the transition system.



ONR Discovery & Invention

ONR BAA 08-004 Summary



Things ONR will look for in white paper submissions

- An understanding of Electronic Warfare principles and needs
- Innovative applications of cutting edge science and technology to address Electronic Warfare priorities
- Efforts that focus on RF Applied Research S&T
 - Electro-optical and infrared technologies are not currently supported, except in conjunction with RF applications
- Clear statements of the effort's objectives, applicability to Electronic Warfare, anticipated end state, and deliverables.
- Clear and concise schedule including intermediate milestones to objectively measure progress toward goals
- Funding request broken out by performing organization and Government fiscal year.



ONR Discovery & Invention

ONR BAA 08-004 Summary



Things that will cause ONR to reject white papers

- **Proposed effort is not Electronic Warfare**
 - Electronic or RF components (outside an EW system/sub-system)
 - Communications or navigation systems (counter comms/nav is okay)
 - Intel, reconn, surveillance (ISR) systems (counter ISR is okay)
- **Proposed effort is not Discovery & Invention (6.2)**
 - Off-the-shelf solutions without any clear innovation
 - Demonstrations and field testing of existing systems or components to show military application
- **Reliance on GFE/GFI without prior arrangement/agreement**
- **Poor program planning**
 - No explanation or understanding of underlying S&T
 - Scattershot approaches with little methodology
 - Lack of intermediate milestones to gauge progress
 - No substantiation for requested budget



ONR Discovery & Invention

ONR BAA 08-004 Final Comments



- **ONR 312 EW will not entertain requests for individual meetings with industry representatives to discuss potential white paper submissions**
 - **No pre-selection of ideas or concepts**
 - **If in doubt, write the white paper and submit it**
- **This is your opportunity to ask questions**
 - **Written questions are permitted, but all questions and answers will be posted to the ONR BAA website**
- **White paper questions of a business nature can be submitted by e-mail through Thursday, 31 January 2008**
 - **All questions and answers will be posted to the ONR BAA website**



ONR Discovery & Invention

ONR BAA 08-004 Points of Contact



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Questions?



ONR

Revolutionary Research . . . Relevant Results



ONR Discovery & Invention

This year: ONR BAA 08-004



Advanced EA System Architectures

Investigate concepts, techniques, and components of advanced RF EA systems

- Wideband, high sensitivity receivers with embedded high-speed EA cueing capability
- Dynamic Technique generators based on received waveform, not pre-canned responses
- RF apertures with rapidly selectable and reconfigurable Rx/Tx capabilities
- End-to-end, real-time modeling and characterization of EA system architecture to permit performance optimization analyses

Advanced RF Countermeasures (CM)

Increase Naval capabilities to defeat advanced RF threats which can have one or more of the following characteristics or features:

- Wide bandwidth
- Waveform agility / diversity
- Wide dynamic range / power management
- Imaging capability (SAR / ISAR)
- Passive detection / tracking capability
- Advanced Electronic Protection (EP)
- Networked sensors
- Data fusion

CM Development Methodology

Provide Naval forces with a standardized methodology for evaluating CM effectiveness, thereby minimizing the need for costly and time consuming developmental field testing at military test ranges.

- Modeling and simulation
- Design tools
- Databases
- Measures of effectiveness

Real-time EA Effectiveness Monitoring

Develop methods to determine in real-time if an EA technique is working, assess how well it is working, and provide feedback to permit dynamic control of EA systems to more efficiently utilize limited EW resources.

- EA artifacts and feedback mechanisms
- M&S of EA system interactions and impacts
- Modifications of Naval sensors to exploit EA characteristics