BROAD AGENCY ANNOUNCEMENT

(BAA) INTRODUCTION:

This publication constitutes a Broad Agency Announcement (BAA) as contemplated in Department of Defense Grant and Agreement Regulation (DODGARS) 22.315(a). A formal Request for Proposals (RFP), solicitation, and/or additional information regarding this announcement will not be issued. Request for same will be disregarded.

The Office of Naval Research (ONR) will not issue paper copies of this announcement. The ONR and Department of Defense (DoD) agencies involved in this program reserve the right to select for award all, some or none of the proposals submitted in response to this announcement. The ONR and other participating DoD agencies provide no funding for direct reimbursement of proposal development costs. Technical and cost proposals (or any other material) submitted in response to this BAA will not be returned. It is the policy of ONR and participating DoD agencies to treat all proposals as sensitive competitive information and to disclose their contents only for the purposes of evaluation.

The DoD Multidisciplinary University Research Initiative (MURI), one element of the University Research Initiative (URI), is sponsored by the DoD research offices: the Office of Naval Research (ONR), the Army Research Office (ARO), and the Air Force Office of Scientific Research (AFOSR) (hereafter collectively referred to as "DoD agencies").

Awards will take the form of grants. Therefore, proposals submitted as a result of this announcement will fall under the purview of the Department of Defense Grant and Agreement Regulations (DoDGARs).

Potential offerors may obtain information on ONR programs and opportunities by checking the ONR website at http://www.onr.navy.mil. Specific information about BAAs and amendments and updates to this BAA will be found at that site under the heading "BAAs".

I. GENERAL INFORMATION

1. Agency Name

Office of Naval Research
875 North Randolph Street - Suite 1425
Code 03R
Arlington, VA 22203-1995

2. Research Opportunity Title

Multidisciplinary University Research Initiative (MURI)

3. Program Name

Fiscal Year (FY) 2008 Department of Defense Multidisciplinary Research Program of the University Research Initiative

4. Research Opportunity Number

BAA 07-036

5. Response Date

White Papers: Monday 06 August 2007

Full Proposals: Tuesday, 23 October 2007

6. Research Opportunity Description

Synopsis

The MURI program supports basic science and/or engineering research at U.S. institutions of higher education (hereafter referred to as "universities") that is of critical importance to national defense. The program is focused on multidisciplinary research efforts that intersect more than one traditional science and engineering discipline to address issues of critical concern to the DoD.

The FY 2008 MURI competition is for the 19 topics listed below. Detailed descriptions of the topics can be found in Section VIII entitled, "Specific MURI Topics", of this BAA. The detailed descriptions are intended to provide the proposer a frame of reference and are not meant to be restrictive to the possible approaches to achieving the goals of the topic and the program. Innovative ideas addressing these research topics are highly encouraged.

White papers and full proposals addressing the following topics (1) through (6) should be submitted to ONR:

(1) A 21st Century Approach to Electronic Device Reliability
(2) Real-Time Methods for the Analysis of Networks
(3) Biologically-Inspired Autonomous Sea Vehicles
(4) Socio-Cultural Modeling for Understanding Asymmetric Threat Environments
(5) Biometrics in the Maritime Domain

(6) Biologically-Inspired Approaches for Team and Coalition Adaptation of Heterogeneous Unmanned Systems for Surveillance over Large and Complex Areas

White papers and Full proposals addressing the following topics (7) through (13) should be submitted to the Air Force Office of Scientific Research (AFOSR):

(7) Harnessing Complexity in the Human-Machine Systems
(8) Assured Information Sharing
(9) A 21st Century Approach to Electronic Device Reliability
(10) Semiconductor Nanomembranes
(11) Exploring the Interface: Mechanics of Nano-Scale Thermal Transport between Dissimilar Materials
(12) Nanocatalysis for Propulsion Applications
(13) Vortex-Particle Dynamics, Interaction and Control for Brownout Mitigation

White papers and full proposals addressing the following topics (14) through (19) should be submitted to the Army Research Office (ARO):

(14) Human, Social, Cultural, and Behavioral Modeling: Dynamic Models of the Effect of Culture on Collaboration and Negotiations
(15) Brain Network Analysis and Modeling for Communication and Orientation
(16) Reasoning by Abductive Inference
(17) Spin-Mediated Magnetic Behavior in Hybrid Metal-Semiconductor Systems
(18) Modeling, Analysis, and Control of Complex Multi-Scale Data Networks
(19) Spray & Combustion of Gelled Hypergolic Propellants for Future Rocket and Missile Engines

Proposals from a team of university investigators may be warranted because the necessary expertise in addressing the multiple facets of the topics may reside in different universities, or in different departments in the same university. By supporting multidisciplinary teams, the program is complementary to other DoD basic research programs that support university research through single-investigator awards. Proposals must name one Principal Investigator as the responsible technical point of contact. Similarly, one institution will be the primary awardee for the purpose of award execution. The relationship among participating institutions and their respective roles, as well as the apportionment of funds including sub-awards, if any, must be described in both the proposal text and the budget. Historically Black Colleges and Universities and Minority Institutions (HBCU/MIs) (as defined by 10 U.S.C. 2323a (1) (c)) are encouraged to participate in the MURI program, either as the lead institution or as a member of a team. However, no specific funds are allocated for HBCU/MI participation.

7. Point(s) of Contact

One or more Research Topic Chiefs are identified for each specific MURI Topic. Questions of a technical nature shall be directed to one of the Research Topic Chiefs identified in Section VIII entitled, "Specific MURI Topics" of this BAA.

Questions of a *policy nature* shall be directed to ONR as specified below:

ONR MURI Program Point of Contact:
Dr. Bill Lukens MURI Program Manager
Office of Naval Research, Code 03R
E-mail Address: 363 MURI@onr.navy.mil

Mailing address:
Office of Naval Research
One Liberty Place
875 North Randolph Street, Suite 1425
Arlington, VA 22203-1995

Questions of a *business nature* shall be directed to the cognizant Contract Specialist, as specified below:

Primary:
Ms. Lynn Christian
Contract Specialist
Contract and Grants Awards Management, Code ONR 0251
Office of Naval Research
875 North Randolph Street, Suite 1425
Arlington, VA 22203-1995
E-Mail: christl@onr.navy.mil

Secondary:
Ms. Vera M. Carroll
Acquisition Branch Head
Contract and Grants Awards Management, Code 0251
Office of Naval Research
875 North Randolph Street, Suite 1425
Arlington VA, 22203-1995
E-mail: carrolv@onr.navy.mil

**** Important Notices Regarding Questions of a Business Nature ****

- All questions shall be submitted in writing by electronic mail.
- Questions presented by telephone call, fax message, or other means will not be responded to.
- Questions regarding **white papers** must be submitted by 2:00 p.m. Eastern Time on **Friday, 20 July 2007.** Questions received after this date and time may not be answered and the due date for submission of the white papers may not be extended.
- Questions regarding **full proposals** must be submitted by 2:00 P.M. Eastern Time on Tuesday, **21 September 2007.** Questions after this date and time may not be answered and the due date for submission of the proposals will not be extended

8. Instrument Type(s)

It is anticipated that all awards resulting from this announcement will be grants.

9. Catalog of Federal Domestic Assistance (CFDA) Numbers

12.300 ONR
12.800 AFOSR
12.431 ARO

10. Catalog of Federal Domestic Assistance (CFDA) Titles

Basic and Applied Scientific Research, (ONR)
Air Force Defense Research Sciences Program, (AFOSR)
Basic Scientific Research, (ARO)

11. Additional Information

The Non-ONR Agency Information:
Air Force Office of Scientific Research
875 North Randolph Street
Suite 325, Room 3112
Arlington, VA 22203-1768

Army Research Office
4300 S. Miami Blvd
Durham, NC 27703-9142

II. AWARD INFORMATION

It is anticipated the awards will be made in the form of grants to universities. The awards will be made at funding levels commensurate with the proposed research and in response to agency missions. Each individual award will be for a three year base period with one 2-year option period to bring the total maximum term of the award to five years. The base and option period will be incrementally funded.

Total amount of funding for five years available for grants resulting from this MURI BAA is estimated to be about $207M, pending out-year appropriations. It is anticipated that the maximum award will be $1.5M per year, with the actual amount contingent on availability of funds, the specific topic, and the scope of the proposed work. It is strongly recommended that potential proposers communicate with the Program Topic Chief regarding these issues before the submission of formal proposals. **Depending on the results of the proposal evaluation, there is no guarantee that any of the proposals submitted in response to a particular topic will be recommended for funding. On the other hand, more than one proposal may be recommended for funding for a particular topic.**

III. ELIGIBILITY INFORMATION

This MURI competition is open only to and full proposals are to be submitted only by, U.S. institutions of higher education (universities) including DoD institutions of higher education,

with degree-granting programs in science and/or engineering.* Ineligible organizations (e.g., industry, DoD laboratories, Federally Funded Research and Development Centers (FFRDCs), and foreign universities) may collaborate on the research but may not receive MURI funds, directly or via subaward.

When a modest amount of additional funding for an ineligible organization is necessary to make the proposed collaboration possible, such funds may be requested via a separate proposal from that organization. This supplemental proposal should be attached to the primary MURI proposal and will be evaluated separately by the responsible Research Topic Chief. If approved, the supplemental proposal will be funded by the responsible agency using non-MURI funds. Since it is not certain that non-MURI funding would be available for ineligible organizations, Principal Investigators are encouraged to restrict funding requests to eligible organizations when practical.

The Canadian government, through Defense Research and Development Canada, has expressed an interest in encouraging collaboration between Canadian researchers and U.S. researchers on the MURI program in research areas of mutual interest. Canadian university researchers, since they are not eligible to receive MURI funds, will be using their own resources that, most likely, will be provided by Canadian government granting agencies. Potential proposers are encouraged to take advantage of this opportunity to collaborate and team with Canadian researchers at no additional cost to DoD if there is suitable expertise that can enhance and strengthen the MURI project.

IV. APPLICATION AND SUBMISSION INFORMATION

1. Application and Submission Process

The proposal submission process is in two stages. Prospective awardees are encouraged to submit white papers to minimize the labor and cost associated with the production of detailed full proposals that have very little chance of being selected for funding. Based on an assessment of the white papers, the responsible Research Topic Chief will provide informal feedback notification to the prospective awardees to encourage or discourage them to submit full proposals.

White papers arriving after the deadline may not receive feedback prior to full proposal submission. However, all full proposals submitted under the terms and conditions cited in the BAA will be reviewed.

Due Date: The due date for white papers is no later than 4:00 P.M. (Eastern Daylight Time) on Monday 06 August 2007.

Where To Submit:

NOTE: White Papers sent by fax will not be considered.

---

*To the extent that it is a part of a U.S. institution of higher education and is not designated as an FFRDC, a University Affiliated Research Center (UARC) or other University Affiliated Laboratory (UAL) is eligible to submit a proposal to this MURI competition and receive MURI funds. However, the eligibility of a UAL (other than an FFRDC) to submit a URI proposal does not exempt the proposal from any evaluation factor contained in this Broad Agency Announcement, to include the potential impact on the institution's ability to perform defense-relevant research and to train students in science and/or engineering.

Submission of White Papers:

White papers may be submitted via e-mail directly to a Research Topic Chief, via the United States Postal Service (USPS), via a commercial carrier or may be hand delivered to the attention of a responsible Research Topic Chief at the agency specified for the topic.

Evaluation/Notification: Initial evaluations of the white papers will be issued on or about Tuesday, 21 August 2007.

Submission of Full Proposal:

Any Offeror may submit a full proposal even if its white paper was not identified as being of "particular value" to the Government. However, the initial evaluation of the white papers should give prospective awardee some indication of whether a later full proposal would likely result in an award.

NOTE: Full Proposals sent by fax or e-mail will not be considered.

Full proposals may be submitted electronically through grants.gov, via the United States Postal Service (USPS), via a commercial carrier or may be hand delivered to the agency specified for the topic.

Registration Requirements for Grants.gov: There are several one-time actions you must complete in order to submit an application through Grants.gov (e.g., obtain a Dun and Bradstreet Data Universal Numbering System (DUNS) number, register with the Central Contract Registry (CCR), register with the credential provider, and register with Grants.gov). See www.grants.gov/GetStarted to begin this process. Use the Grants.gov Organization Registration Checklist at www.grants.gov/assets/OrganizationRegCheck.doc to guide you through the process. Designating an E-Business Point of Contact (EBiz POC) and obtaining a special password called an MPIN are important steps in the CCR registration process. Applicants, who are not registered with CCR and Grants.gov, should allow at least 21 days to complete these requirements. It is suggested that the process be started as soon as possible.

Questions: Questions relating to the registration process, system requirements, how an application form works, or the submittal process must be directed to Grants.gov at 1-800-518-4726 or support@grants.gov.

VERY IMPORTANT – Download PureEdge Viewer: In order to download the application package, you will need to install PureEdge Viewer. This small, free program will allow you to access, complete, and submit applications electronically and securely. For a free version of the software, visit the following web site: www.grants.gov/DownloadViewer.

2. Content and Format of White Papers and Full Proposals

The white papers and full proposals submitted under this BAA are expected to address unclassified basic research. The full proposal submissions will be protected from unauthorized disclosure in accordance with FAR 15.207, applicable law, and DoD regulations. Proposers are expected to appropriately mark each page of their submission that contains proprietary information. Grants awarded under this announcement will be unclassified.

White Paper Submission: Contents and Format of Applications

Each topic in this announcement has one or more Research Topic Chiefs identified from one of the participating agencies; ONR, AFOSR, or ARO. You should submit your application to one of the Research Topic Chiefs at the agency for which you are applying.

White paper format should be as follows:

- Paper Size - 8.5 x 11 inch paper
- Margins - 1 inch
- Spacing - single
- Font - Times New Roman, 12 point
- Number of Pages - no more than four (4) single-sided pages (excluding cover letter, cover, and curriculum vitae). White papers exceeding the page limit may not be evaluated.

White Paper content should be as follows:

- A one page cover letter (optional)
- A cover page, labeled "PROPOSAL WHITE PAPER," that includes the BAA number, proposed title, and proposer's technical point of contact, with telephone number, facsimile number, e-mail address, topic number, and topic title
- Identification of the research and issues
- Proposed technical approaches
- Potential impact on DoD capabilities
- Potential team and management plan
- Summary of estimated costs
- Curriculum vitae of key investigators

The white paper should provide sufficient information on the research being proposed (e.g., hypothesis, theories, concepts, approaches, data measurements and analysis, etc.) to allow for an assessment by a technical expert. It is not necessary for white papers to carry official institutional signatures.

White papers may be submitted via e-mail, via the United States Postal Service (USPS), via a commercial carrier or may be hand delivered to the attention of a responsible Research Topic Chief at the agency specified for the topic. For hard copy submissions, use the addresses provided in Section IV entitled, "Application and Submission Information" paragraph number 5 entitled, "Address for the Submission of Hard Copy White Papers and Full Proposals". White papers should be stapled in the upper left hand corner; plastic covers or binders should not be used. Separate attachments, such as individual brochures or reprints, will not be accepted.

Copies – one (1) original and two (2) copies.

Grants.gov Full Proposal Submission: Content and Format of Applications

Application forms and instructions are available at Grants.gov. To access these materials, go to http://www.grants.gov, select "Apply for Grants", and then select "Download Application Package". Enter the CFDA for the respective agency to which you are directing the application (ARO – 12.431, ONR – 12.300, AFOSR – 12.800, as found on page four of this announcement)

and the funding opportunity number, designated as "research opportunity number" on page two of this announcement. Each topic in this announcement has a Research Topic Chief identified from one of the participating agencies; ONR, AFOSR, or ARO. You should direct your application to the agency associated with the topic for which you are applying. NOTE: You will not be able to download the Application Package unless you have installed PureEdge Viewer (See: http://www.grants.gov/DownloadViewer).

Content and Form of Application – SF 424 (R&R)

You must complete the mandatory forms and any applicable optional forms (e.g., SF-LLL Disclosure of Lobbying Activities) in accordance with the instructions on the forms and the additional instructions below. **Files that are attached to the forms must be in Adobe Portable Document Format (PDF) unless otherwise specified in this announcement.**

Form: SF 424 (R&R)

Complete this form first to populate data in other forms. Complete all the required fields in accordance with the pop-up instructions on the form. To activate the instructions, turn on the "Help Mode" (icon with the pointer and question mark at the top of the form). The list of certifications and assurances referenced in Field 18 can be found on the ONR Home Page at Contracts and Grants. The certification package for grants is entitled, "Certifications for Grants and Agreements." In Field 4, designate "MURI" and the topic number. For example, "MURI-topic 5."

Form Research & Related Other Project Information.

Complete questions 1 through 5 and attach files. The files must comply with the following instructions:

Project Summary/Abstract (Field 6 on the Form)

The project summary should be a single page that identifies the research problem, technical approaches, anticipated outcome of the research, if successful, and impact on DoD capabilities. It should identify the Principal Investigator, the university and other universities involved in the MURI team if any, the proposal title, the agency to which the proposal is submitted, the MURI topic number and the total funds requested from DoD for the 3-year base period, the 2-year option period and the 5-year total period. The project summary must not exceed 1 page when printed using standard 8.5" by 11" paper with 1" margins (top, bottom, left and right) with font Times New Roman, 12 point. To attach a Project Summary/Abstract, click "Add Attachment."

Project Narrative (Field 7 on the form)

The Following Formatting Rules Apply for Field 7

- Paper size when printed - 8.5 x 11 inch paper
- Margins - 1 inch
- Spacing -single
- Font - Times New Roman, 12 point
- Number of pages - no more than twenty-five (25) single-sided pages. The cover, table of contents, list of references, letters of support, and curriculum vitae are excluded from the page limitations. Full proposals exceeding the page limit may not be evaluated.

Include the Following in Field 7

The first page of your narrative must include the following information:

- Principal Investigator name
- Phone number, fax number and e-mail address
- Institution, Department, Division
- Institution address
- Other universities involved in the MURI team
- Current DoD Contractor or Grantee? If yes, provide Agency, point of contact; phone number
- Proposal title
- Institution proposal number
- Agency to which proposal is submitted
- Topic number and topic title

- Table of Contents: List project narrative sections and corresponding page numbers.

- Statement of Work: A Statement of Work (SOW) should clearly detail the scope and objectives of the effort and the specific research to be performed under the grant if the proposal is selected for funding. It is anticipated that the proposed SOW will be incorporated as an attachment to any resultant award instrument. To this end, this project narrative must include a severable self-standing SOW, without any proprietary restrictions, which can be attached to a grant award.

- Technical Approach: Describe in detail the basic science and/or engineering research to be undertaken. State the objective and approach, including how data will be analyzed and interpreted. Discuss the relationship of the proposed research to the state-of-the-art knowledge in the field and to related efforts in programs elsewhere. Include appropriate literature citations/references. Discuss the nature of expected results. Discuss potential applications to defense missions and requirements. Describe plans for the research training of students. Include the number of full time equivalent graduate students and undergraduates, if any, to be supported each year. Discuss the involvement of other students, if any.

- Project Schedule, Milestones and Deliverables: A summary of the schedule of events, milestones, and a detailed description of the results and products to be delivered.

- Assertion of Data Rights: A summary of any proprietary rights to pre-existing results, prototypes, or systems supporting and/or necessary for the use of the research, results, and/or prototype. Any data rights asserted in other parts of the proposal that would impact the rights in this section must be cross-referenced. If there are proprietary rights, the proposer must explain how these affect its ability to deliver research data, subsystems and toolkits for integration. Additionally, proposers must explain how the program goals are achievable in light of these proprietary limitations. If there are no claims of proprietary rights in pre-existing data, this section shall consist of a statement to that effect.

- Management Approach: A discussion of the overall approach to the

management of this effort, including brief discussions of: required facilities; relationships with any subawardees and with other organizations; availability of personnel; and planning, scheduling and control procedures.

(a) Describe the facilities available for the accomplishment of the proposed research and related education objectives. Describe any capital equipment planned for acquisition under this program and its application to the proposed research. If possible, budget for capital equipment should be allocated to the first budget period of the grant. Include a description of any government furnished equipment/hardware/software/information, by version and/or configuration that are required for the proposed effort.

(b) Describe in detail proposed subawards to other eligible universities or relevant collaborations (planned or in place) with government organizations, industry, or other appropriate institutions. Particularly describe how collaborations are expected to facilitate the transition of research results to applications. Descriptions of industrial collaborations should explain how the proposed research will impact the company's research and/or product development activities. If subawards to other universities are proposed, make clear the division of research activities, to be supported by detailed budgets for the proposed subawards.

(c) Designate one individual as the Principal Investigator for the award, for the purpose of technical responsibility and to serve as the primary point-of-contact with an agency's Program Topic Chief. Briefly summarize the qualifications of the Principal Investigator and other key investigators to conduct the proposed research.

(d) List the amount of funding and describe the research activities of the Principal Investigator and co-investigators in on-going and pending research projects, whether or not acting as Principal Investigator in these other projects, the time charged to each of these projects, and their relationship to the proposed effort.

(e) Describe plans to manage the interactions among members of the proposed research team.

(f) Identify other parties to whom the proposal has been, or will be sent, including agency contact information.

- List of References: List publications cited in above sections.
- Letters of Support: Up to three Letters of Support from various DoD agencies may be included.
- Curriculum Vitae: Include curriculum vitae of the Principal Investigator and key co-investigators.

All applications should be in a single PDF file. To attach a Project Narrative in Field 7, click "Add Attachment."

Bibliography & References Cited (Field 8 on the form)

This field not required.

Facilities & Other Resources (Field 9 on the form)

This field not required.

Equipment (Field 10 on the form)

This field not required.

Other Attachment (Field 11 on the form)

Attach budget proposal at field 11. You must provide a detailed cost breakdown of all costs, by cost category, by the funding periods described below, and by task/sub-task corresponding to the task number in the proposed Statement of Work which was provided in Field 7 of the Research and Related Other Project Information Form. The option must be separately priced.

. The budget should adhere to the following guidelines:

Detailed breakdown of all costs, by cost category, by the calendar periods stated below. For budget purposes, use an award start date of 01 May 2008. For the three-year base grant, the cost should be broken down to reflect funding increment periods of:

(1) Five months (01 May 08 to 30 Sep 08),
(2) Twelve months (01 Oct 08 to 30 Sep 09),
(3) Twelve months (01 Oct 09 to 30 Sep 10), and
(4) Seven months (01 Oct 10 to 30 Apr 11).

Note that the budget for each of the calendar periods (e.g. 01 May 08 to 30 Sep 08) should include only those costs to be expended during that calendar period.
The budget should also include an option for two additional years broken down to the following funding periods:

(1) Five months (01 May 11 to 30 Sep 11),
(2) Twelve months (01 Oct 11 to 30 Sep 12), and
(3) Seven months (01 Oct 12 to 30 Apr 13).

Annual budget should be driven by program requirements. Elements of the budget should include:

- Direct Labor - Individual labor category or person, with associated labor hours and unburdened direct labor rates.
- Indirect Costs - Fringe benefits, overhead, G&A, Cost of Money (COM), etc. (must show base amount and rate). Justify.
- Travel - Number of trips, destination, duration, etc. Justify.
- Subcontract - A cost proposal as detailed as the proposer's cost proposal will be required to be submitted by the subcontractor.
- Consultant - Provide consultant agreement or other document that verifies the proposed loaded daily/hourly rate. Include a description of the nature of and the

need for any consultant's participation. Strong justification must be provided, and consultants are to be used only under exceptional circumstances where no equivalent expertise can be found at a participating university. Provide budget justification.

- Materials - Specifically itemized with costs or estimated costs. An explanation of any estimating factors, including their derivation and application, shall be provided. Include a brief description of the proposer's procurement method to be used (competition, engineering estimate, market survey, etc.). Justify.

- Other Directs Costs - Particularly any proposed items of equipment or facilities. Equipment and facilities generally must be furnished by the contractor/recipient (justifications must be provided when Government funding for such items is sought). Include a brief description of the proposer's procurement method to be used (competition, engineering estimate, market survey, etc.). Justify.

Funding breakdown by task/sub-task corresponding to the task number in the proposed Statement of Work which was provided in Field 7 of the Research and Related Other Project Information Form must also be attached.

SF-LLL Disclosure of Lobbying Activities Form

If applicable, complete SF- LLL. Applicability: If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the grant/cooperative agreement, you must complete and submit Standard Form - LLL, "Disclosure Form to Report Lobbying."

Proposal Receipt Notices

After a full proposal is submitted through Grants.gov, the Authorized Organization Representative (AOR) will receive a series of three e-mails. It is extremely important that the AOR watch for and save each of the e-mails. You will know that your proposal has reached ONR, ARO or AFOSR when the AOR receives e-mail Number 3. You will need the Submission Receipt Number (e-mail Number 1) to track a submission. The three e-mails are:

Number 1 – The applicant will receive a confirmation page upon completing the submission to Grants.gov. This confirmation page is a record of the time and date stamp for the submission.

Number 2 – The applicant will receive an e-mail indicating that the proposal has been validated by Grants.gov within a few hours of submission. (This means that all of the required fields have been completed.)

Number 3 – The third notice is an acknowledgment of receipt in e-mail form from the designated agency within ten days from the proposal due date. The e-mail is sent to the authorized representative for the institution. The e-mail for proposals notes that the proposal has been received and provides the assigned tracking number. Hard copy submissions will receive only e-mail number 3.

Hard Copy Full Proposal Submission: Content and Format of Applications

If submitting a full proposal by hard copy as opposed to formally through grants.gov, please complete the Grants.gov forms as described, print them out, and submit to the address in Section IV paragraph number 5 entitled "Address for the Submission of Hard Copy White Papers and Full Proposals". Full hard copy proposals should be stapled in the upper left hand corner; plastic covers or binders should not be used. Separate attachments, such as individual brochures, or reprints, will not be accepted.

Copies – one (1) original and five (5) hard copies.

3. Significant Dates and Times

Schedule of Events		
Event	**Date**	**Time**
White Papers Due	06 August 2007	4:00 PM Eastern Daylight Time
Notification of Initial DoD Evaluations of White Papers	21 August 2007*	
Full Proposals Due	23 October 2007	4:00 PM Eastern Daylight Time
Notification of Selection for Award	25 January 2008*	
Start Date of Grant	01 May 2008*	

*** These dates are estimates as of the date of this announcement.**

4. Submission of Late Proposals

Any full proposal submitted through Grants.gov where the time and date for submission (e-mail Number #1) is after the deadline for proposal submission in Section IV entitled, "Application and Submission Information" paragraph number 3 entitled, "Significant Dates and Times" will be late and will not be evaluated unless the Grants.gov website was not operational on the due date and was unable to receive the proposal submission. If this occurs, the time specified for the receipt of proposals through Grants.gov will be extended to the same time of the day specified in this BAA on the first workday on which the Grants.gov website is operational.

For hard copy full proposal submission, any proposal, modification, or revision that is received at the designated DoD agency after the exact time specified for receipt of proposals is "late" and will not be considered unless it is received before the award is made, the contracting officer determines that accepting the late proposal would not unduly delay the acquisition, and:

(a) the proposal was sent to the address specified for the designated agency by U.S. Postal Service Express Mail three or more business days prior to the date

specified for the receipt of proposals (the term "business days" excludes weekends and U.S. Federal holidays); or

(b) there is acceptable evidence to establish that it was received at the DoD agency designated for receipt of proposals and was under the Government's control prior to the time set for receipt of proposals; or

(c) it was the only proposal received.

However, a late modification of an otherwise timely and successful proposal that makes its terms more favorable to the Government will be considered at any time it is received and may be accepted. This applied to hard copy and Grants.gov submissions.

Acceptable evidence to establish the time of receipt at the DoD agency includes the time/date stamp of that installation on the proposal wrapper, other documentary evidence of receipt maintained by the installation, or oral testimony or statements of Government personnel.

If an emergency or unanticipated event interrupts normal Government processes so that proposals cannot be received at the Government office designated for receipt of proposals by the exact time specified in the announcement, and urgent Government requirements preclude amendment of the announcement closing date, the time specified for receipt of proposals will be deemed to be extended to the same time of day specified in the announcement on the first work day on which normal Government processes resume.

Note that proposals delivered by commercial carriers are considered "hand carried" and that no exception can be made to allow such proposals to be considered if for any reason they are received after the deadline. Proposers are advised that some proposals responding to past announcements that were sent via commercial carriers were delayed during shipment and arrived after the deadlines, typically by one or two days. To decrease the probability that proposals delivered by commercial carriers will arrive after the deadline and thus be ineligible to compete, proposers are urged to schedule delivery to occur several days before the deadline.

5. Address for the Submission of Hard Copy White Papers and Full Proposals

Submission of white papers and submission of hard copy full proposals shall be sent to the addresses below:

Hard copies of white papers and full proposals addressing topics (1) to (6) should be sent to the Office of Naval Research at the following address:

Primary

Office of Naval Research
For full proposals include: ATTN: ONR Code 03R
For white papers include: ATTN: (list name of responsible Research Topic Chief)
875 North Randolph Street - Suite W256A*
Arlington, VA 22203-1995
Point of Contact: Paula Barden
703-696-4111

Secondary

Office of Naval Research
For full proposals include: ATTN: ONR Code 03R
For white papers include: ATTN: (list name of responsible Research Topic Chief)
875 North Randolph Street - Suite 257*
Arlington, VA 22203-1995
Point of Contact: Dr. William Lukens
703-696-4668

*This is the address for hand delivery, delivery via USPS and delivery via commercial delivery services.

If a telephone number is required, please use 703-696-4111 or 703-696-4668.

Important Notes Regarding Submission of White Papers and Proposals:

If the Offeror is using USPS, please allow an additional five (5) business days for the package to be delivered to this address due to USPS mail being sent to a central location for special processing before it is sent to this address.

Hard copy white papers and full proposals addressing topics (7) to (13) should be sent to the Air Force Office of Scientific Research at the following address:

Air Force Office of Scientific Research
For full proposals include: ATTN: Mailroom (MURI 08)
For white papers include: ATTN: (list name of responsible Research Topic Chief)
875 North Randolph Street
Suite 325, Room 3112
Arlington, VA 22203-1768
Point of Contact: Dr. Spencer Wu
703-696-7315

Hard copy white papers and full proposals addressing topics (14) to (19) should be sent to the Army Research Office at one of the following addresses:

For delivery by USPS (ordinary First Class or Priority Mail (but not Express Mail)):
U.S. Army Research Office (FY08 MURI)
P. O. Box 12211 Research Triangle Park,
NC 27709-2211

For commercial delivery (such as Express Mail, FedEx, UPS, etc.):

U.S. Army Research Office (FY08 MURI)
For full proposals include: ATTN: Dr. Larry Russell
For white papers include: ATTN: (list name of responsible Research Topic Chief)
4300 S. Miami Blvd
Durham, NC 27703-9142
919-549-4211

V. EVALUATION INFORMATION

1. Evaluation Criteria

White papers will be evaluated by the responsible Research Topic Chief to assess whether the proposed research is likely to meet the objectives of the specific topic, and thus whether to encourage the submission of a full proposal. The assessment will focus on scientific and technical merit (criterion 1, below) and relevance and potential contribution to DoD (criterion 2, below), although the other criteria may also be used in making the assessment. Full proposals responding to this BAA in each topic area will be evaluated using the following criteria. The first three evaluation factors are of equal importance:

(1) scientific and technical merits of the proposed basic science and/or engineering research;

(2) relevance and potential contributions of the proposed research to the topical research area and to DoD missions; and

(3) potential impact on the institution's ability to perform defense-relevant research and to train, through the proposed research, students in science and/or engineering (for example, by acquiring or refurbishing equipment that can support DoD research and research-related educational objectives).

The following four evaluation criteria are each of lesser importance than any of the above three, but are equal to each other:

(4) the qualifications and availability of the Principal Investigator and key co-investigators;

(5) the adequacy of current or planned facilities and equipment to accomplish the research objectives;

(6) the impact of interactions with other organizations engaged in related research and development, in particular DoD laboratories, industry, and other organizations that perform research and development for defense applications; and

(7) the realism and reasonableness of cost (cost sharing is not a factor in the evaluation).

Decisions for exercising options will be based on accomplishments during the base years and potential research advances during the option years that can impact DoD research priorities and technological capabilities.

2. Evaluation Panel

White papers will be reviewed either solely by the responsible Research Topic Chief for the specific topic or by an evaluation panel chaired by the responsible Research Topic Chief. An evaluation panel will consist of technical experts who are Government employees.

Full proposals will be evaluated by an evaluation panel chaired by the responsible Research Topic Chief for the particular topic and will consist of technical experts who are Government

employees. Evaluation panel members are required to sign "no conflict of interest" statements.

3. Selection Process

Full proposals will undergo a multi-stage evaluation procedure. The respective evaluation panels will review proposals first. Findings of the evaluation panels will be forwarded to senior DoD officials who will make funding recommendations to the awarding officials.

VI. AWARD ADMINISTRATION INFORMATION

1. Administrative Requirements

- CCR - Successful proposers not already registered in the Central Contractor Registry (CCR) will be required to register in CCR prior to award of any grant, contract, cooperative agreement, or other transaction agreement. Information on CCR registration is available at http://www.onr.navy.mil/02/ccr.htm.

- Certifications - The following certification applies to each grant applicant seeking federal funds exceeding $100,000:

Certification Regarding Lobbying Activities

(1) No Federal appropriated funds have been paid or will be paid by or on behalf of the applicant, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the Federal contract, grant, loan, or cooperative agreement, the applicant shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.
(3) The applicant shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.
This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, title 31, U.S.C. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

2. Reporting

In general, for each grant award, annual reports and a final report are required summarizing the technical progress and accomplishments during the performance period, as well as any other reports as requested by the Research Topic Chief.

VII. OTHER INFORMATION

1. Government Property/Government Furnished Equipment (GFE) and Facilities

Each proposer must provide a specific description of any equipment/hardware that each participating institution needs to acquire to perform the work. This description should identify the component, nomenclature, and configuration of the equipment/hardware that it proposes to purchase for this effort. The purchase on a direct reimbursement basis of special test equipment or other equipment that is not included in a deliverable item will be evaluated for allowability on a case-by-case basis. Maximum use of Government integration, test, and experiment facilities is encouraged in each of the proposer's proposals.

Government research facilities and operational military units are available and should be considered as potential Government furnished equipment/facilities. These facilities and resources are of high value and some are in constant demand by multiple programs. It is unlikely that all facilities would be used for the MURI program. The use of these facilities and resources will be negotiated as the program unfolds. Proposers should explain which of these facilities they recommend.

2. Use of Animals and Human Subjects in Research

If animals are to be utilized in the research effort proposed, the proposer must complete a DoD Animal Use Protocol with supporting documentation (copies of AAALAC accreditation and /or NIH assurance, IACUC approval, research literature database searches, and the two most recent USDA inspection reports) prior to award. Similarly, for any proposal that involves the experimental use of human subjects, the proposer must obtain approval from the proposer's committee for protection of human subjects (normally referred to as an Institutional Review Board, (IRB)). The proposer must also provide NIH (OHRP/DHHS) documentation of a Federal Wide Assurance that covers the proposed human subjects study. If the proposer does not have a Federal Wide Assurance, a DoD Single Project Assurance for that work must be completed prior to award. Please see http://www.onr.navy.mil/02/howto.htm for further information.

3. Department of Defense High Performance Computing Program

The DoD High Performance Computing Program (HPCMP) furnishes the DoD S&T and DT&E communities with use-access to very powerful high performance computing systems. Awardees of DoD contracts, grants, and assistance instruments may be eligible to use HPCMP assets in support of their funded activities if Research Topic Chief approval is obtained and if security/screening requirements are favorably completed. Additional information and an application may be found at http://www.hpcmo.hpc.mil/.

VIII. SPECIFIC MURI TOPICS

FY08 MURI Topic #1

Submit white papers and proposals to the Office of Naval Research. See AFOSR topic #9 if submitting to the Air Force Office of Scientific Research

A 21st Century Approach to Electronic Device Reliability

Background: Although historically very useful, the traditional reliability technique of three temperature accelerated life testing has, in many cases, proven inadequate for military critical systems based on compound semiconductor devices. In particular, device lifetimes can be vastly overestimated when temperature accelerated life testing requires elevated temperatures so extreme as to activate degradation mechanisms that are statistically insignificant to failure mechanisms at operational levels. This problem, and the inability to define accelerated life tests for electric field and current driven failure modes has been brought to the forefront by the emerging device technologies such as: HV-GaAs and GaN. A new class of procedures is necessary to provide adequate reliability prediction. These procedures need to augment the approach used for traditional compound semiconductor devices and develop techniques appropriate to the new family of refractory materials, which can operate at higher temperatures and significantly higher fields.

Objective: Establish accelerated life-testing procedures that can accurately predict operational lifetimes for devices that fail because of: 1) field or current driven mechanisms, or 2) low-activation-energy mechanisms that are thermally activated. A requisite feature of these procedures is the ability to extract operational lifetimes from an analytical description of the underlying physical phenomena that lead to the device degradation. Although the demonstration vehicle will be compound semiconductors the formalisms should work for elemental materials as well.

Research Concentration Areas: Given that the objective is to develop new analytical formalisms which can be used to reliably predict operational lifetimes for all compound semiconductors (similar to those that describe the degradation of Si CMOS due to hot carrier related damage to the oxide or the traditional Arrhenius testing), the research must have two main components: An experimental effort to identify and establish the dependence of the underlying physical phenomena causing degradation and a theoretical effort to develop analytical formalisms that can describe and predict the dynamics of these phenomena. The research areas should include but not be limited to: 1) materials science studies utilizing techniques such as: electron microscopy, chemical imaging, IR thermography, microRaman; 2) defect characterization techniques such as: Deep Level Transient Spectroscopy (DLTS) and Deep Level Optical Spectroscopy (DLOS); 3) the development of test structures and methodologies suitable for the characterization of accelerants other than temperature, 4) the development of physics based analytical formalisms that can be used to extrapolate operation lifetimes from the data and 5) the application of statistical methods to assure the results are statistically meaningful.

Impact: Practical, more accurate accelerated lifetime tests will provide many benefits, including:

- A more rapid and successful insertion of technologies such as GaN and HV-GaAs.
- An improved process for high yield manufacturing.
- Application-specific optimization of devices for performance, lifetime and life cycle cost.
- Improved prequalification – better understanding of device performance/lifetime characteristics before technology insertion, leading to higher confidence.
- Ability to insert device technologies into high reliability applications such as space
- Accelerated insertion of new materials and devices into DoD weapon systems

Research Topic Chief: Dr. Paul Maki, ONR, 703-696-3060, makip@onr.navy.mil ; Dr. Donald Silversmith, 703-588-1780, donald.silversmith@afosr.af.mil; Dr. Kitt Reinhardt, 703-588-0194, kitt.reinhardt@afosr.af.mil

FY08 MURI Topic #2

Submit white papers and proposals to the Office of Naval Research

Real-Time Methods for the Analysis of Networks

Background: Many phenomena we encounter today can be modeled as networks or graphs (e.g., biological systems, social systems, computer and communication networks, social networks, etc.). Typical models represent the system as nodes and links that are analyzed separately and treated as indistinguishable, often having no characteristics other than their network position or linkage. However, the characteristics of most real-world networks include a variety of features such as geographical location, textual content, amount of traffic, and others. In addition, networks are often dynamic, evolving, and inter-dependent. Examples of network-based data of interest to the DoD include terrorist networks, where the nodes would be human actors and the links might represent money flow or the networked battlespace, where the nodes might be ships/planes/soldiers/sensors and the links represent the data flow between them. Some of the typical measures used to describe networks include node degree distribution, connectivity of the network, number of nodes and links, characteristic path length, number of cliques, and many others. However, most of these are based on first order characteristics, e.g., nodes only, not on the network as a whole. Research has shown that these do not adequately characterize network structure. For example, many different graphs or networks exist that have the same node degree distribution, but are very different from each other when we view them from a domain perspective. New theories for network analysis are needed to fully understand and to take advantage of data and information that are acquired in a network framework.

Objective: To develop novel theory, mathematics, and statistical methods for analyzing network-based data; to develop new methodologies for encoding networks and graphs that go beyond decomposing the network into separate sets of nodes and links; and to develop real-time methods for exploiting network-based data.

Research Concentration Areas: Areas of interest include, but are not limited to the following: (1) creation of a new algebra for networks, where the basic data type is a network; (2) development of probability distributions over networks and understanding of network populations and random samples; (3) construction of time series methods for network-based data; (4) development of methods for fusing different types of networks and integrating networks with other data sources; (5) development of new models for dynamic and evolving networks; (6) construction of algorithms that use network-based data for anomaly detection and prediction, especially in massive data sets; (7) representation and understanding of the spatio-temporal aspects and the environment or context of the network; (8) development of methods for defining and analyzing metadata on networks; and (9) development of information theory based on networks. To achieve the objectives of this topic, basic research in several disciplines is needed. These include discrete math, statistics, information theory, physics, computer science, machine learning, graph theory, social network analysis, geographic information systems, and others.

Impact: To realize the full potential of a network-centric environment, we should begin to think of networks and the network nature of our data as additional information that can be exploited and used for analysis and knowledge discovery. Given the prevalence of network environments in industry and defense applications, understanding the state of the networks and using this as

an information source that can be integrated with other data and information sources is critical to the success of this operational paradigm. This research will help analysts identify vulnerabilities in networks of all types and to assess how these networks might change in response to interventions.

Research Topic Chiefs:

Wendy Martinez, Ph.D., ONR, 703-696-4320, martinwe@onr.navy.mil
Donald Wagner, Ph.D., ONR, 703-696-4313, wagnerd@onr.navy.mil
Rebecca Goolsby, Ph.D., ONR, 703-588-0558, goolsbr@onr.navy.mil

FY08 MURI Topic #3

Submit white papers and proposals to the Office of Naval Research

Biologically-Inspired Autonomous Sea Vehicles

Background: Biologically-inspired design is highly adaptive, effective, and efficient, and has been used for many products and devices. Biological systems, evolved over time, provide highly efficient and capable means for performing particular functions. It is desirable to make use of biologically inspired design to develop enhanced capabilities for autonomous sea vehicles such as unmanned surface vehicles and unmanned underwater vehicles. The enhanced capabilities could be applied to sea weapons to improve the tactical advantages, and to counter terrorists, such as stopping suspicious marine vessels. These enhanced capabilities include stealth, speed, endurance, maneuverability, sea keeping, payload fraction, sensing, and autonomous control. Mimicking biological design in systems engineered by humans is very challenging, due to the complexities of biological systems. There has recently been work in areas such as bio-inspired vision, maneuvering and control, group behavior for application to swarming robots, and neuronal chips, but additional breakthroughs are needed to understand these phenomena at a level necessary to begin technology development. Recent advancements have been made in Robo-Tuna and lobster robot mimicking fish and lobster locomotion; neuroscience based nonlinear control for autonomous vehicles, prosthetic leg using artificial muscle, and deployment of a swarm of robots to multiple destinations.

Objective: Understand the fundamentals of marine biological systems in sensing and detection, control and maneuvering, offensive and defensive bio-mechanisms, and cooperative behavior. Develop scientific knowledge and approach to mimic the biological behaviors and capabilities for autonomous sea vehicles including surface and underwater vehicles.

Research Concentration Areas: Research involves multidisciplinary efforts in, but are not limited to, the following: (1) detection and classification using bio-sensors and neuronal chips; (2) maneuvering and control techniques and algorithms based on biological system architecture; (3) biological-inspired propulsion; (4) biologically inspired materials and structures; and (5) self assembly, swarm formation, and cooperative behavior amongst numerous heterogeneous vehicles.

Impact: This topic represents military research that will facilitate a paradigm shift in sea warfare and weapons development, by enabling the incorporation of biologically inspired technologies into autonomous vehicles, increasing their mission capability. This will enable more widespread use of autonomous vehicles for military applications, decreasing the risk to personnel and high-value platforms. Furthermore, results of this effort will provide a revolutionary approach for various naval missions, including anti-terrorism such as stopping suspicious marine vessels, and weaponization of autonomous sea vehicles, .

Research Topic Chiefs: Dr. Kam W. Ng, ONR, 703-696-0812, ngkw@onr.navy.mil ; Dr. Robert A. Brizzolara, ONR, 703-696-2597, brizzor@onr.navy.mil

FY08 MURI Topic #4

Submit white papers and proposals to the Office of Naval Research

Socio-cultural Modeling for Understanding Asymmetric Threat Environments

Background: The United States military plays a variety of significant roles in humanitarian efforts, conflict resolution and peace keeping in non-Western settings. The background of these conflicts is increasingly complex, involving socio-cultural factors (including local politics, economics, social values and religious or "sacred values") and unusual tactics (mass rape, genocide, child soldiers, IEDs, maiming) creating threat environments that are difficult to comprehend. Choosing the most effective response in these situations is problematic. Combatant commanders, intelligence analysts, and military planners often rely on their own (primarily Western) experience and reaction; they lack tools for analyzing and understanding these non-Western environments and for evaluating courses of action in a variety of domains (for example, civ-mil and PSYOPS).

Objective: To develop new and innovative theory and associated computational methods for decision-making that incorporate socio-cultural models with the goal of understanding asymmetric forces in non-Western settings; to create algorithms and methodologies for exploring scenarios that take into account socio-cultural factors; political and economic factors; local attitudes, values, and social structure; and local asymmetric threat strategies. The domain of interest will be Afghanistan, Sudan, or Somalia.

Research Concentration Areas: This research needs inputs from social scientists (particularly anthropologists and sociologists, but also economists and political scientists) to provide insight and depth of understanding of non-Western societies and their associated norms, values, and behaviors, and computer scientists, mathematicians and physicists to develop novel models of identified socio-cultural processes relevant to addressing the combatant commander's needs. Research areas of interest include, but are not limited to: (1) development of methods for rapid understanding of complex, non-Western situations; (2) understanding developing trends and tipping points for planning operations in a variety of domains; (3) creation of new theory, models, and methodologies for understanding the socio-cultural aspects of asymmetric threats; (4) development of modeling and simulation tools that enable the combatant commander to develop and evaluate plans that could counter the creation and strengthening of asymmetric forces in a complex warfighting environment.

Impact: Sensitive, robust socio-cultural models will provide the warfighter with improved situation awareness, improved course of action analysis and better understanding and insight into complex, non-Western environments and operational adaptation.

Research Topic Chiefs: Dr. Rebecca Goolsby, ONR, 703-588-0558, goolsbr@onr.navy.mil ; Dr.Wendy Martinez, ONR, 703-696-4320, martinwe@onr.navy.mil

FY08 MURI Topic # 5

Submit white papers and proposals to the Office of Naval Research

Biometrics in the Maritime Domain

Background: In the Global War on Terrorism, adversaries are adept at concealing their identity, and may be able to thwart our battlespace awareness. Existing DoD systems lack a robust system capable of capturing and accurately comparing biometric based identification information in order to identify individuals of potential threat to joint forces, and ensuring positive identification of personnel during field operations. DoD biometric systems also lack the ability to support naval expeditionary operations and inadequately support intelligence and law enforcement activities. Shipboard, expeditionary biometrics are of particular importance in the maritime domain for informing decisions involved in interception operations and monitoring of watercraft traffic in critical littoral areas of operation. Moreover, both improved affordability and reduced risk can be achieved if the system can be used at operational distances of 20m-100m. For Biometrics use by the Navy, it is of particular interest to acquire biometrics of persons of interest in small or medium crafts, using self-contained shipboard or patrol vessel mounted systems. There has been considerable work in face recognition and other biometrics including a DARPA program in human identification at a distance. Under that program, face recognition under extreme lighting and at over 50m was evaluated. It also evaluated gait recognition at similar distances and iris recognition was demonstrated at 2-3 meters. However, those results were under controlled daylight conditions with cooperating subjects. For the Navy's purposes, operational use 24/7 on moving ships with moving and non-cooperative subjects is required. There is also strong interest in developing robust biometrics from human motion, including, but not limited to gait. Humans are capable or recognizing familiar individuals from face or body motion under low illumination, but this capability has not been replicated with an engineered system. Because of the need to obtain positive identification of persons encountered in the field, regardless of biometric countermeasures, biometric identification provided by nuclear DNA would be particularly valuable if it could be conducted in the field with a compact system, with match results obtained within minutes.

Objective: To support research leading to the development of new technologies to enable robust biometric identification of individuals at modest to long distances during expanded maritime interception operations using face, iris, movement or other bio-measures, and to support scientific research that could enable robust positive identification of individuals encountered in the field, within minutes, based on nuclear DNA collection, hand images, and hand scans.

Research Concentration Areas: 1. Conduct basic research in advanced machine vision, imaging sensors and pattern recognition for biometrics that could lead to a Maritime Biometric system, which can capture and perform face-based recognition from at least 50m and/or iris based recognition from 10m. An important and challenging aspect of this research is addressing non-cooperative subjects, handling wide ranges of pose and outdoor and indoor illumination, including non-visible illumination at night, image stabilization, handling of motion blur, and addressing atmospheric disturbances/spray to be expected in ship-to-ship imaging. 2. Conduct research on novel biometrics, including face and body motion, gait, hand images, and hand scans. Gait research should address robustness to ship motion or terrain. Motion biometric research that takes advantage of biomechanical and neuro-motor control constraints would be of particular interest. 3. Conduct basic research to enable collection and identification of humans by means of nuclear DNA within minutes of sample collection. This includes research on

automated nuclear DNA extraction and quantitation, DNA amplification for short tandem repeat loci, alternative patterns of base pairs for ID, DNA chip primers, separation and detection of products and automated genotyping. There are also substantial challenges in miniaturizing some of these procedures and designing sequential operations for automation, and research on novel approaches such as microfluidic analytics are encouraged.

Impact: Robust biometrics technology is the key enabler of the Identity Dominance in the OPNAV Maritime Domain program, whose goal is improved naval battlespace awareness. In the GWOT, adversaries demonstrate adept ability in concealing their identity in order to thwart our forces' battlespace awareness. Current biometric technology is not tailored to support naval expeditionary operations and support intelligence exploitation in this environment. Multiple biometrics (face, iris, hand, and gait) for improved identification performance in an austere and mobile environment, and the ability for standoff acquisition of biometrics between two vessels are key enabling technologies to support on-scene decision making.

Research Topic Chief: Dr. Thomas McKenna, ONR, 703-696-4503, mckennt@onr.navy.mil

FY08 MURI Topic #6

Submit white papers and proposals to the Office of Naval Research

Biologically-Inspired Approaches for Team and Coalition Adaptation of Heterogeneous Unmanned Systems for Surveillance over Large and Complex Areas

Background: There is currently a wide range of research efforts examining the control of groups of unmanned vehicles to carry out cooperative or collaborative missions. However, many of the approaches used in these efforts are highly centralized, designed for a narrow set of requirements, and have significant scalability limitations. This can be particularly problematic for the use of unmanned systems across different domains (air, sea surface, undersea, ground) and distributed across large, complex areas with limited communications. Other research efforts have attempted to address scalability issues by using largely decentralized, reactive, or swarm approaches, some of which have been inspired by biological phenomena such as schools of fish, flocks of birds, ant colonies, and insect swarms. While these types of approaches may be suitable for some types of problems, they also have significant challenges in addressing complex mission tasking, utilizing heterogeneous resources, dealing with resource-limited situations, and ensuring that needed tasks will be done in the time required by the warfighter, which is critical for many military operations. Further, there has been little thought about how warfighters can effectively collaborate with these larger and more amorphous groups of unmanned systems. Given recent advances in autonomous control, it is now possible to consider biologically-inspired approaches that involve more complex organizational and cooperative mechanisms in team and coalition behaviors in order to provide mission coverage of large, complex areas. Relevant team behavior may be derived from recent advances in understanding of the social and cooperative behaviors used for collaboration by tens of predators with high-level cognitive abilities such as lions, meerkats, hyenas, dwarf mongooses, wolves, and even humans. Further, to cover large and complex areas, it will also be necessary to support the ability to dynamically and opportunistically adapt teams and to form shifting coalitions between multiple teams. While the problem of allocating tasks to individual unmanned systems has been studied under numerous efforts, there has been much less work on the coalition formation problem for unmanned systems. In general, this problem is NP-hard and cannot be solved exactly for problems of meaningful complexity. As a result, examples found in biology of the behaviors of certain types of marine mammals and primates may be of great value. This type of approach may provide the way to achieve both scalability and the ability to execute complex, time-critical mission tasking with required levels of reliability over large, complex areas. It also may have some relevance to responding to enemy behaviors that may be examined using models of competing groups of predators, such as the threat of swarming small boats.

Objective: To utilize biological models of social and collaborative behavior by intelligent predators for experimentation and development of principles and methodologies for autonomy to reliably perform complex, time-critical mission tasks over large complex, areas by large numbers of heterogeneous unmanned systems. This should support dynamic and opportunistic team and coalition adaptation, be robust to limited communications and uncertain information, and assist the warfighter in being able to effectively collaborate with large groups of vehicles in complex organizational structures.

Research Concentration Areas: This topic requires collaboration between biologists, computer scientists, cognitive psychologists, and vehicle control engineers in multiple domains that have traditionally been separated (air, sea, undersea, ground). Research focus areas include: Coalition formation supporting dynamic and opportunistic restructuring of the organization of over 100 heterogeneous unmanned vehicles leveraging biological models of social behaviors of animals with high-level cognitive abilities, distributed artificial intelligence, software-agent, and decentralized control

and optimization frameworks; Cooperative behaviors of tens of unmanned vehicles with limited communications leveraging biological models of cooperation of intelligent predators for role allocation, cueing, and coordination of contributions, robotics research, and distributed asynchronous optimization and control supporting complex spatial and temporal criteria and limited resources; Experimentation and theory development of the value of individual unmanned system optimization vs. group and coalition optimization and short-term vs. long-term optimization at each level; Robustness properties and guarantees of constraint maintenance; Human role in the system at a high level of that is less than a peer relationship, but more collaborative than a traditional operator, based on biological models, cognitive psychology, and human factors;

Impact: This MURI will develop the underlying principles and technology that will enable autonomous systems to reliably maintain persistent surveillance of large complex areas with many heterogeneous platforms/sensors and a small number of humans. Ensuring that such technologies are scalable to large and complex areas is critical for surveillance of coastal areas, large ports, riverine, and urban environments. Ensuring that humans can interact with large numbers of unmanned systems at the appropriate level of abstraction will be critical for ensuring there these systems are flexible and responsive for operational adaptation against unconventional threats by forward-deployed naval forces with limited manning.

Research Topic Chief: Mr. Marc Steinberg, ONR, 703-696-5115, steinbm@onr.navy.mil

FY08 MURI Topic #7

Submit white papers and proposals to the Air Force Office of Scientific Research

Harnessing Complexity in Human-Machine Systems

Background: Rapid technological advancement over the past twenty years has fundamentally changed the way we conduct warfare. As an example, in a net-centric military system that involves weapons with sensors, reconnaissance UAVs, and distributed information management systems, warfighters are no longer simply users of the system; they are essential system components. The growth of such large-scale distributed military systems, which is often ad hoc and opportunistic, is a double-edged sword. On the one hand, new interactions are possible, with human and machine working together in a synergistic manner. More information is available for decision makers, and the emerging properties of such systems are providing new and important functionalities. On the other hand, such systems may have new vulnerabilities, and there are issues of control and information overload. Because these systems can evolve in an ad hoc manner, there is a greater challenge in ensuring desired usability. In addition, we do not know how the human components of such systems affect overall performance. Furthermore, we need a better understanding of the underlying vulnerabilities of these systems and how to protect them from attack. It is troublesome to depend on highly complex and distributed systems when we do not know how to adequately control, employ, or protect such important assets.

Objective: This program will develop the scientific underpinnings and propose revolutionary approaches for mathematically modeling and comprehending large-scale complex military systems with an emphasis on how human and machine components of these systems interact at a fundamental level. The focus will be on developing an understanding of system complexity that incorporates formal cognitive and computational models of both human and machine behavior. This will be a multidisciplinary program that will draw inspiration from computer science, mathematics, biological systems, cognitive science, and other disciplines.

Research Concentration Areas: Areas of interest include, but are not limited to, the following: (1) mathematically-based methods for measuring and understanding performance of a large-scale complex system; (2) integration of formal models of cognition and computation; (3) small world networks and graph-theoretical approaches to understanding the functionality and emerging behavior of large-scale complex systems; (4) biologically inspired models that characterize the flow of information and actions through a complex distributed system; (5) new methods for filtering and configuring large amounts of information for presentation to decision makers or other system actors; and (6) new approaches to the specification, design, and implementation of human-machine systems architectures.

Impact: This will introduce new approaches for design of future complex systems and deployment/employment of current and future systems that will increase the situational awareness and overall effectiveness of warfighters and the military systems they inhabit at all levels. It will address the gap in today's sensor networks between the volume of usable information delivered by a sensor network and the potential of coordinated information existing within network outputs. The program will introduce new ways of developing the underlying software needed to grow and exploit these complex systems.

Research Topic Chief: Dr. David R. Luginbuhl, AFOSR, 703-696-6207, david.luginbuhl@afosr.af.mil

FY08 MURI Topic #8

Submit white papers and proposals to the Air Force Office of Scientific Research

Assured Information Sharing

Background: Data from the various data sources at multiple security levels as well as from different services and agencies including the Air Force, Navy, Army, Local, State and Federal agencies have to be integrated so that the data can be mined, patterns and information extracted, relationships identified, and decisions made. The databases would include for example, military databases that contain information about military strategies, intelligence databases that contain information about potential terrorists and their patterns of attack, and medical databases that contain information about infectious diseases and stockpiles. Data could be structured data or unstructured data including geospatial data. Unless the data is integrated and the big picture is formed, it will be impossible to inform all the parties concerned about the incidences that have occurred. While the different agencies have to share data and information, they also need to enforce appropriate security and integrity policies so that the data does not get into the hands of unauthorized individuals. Essentially the agencies have to share information as much data as possible but at the same time maintain the security and integrity requirements.

Objective: The Assured Information Sharing program will develop revolutionary approaches to information sharing across and within security levels and will ensure that confidentiality, privacy, trust, release, dissemination, data quality and provenance policies are enforced. This research program will develop theories for assured information sharing based on risk analysis, game theoretical concepts and statistical models and subsequently design practical algorithms to enable multiple parties to share data and at the same time enforce various security and integrity policies.

Research Concentration Areas: Areas of interest include but are not limited to the following: (1) Policy specification and enforcement for inter-agency information sharing including policies for confidentiality, privacy, trust, release, dissemination, data quality and provenance (2) Theory for incentive-based information sharing and Risk-based access control (3) Principles of social network analysis for inter-agency information sharing (4) Service oriented as well as federated architectures for information sharing and dissemination (5) Multi-party cryptographic computation techniques for enforcing confidentiality and privacy (6) Secure knowledge models based on semantic models such as the resource description framework for uniform views across multiple organizations (7) Practical algorithms for handling heterogeneous policies and sharing unstructured geospatial and multimedia data across organizations (8) Data mining and probing techniques for extracting information from untrustworthy partners (9) TCB (Trusted computing base)-based approaches for sharing data across multiple security levels as well as approaches for Multiple Independent Level security (MILS) enforcement (10) Computational methods such as grid computing for information sharing.

Impact: The net centric warfare vision is dependent upon secure, rapid data collection and information sharing among all DOD components, coalition partners, and government departments (National, State and local). Sensor and collection S&T now produces more data than can be processed and shared effectively. This research should make great strides toward solving information sharing problems.

Research Topic Chief: Dr. Robert Herklotz, AFOSR, (703) 696-6565, robert.herklotz@afosr.af.mil.

FY08 MURI Topic #9

Submit white papers and proposals to the Air Force Office of Scientific Research. See ONR topic #1 if submitting to the Office of Naval Research

A 21st Century Approach to Electronic Device Reliability

Background: Although historically very useful, the traditional reliability technique of three temperature accelerated life testing has, in many cases, proven inadequate for military critical systems based on compound semiconductor devices. In particular, device lifetimes can be vastly overestimated when temperature accelerated life testing requires elevated temperatures so extreme as to activate degradation mechanisms that are statistically insignificant to failure mechanisms at operational levels. This problem, and the inability to define accelerated life tests for electric field and current driven failure modes has been brought to the forefront by the emerging device technologies such as: HV-GaAs and GaN. A new class of procedures is necessary to provide adequate reliability prediction. These procedures need to augment the approach used for traditional compound semiconductor devices and develop techniques appropriate to the new family of refractory materials, which can operate at higher temperatures and significantly higher fields.

Objective: Establish accelerated life-testing procedures that can accurately predict operational lifetimes for devices that fail because of: 1) field or current driven mechanisms, or 2) low-activation-energy mechanisms that are thermally activated. A requisite feature of these procedures is the ability to extract operational lifetimes from an analytical description of the underlying physical phenomena that lead to the device degradation. Although the demonstration vehicle will be compound semiconductors the formalisms should work for elemental materials as well.

Research Concentration Areas: Given that the objective is to develop new analytical formalisms which can be used to reliably predict operational lifetimes for all compound semiconductors (similar to those that describe the degradation of Si CMOS due to hot carrier related damage to the oxide or the traditional Arrhenius testing), the research must have two main components: An experimental effort to identify and establish the dependence of the underlying physical phenomena causing degradation and a theoretical effort to develop analytical formalisms that can describe and predict the dynamics of these phenomena. The research areas should include but not be limited to: 1) materials science studies utilizing techniques such as: electron microscopy, chemical imaging, IR thermography, microRaman; 2) defect characterization techniques such as: Deep Level Transient Spectroscopy (DLTS) and Deep Level Optical Spectroscopy (DLOS); 3) the development of test structures and methodologies suitable for the characterization of accelerants other than temperature, 4) the development of physics based analytical formalisms that can be used to extrapolate operation lifetimes from the data and 5) the application of statistical methods to assure the results are statistically meaningful.

Impact: Practical, more accurate accelerated lifetime tests will provide many benefits, including:

- A more rapid and successful insertion of technologies such as GaN and HV-GaAs.
- An improved process for high yield manufacturing.

- Application-specific optimization of devices for performance, lifetime and life cycle cost.
- Improved prequalification – better understanding of device performance/lifetime characteristics before technology insertion, leading to higher confidence.
- Ability to insert device technologies into high reliability applications such as space
- Accelerated insertion of new materials and devices into DoD weapon systems

Research Topic Chiefs: Dr. Donald Silversmith, 703-588-1780, donald.silversmith@afosr.af.mil; Dr. Kitt Reinhardt, 703-588-0194, kitt.reinhardt@afosr.af.mil; Dr.PaulMaki, ONR, 703-696-3060, makip@onr.navy.mil

FY08 MURI Topic #10

Submit white papers and proposals to the Air Force Office of Scientific Research

Semiconductor Nanomembranes

Background: Thin, inorganic, crystalline semiconductor materials, so thin that their mechanical compliance can match a wide range of hosts, unlock a range of new opportunities for exploiting the outstanding features of semiconductors in entirely new environments to create new functions. Relative to "bulk" semiconductors, crystalline semiconductor nanomembranes have many unique features. Semiconductor nanomembranes are or can be thin, extremely flexible, transparent, transferable and integratable , stackable, permeable or not, patternable into any form of nanostructure with dimensions varying from 1D to 3D, amenable to distinctive strain engineering, surface sensitive because of the high surface area to volume ratio, and amenable to integration with bottom-up self-assembly processes. Semiconductor nanomembranes leverage the extensive infrastructure for device processing, taking advantage of the availability of high-quality material, advanced lithography, and other existing processes for device manufacturing. Silicon (Si) leads the group of semiconductors with significant technological impact. In the pending challenges to the continued evolution of miniaturization, Si-based nanomembranes and their derivatives (nanoribbons, platelets, coils, and tubes) offer two distinct advantages. One, they circumvent one of the most significant barriers in extending Si-based device technology in electronics and optics - the inability to grow crystalline films on oxides. Two, they represent a significant possibility of a revolution that can broaden the reach of silicon technology into previously inaccessible domains. These include, for example:

- Si-based nano-optics (imaging systems, photonic crystals, wave guides, lenses and curved detectors, adaptive optics, Si/oxide/Si quantum cascade lasers)
- Very fast macroelectronics and flexible electronics (antenna arrays, conformal sensor arrays, flexible cell phones, electronic paper, curved displays, smart textiles)
- Transparent electronics (displays, electronics integration with biological assays)
- Thermoelectric energy conversion devices
- Integration with microfluidic platforms for thermal management and chemical and biological sensing
- NEMS or other devices relying on unique mechanical properties
- 3D stacked electronics, vertical-transport devices
- Integrated structures with novel properties
- Metamaterials

A similar case can be made for nanomembranes made from other semiconductors. The bulk properties of III-V materials and III-N materials can be leveraged with nanomembranes of these materials. Complex-oxide membranes hold promise in the integration of magnetic, non-linear optical, transport control, and catalytic functions with semiconductors. Integration across different classes of materials combines the best features of each class, without the severe issues associated with bulk-materials integration. Furthermore, polycrystalline or amorphous membranes of Si, SiGe, GeSn or other semiconductors offer opportunities in the areas above when less demanding alternatives suffice.

Objective: Design and develop processing methods and demonstrate device components for crystalline semiconductor nanomembranes directed toward an application outcome in one or more of the above areas, which can be broadly grouped into 1) Silicon nano-optics, 2) novel fast electronics, 3) microfluidics, 4) nanomechanical systems, 5) sensors, 6) energy conversion and

7) complex-materials integrated systems exhibiting unique properties as a consequence of the integration. Achieve solutions that would enable large-scale integration and efficiencies compared to current technologies.

Research Concentration Areas: Areas of interest include, but are not limited to the following: (1) novel material processing techniques for realizing silicon nanomembrane structures and derivatives with defined size distribution and controlled doping; (2) membrane transfer and bonding technologies to assure positional fidelity and device performance after integration, (3) studies of electrical and structural properties of membrane/host or membrane/membrane interfaces, (4) innovative device structures that combine two or several of the unique features of crystalline semiconductor nanomembranes (e.g., transparency and conformability, surfaces and electrical conductivity, deformability and optical properties, ...), (5) investigation of nanomembrane based metamaterials, (6) study of light-phonon scattering in engineered nanoscale structures, (7) membrane based 3D device integration, and (8) disposable devices with remote sensing and signaling function. Primary focus in these areas would be in silicon-based semiconductors. Important is the demonstration of functional devices and components.

Impact: Crystalline, strain engineered, semiconductor nanomembranes unlock a range of new opportunities for semiconductors with new functions in entirely new environments and solve current difficult device challenges. Because of the unique properties of nanomembranes, these opportunities transcend conventional boundaries for the application of semiconductors, impacting sensing, security, communication and computing, health, and energy utilization. The outstanding electronic, optical, or mechanical features of semiconductor materials can be exploited in ways heretofore not possible, extending the reach of semiconductor technology into regions previously inaccessible to it.

Research Topic Chief: Dr. Gernot S. Pomrenke, AFOSR, 703-696-8426, gernot.pomrenke@afosr.af.mil

FY08 MURI Topic #11

Submit white papers and proposals to the Air Force Office of Scientific Research

Exploring the Interface: Mechanics of Nano-Scale Thermal Transport between Dissimilar Materials

Background: There is a critical need for materials and structures with advanced thermal transport properties such as switchable and/or asymmetric thermal conductivity (k), low- and high-k materials at low- and high-mass density, and photonic selectivity to service the demanding thermal requirements of military systems. Recent advances in areas such as computational chemical and materials science, novel chemical and physical routes for selective architecture of materials from the molecular to the nano-scale, high-throughput three-dimensional fabrication techniques, and novel photonic crystals, among others, provide unique opportunities to create new materials and structures with unprecedented thermal properties. While a great deal of experimental work has been performed to optimize the balance between functional and thermo-structural requirements, the optimization process is not likely to lead to a real breakthrough without the support of a detailed theory of the physics-based mechanisms governing the emission of radiation at very high temperatures. Thermal transport at the nano-scale plays an important role in determining the performance of many state-of-the-art engineering systems. Especially on small length and time-scales, thermal transport is sensitive to the properties of interfaces. The promise of nanostructured materials for increasing the efficiency of thermoelectric energy conversion, improving heat conduction in composites and heat transfer fluids all depend critically on thermal transport across solid-solid or solid-liquid interfaces. In studying thermal transport across heterogeneous interfaces, thoughts should also be given to theoretical limits and how these might be achieved. Furthermore, since thermal transport across interfaces is sensitive to atomic-level structure, a better understanding of the interface thermal transport might provide a convenient, noninvasive measurement technique.

Objective: Understand the mechanisms responsible for nano-scale thermal transport between dissimilar materials at the molecular level to determine how heat is transferred across the boundary between two materials. Ultimately, we want to predict the effect of composition and structure on thermal properties, in particular understanding how surface chemistry may be used to create materials and structures with unprecedented and/or tunable thermal and spectral properties.

Research Concentration Areas: Suggested research areas include but are not limited to: (1) multi-scale modeling to understand the fundamentals of heat transfer on the atomic to micro-scale, (2) understanding how interfaces and acoustic band gaps affect heat transfer at the micro-scale, (3) development of models for radiative heat transfer that link mechanisms from the micro- to the macro-scale, including the effects of tunneling, (4) exploration of novel mechanisms for optimizing thermal and spectral properties through surface chemistry, and (5) study of the kinetics and mechanisms of material degradation during heat transfer.

Impact: The possibility of engineering the spectral emissivity of materials at high temperature may offer unique technological advantages for military systems ranging from compact power for the dismounted soldier to microelectronics to satellite systems. The fundamental knowledge gained, and the new chemical and physical means developed, to prepare novel materials and structures for improved thermal management will result in enhanced performance, reliability,

and thermal-signature control of a variety of military power, weapons, and electronic systems.

Research Topic Chiefs: Major Jennifer Gresham, AFOSR, 703-696-7787, jennifer.gresham@afosr.af.mil ; Dr. Joan Fuller, AFOSR, joan.fuller@afosr.af.mil ; Dr. Robert Mantz, ARO, 919-549-4309, robert.a.mantz@us.army.mil

FY08 MURI Topic #12

Submit white papers and proposals to the Air Force Office of Scientific Research

Nanocatalysis for Propulsion Applications

Background: The use of catalysts to accelerate the speed of chemical reactions plays an important role in military and commercial technology. Applications of chemical catalysis of importance to the DoD include accelerating the rate of combustion and increasing the heat sink capacity in hydrocarbon-fueled, regeneratively cooled engines, which rely on the fuel to absorb engine heat loads. Some of the primary challenges to improving the performance of aircraft and rocket propulsion systems can be addressed by the use of catalysts added to fuels or fuel systems. The use of a soluble or suspended catalyst is preferred because it reduces the need to develop specialized components and can be applied to a variety of platforms and configurations. Soluble or suspended catalysts have the additional advantage of being transported to the combustion region and could therefore be used to increase the rate of combustion. For example, it has been shown that nanocatalysts that form very stable colloidal suspensions in fuel can help fuels to ignite at lower temperatures, increase their combustion efficiency, and increase the heat sink capability of fuels. Recent advances in the ability to tailor, control, and diagnose nanoscale particles offer the possibility that nanostructured catalysts can be developed that bring together many of these properties with the prospect of greatly enhancing performance in propulsion systems. However, a fundamental understanding of how these catalytic processes occurs, or how multifunctional catalysts would perform and interact does not exist. This program seeks to bring together recently developed experimental and theoretical methods and approaches to develop the necessary understanding of the mechanisms of catalysis in these systems so that the optimum nanostructured catalysts can be developed for use in propulsion systems. A multidisciplinary effort is required to address this developing opportunity including fundamental research in chemistry, physics, surface and materials science, and computational simulation and modeling.

Objective: The objective of this effort is to develop an understanding of the unique properties of nanostructures as catalysts and develop methods by which they can be exploited in propulsion systems. This involves developing an understanding of the detailed relationships between the structure, geometry, and morphology of the nanostructures and their catalytic properties. The role of interactions between metal catalysts and supports, catalytic active sites, promoters, and other participants in the catalytic process will be investigated. The underlying principles of interaction will be elucidated and the widespread utility and feasibility of this approach will be demonstrated.

Research Concentration Areas: Areas of interest include: 1) Understanding the fundamentals of catalytic processes including interactions between metal atoms and metal oxide support, charge donation, and charge transfer and their role in determining catalytic properties; 2) Understanding the role and effects of water, impurities, contaminants, temperature and pressure on catalytic performance; 3) Understanding the aging and long time behavior of catalysis including issues of mobility, sintering, fouling, and temperature cycling; 4) Developing methods to theoretically model, predict, and design catalytic systems for propulsion applications, including the ability to control catalytic performance and properties; 5) Developing multifunctional catalysts that can be easily dissolved or suspended in fuels; 6) Demonstrating the selectivity and efficiency of nanostructured catalysts on model hydrocarbon systems.

Impact: The potential selectivity and efficiency offered by using nanostructures for chemical catalysis could develop revolutionary capabilities in a myriad of military systems including advanced propulsion for air and space platforms ultimately resulting in reduced time, risk, and cost for developing a propulsion capability for military and commercial space flight. Using nanocatalysts, combustion and oxidative processes could be carried out at lower temperatures reducing stress on materials and reducing emissions. Nanocatalysts also can play key roles in fuel cell and solar energy technologies, and could form the basis for extremely sensitive nanoscale sensors for a wide range of applications including chemical warfare agents and toxic wastes. Nanocatalysts and nanostructured substrates could provide new efficient synthesis pathways of novel chemicals and materials and have a tremendous cost-saving impact on the multi-billion dollar chemical industry that relies on catalysts in numerous synthetic processes.

Research Topic Chief: Dr. Michael R. Berman, AFOSR, 703-696-7781, michael.berman@afosr.af.mil

FY08 MURI Topic #13

Submit white papers and proposals to the Air Force Office of Scientific Research

Vortex-Particle Dynamics, Interaction and Control for Brownout Mitigation

Background: The global war on terrorism necessitates military operations in desert environments for decades to come. The rapid insertion and extraction of conventional forces and materiel, as well as special operations forces, relies heavily upon rotorcraft operations. Unfortunately, there has been a high rate of aircraft loss/damage and loss of life during desert landings due to brownout conditions, where dust recirculation from rotor downwash obscures the pilot's view and removes all visual cues. Such conditions dramatically increase risk to the crew and aircraft when landing at sites where particulate matter may be entrained in downwash flows, which often occurs in combat and training operations. While there are some helicopter brownout mitigation approaches being pursued by the services, none attempts to address the problem by understanding and manipulating the fundamental physics leading to brownout. Moreover, such conditions are likely to occur for any aircraft (V-22, F-35) vertically descending/ascending in ground effect. During a recent workshop, researchers, rotorcraft designers and operators agreed that aerodynamic mitigation of brownout is feasible. Helicopter brownout is an aerodynamically complex phenomenon, requiring understanding of rotor blade configuration and disk loading, blade tip vortex strength and dynamics, fuselage configuration, engine inlet and exhaust, rotor/fuselage/engine interactions, aircraft maneuvering/vehicle dynamics, particulate (dust, sand, snow, water) characteristics including entrainment and dispersion. Similar complexities would exist for V-22 and F-35 aircraft. A physics-based solution to brownout for any aircraft/rotorcraft configuration demands creative integration of traditionally disparate aerodynamics, flight dynamics, propulsion, and particle mechanics disciplines.

Objective: This program seeks to develop the fundamental scientific understanding to enable large-scale manipulation and control of vortex-particle dynamics of aircraft and rotorcraft maneuvering in ground effect. Goals for this effort include 1) development of physically based predictive models for unsteady fluid-structure interactions of two-phase flows by integrating theoretical, numerical and experimental methods; 2) identification and exploitation of fluid-structural interactions to control two phase flows and 3) small-scale flight demonstration of aircraft or rotorcraft vortex-particle manipulation and control while maneuvering in ground effect.

Research Concentration Areas: Research areas of interest include, but are not limited to: (1) physics of unsteady two-phase flows (solid-gas/liquid-gas); (2) non-homogeneous particle entrainment; (3) unsteady fluid-structure interactions of recirculating flows with fuselage, aerodynamic surfaces and propulsion system; (4) multi-scale modeling techniques; (5) integration of theoretical, numerical and experimental analysis techniques and (6) two-phase flow control methodologies.

Impact: This research provides a foundation for enabling aircraft and rotorcraft to land and maneuver safely in ground effect in desert, snow, and water environments by manipulating and controlling large-scale particle-laden vortex flows. An in-depth understanding of the two-phase flow field and its interaction with aircraft/rotorcraft fuselage, aerodynamic surfaces and propulsion system may lead to new integrated design practices and to an unprecedented ability to operate effectively in all ground environments. Such advances will influence future aircraft/rotorcraft design processes, modification programs for existing fleet aircraft and flight training.

Research Topic Chief: Lt Col Jefferies, AFOSR, 703-696-6961, rhett.jefferies@afosr.af.mil

FY08 MURI Topic #14

Submit white papers and proposals to the Army Research Office

Human, Social, Cultural, and Behavioral Modeling: Dynamic Models of the Effect of Culture on Collaboration and Negotiations

Background: Stability, security, transition, and reconstruction (SSTR) operations require the Department of Defense (DoD) to utilize different collaboration and negotiation strategies for planning and operations than do traditional combat operations. What is needed is an understanding of how significant cultural dimensions effect the ability to interact, collaborate, and negotiate with friendly, neutral, and unfriendly individuals and how to successfully model those effects so they may be used in dynamic training and mission planning.

Objective: The objective of this research is to identify and/or develop adequate theory to help us understand how culture impacts dynamic collaboration and negotiations and to develop a model to predict collaboration and negotiation performance. The research should identify cultural differences that affect behavior in intercultural interactions under conditions of interdependence, such as orientation toward collaboration, conflict management styles, and communication norms. The model should accommodate the conceptualization of common and unique properties of culture, at the national, local, and organizational levels of analysis, the influence of context (e.g., prior experience and type of scenario or mission); as well as objective measures of collaboration (e.g., trust, conflict, communication patterns, and self-synchronization), organizational structure (e.g., hierarchical vs. matrixed), and local operational success (e.g., situational understanding, mission success, and second- and third-order effects in an environment). The validated model will lead to recommendations for how to use cultural knowledge to dynamically influence interactions, collaboration, and successful negotiations among team members, friendly, neutral, and especially unfriendly individuals and groups. The cultures of particular interest are the major variants of the Iraqi, Iranian, Turkish, and other Arabic cultures in that order of precedence.

Research Concentration Areas: This topic encourages collaboration among researchers from social/behavioral science fields such as psychology, communications, management and organizational science, and sociology and from researchers with relevant interests in social network science and/or mathematical/computational modeling. Research areas of interest include: 1) What is the relative importance of local, organizational, and national culture in achieving collaboration and/or successful negotiations?; 2) How are cultural, local, organizational, and national, values expressed in collaborative and negotiations behavior?; 3) How do the major dimensions of Iraqi, Iranian, and Turkish culture effect negotiations? 4) What situational or contextual factors that mediate the influence of local, organizational, and national cultural factors during collaborations and negotiations?; 4) What metrics can be extracted in real-time to diagnose effective or ineffective collaboration and negotiation relative to mission success?; 5) What visualization techniques and strategies can be used to dynamically influence collaboration and negotiation?; 6) What unobtrusive data collection methodologies can be implemented?; and 7) How can advances in network science be used to improve coalition negotiations, formation, and operations.

Impact: This research will advance our understanding of the important cultural and contextual variables that affect successful collaboration and negotiations with members from diverse organizations plus friendly, neutral and unfriendly national cultures. The research will lead to validated models and recommendations for predicting and influencing real-time collaboration in

SSTR operations. We expect that it will also lead to improved negotiation training that is dynamic in nature.

Research Topic Chief: Dr. Micheline Strand, ARO, 919-549-4343, Micheline.Strand@us.army.mil

FY08 MURI Topic #15

Submit white papers and proposals to the Army Research Office

Brain Network Analysis and Modeling for Communication and Orientation

Background: Breakthroughs in neuroscience and cognitive science in recent years, coupled with technological advances in analytic hardware and software, have significantly advanced research progress on brain-computer interfaces (BCIs) that decode the activity in brain networks. Current BCI research is focused on network analysis; direct communication BCIs are less developed. Progress in understanding brain semantics and communication is potentially of great importance to the military because BCIs would eliminate the intermediate steps required in traditional human-machine interfaces, connecting directly to mental life. Neural activity in the human brain occurs over elaborate highly interconnected networks, capable of stable computation across a wide range of conditions. Understanding these complex networks can provide significant gains in the improvement of human engineered networks through reverse engineering. Within the neural patterns that might be analyzed, those used for visual sensory orientation (oculomotor sequences) and intended speech (oropharyngeal networks) present leveraged starting points. Feedback mechanisms produce on-going optimal tuning between brain activity and intended outcomes and involve more cortical networks. The close linkage between the oculomotor and verbal systems is demonstrated most obviously in reading. Further, the oculomotor system often acts as a proxy for the attentional focus and provides a direct readout of orientation to external stimuli. In the internal processing of intentions, meaning, and speech the oculomotor system form dynamic networks in inferotemporal and occipital cortex. These behaviors have widely distributed patterns of intense specific brain activity comparable to limb control and culminate in a single serial sequence of movements, which makes them uniquely amenable to computational decoding. Thus, a concerted research effort should be successfully able to develop a databased computational model that could decode (1) intended mental speech, and (2) the attentional orientation of an individual based solely upon recorded brain activity. Adaptively tuning the algorithmic system for individual variation in specified and limited contexts would have to be an integral part of closing the loop between human and machine, i.e. the machine would have to learn the user and the environment while the user may have to learn to think "clearly," i.e. develop an expertise in this modality.

Objectives: The overall objective of this program is to create the necessary understanding, models and technologies needed to eventually produce a non-invasive brain-machine interface usable in humans that can translate intended (non-vocalized) speech and directional orientation into machine-readable form, i.e. a "thought helmet." The goal is to achieve reliable and real-time adaptation and read-out through closed-loop control. Issues to be addressed are (1) models of the dynamic relationship between visual and auditory knowledge, intent, associated brain activities and command instructions; (2) adaptive model identification from real-time measurements of neural signals; (3) mechanisms for learning and attention control, and (4) functional validation of the network analysis, signal detection and intent interpretation algorithms.

Research Concentration Areas: Areas of interest include, but are not limited to, the following: (1) understanding human neurophysiological data and semantic information processing for generating oculomotor and verbal command streams; (2) modeling human intention through visuo-spatial and acoustic processing system sand signals; (3) developing innovative algorithms for translating these signals into motor commands; (4) understanding the biological mechanisms

that interrelate visual and acoustic systems; (5) identifying and characterizing feedback channels and signals, and (6) investigating of new approaches for brain signal collection that provide optimal signals for control. Both human (non-invasive) and animal (possible invasive) methodologies are appropriate to advance the project, but will require the appropriate approvals.

Impact: Direct readout of a Soldier's verbal and attentional intent has applications beyond tactical combat ranging from the prosthetic to the forensic. Civilian dual-use capability in conditions involving motor neuron dysfunction is a not inconsiderable benefit. Having a soldier gain the ability to communicate without any overt movement would be invaluable both in the battlefield as well as in combat casualty care. Most directly, it would provide a revolutionary technology for silent communication and orientation that is inherently immune to external environmental sound and light. Evolution of this research thrust beyond this MURI could lead to direct mental control of military systems by thought alone.

Research Topic Chiefs: Dr. Elmar Schmeisser, ARO, 919-549-4318, Elmar.Schmeisser@us.army.mil; Dr. Liyi Dai, ARO, 919-4350, Liyi.Dai@us.army.mil

FY08 MURI Topic #16

Submit white papers and proposals to the Army Research Office

Reasoning by Abductive Inference

Background: Traditional automated inference systems assume the existence of a set of "axioms," statements assumed true; a conjecture, which must be proven or disproven; and a set of rules of inference. Many military applications, however, need theoretically sound techniques for reasoning from evidence, even in the face of information that may be incomplete, inexact, inaccurate, or from diverse sources. One relevant military example might be the case of constructing a plausible hypothesis for events that led up to detonation of an improvised explosive device. Such evidential reasoning, sometimes called "abductive reasoning" or "Evidential Inference (EI)," proceeds backwards from the observation to a set of plausible explanations or hypotheses. Since observations are inherently corrupted by measurement distortions and noise, probabilistic methods are generally required. Although some progress has been made in EI, good quantitative representations for the uncertain nature of "best guess" decision-making do not currently exist. This research will exploit recent breakthroughs in areas such as statistical-relational learning (SRL) to build a quantitative theoretical framework for reasoning by abduction in the face of real-world uncertainties.

Objective: Develop an analytical framework that provides for accurate and efficient computational procedures for automatic generation and evaluation of hypotheses, given measured evidence, particularly when the evidence is provided by sets of diverse, distributed, and noisy sensors and information.

Research Concentration Areas: The needs of the modern Army for autonomous and semiautonomous forward mobility require additional research on evidential-inference. This includes, but is not limited to the following areas: **1:** Improved performance (in all dimensions) of evidential-inference engines, primarily through algorithm improvement, but may include new parallel implementations on specialized hardware, **2:** More formal treatment of probabilistic representations and confidence, for example use of techniques such as Bayes' networks, Dempster-Schafer and Markov-like strategies and Maximum a-Posteriori optimization methods, **3:** Consideration of sensor and information fusion and the development of methods for implementing EI on sensor networks that may be supplemented with contextual information. This research concentration includes the incorporation of formal models of sensors and sensor noise, the impact of noise on explanation confidence into the Evidential Reasoning process, and consideration for the constraints imposed by the low power requirements of sensor networks, **4:** Evaluation of proposed EI architectures to specific problem environments, such as remote imaging. This may include distributed networks of sensors, and should include some consideration of information security, **5:** Modeling of biological EI systems. Experiments in Cognitive Psychology about how humans do EI will likely yield information, which is applicable to, advanced, automated or semi automated systems.

Impact: Military, peacekeeping, and humanitarian operations increasingly occur in urban regions, with the enemy exhibiting unpredictable or even irrational behavior. Methods are needed which can assist the commander in making appropriate judgments, in the face of severe time constraints and with incomplete situational awareness. Such analysis can equally well be applied to homeland security applications.

Research Topic Chief: Dr. Randy Zachery, ARO, 919-549-4368, randy.zachery@us.army.mil

FY08 MURI Topic #17

Submit white papers and proposals to the Army Research Office

Spin-Mediated Magnetic Behavior in Hybrid Metal-Semiconductor Systems

Background: In the past, the reliance on magnetic fields for the manipulation of magnetic elements has stymied the integration of magnetic and semiconductor-based electronics. However, the recent breakthroughs in the field of multiferroics and in the manipulation of electronic spins, nuclear spins, and magnetic inclusions within semiconductors using spin currents removes this impediment and presents an exciting new opportunity for incorporating spin-mediated magnetics into current electronic and communications systems. Among other things this will enable a radical shift in future approaches to logic processing and computer architecture. In particular, the forced separation of memory and logic elements will now be relaxed. The scientific advances have come on several fronts. It has been demonstrated that spin angular momentum transfer from spin currents can be used to switch memory elements, drive the precession of ferromagnetic inclusions at r.f. frequencies, and even polarize the underlying nuclear spin lattice (at lower temperatures). In addition, carrier population modulation (optical or electrical) and g-tensor manipulation of spin currents in semiconductors enables electrical tuning of these systems. Integration of multiferroic materials is another means of introducing electrically tunable magnetic fields. Finally, at lower temperatures, proximity effects with ferromagnetic contacts can again produce nuclear spin polarizations (up to 20% in semiconductor systems) and generate effective magnetic fields of several Tesla, which could potentially be exploited in hybrid electronic devices. All of these developments suggest that it should be possible to control spin transport, local magnetic order, and the electrical/optical/magnetic properties of metal-semiconductor hybrid systems with nanoscale precision. Applications for such capabilities would include the development of addressable high-density memory, high-speed magneto-optical modulators, circularly polarized light emission, nanoscale microwave and millimeter wave oscillators for signal processing and chip-to-chip communications, reconfigurable circuitry, and spin-based logic processors. The goal of this program is to develop the fundamental understanding of the physical phenomena, establish the fundamental materials engineering expertise and establish the basic device concepts needed to transition these concepts to reality.

Objective: Develop the fundamental understanding and establish the engineering expertise needed to exploit spin -mediated processes for providing nanoscale control over spin transport and local magnetic order in future spin-based devices, and for tailoring the electrical/optical/magnetic properties of metal-semiconductor hybrid systems.

Research Concentration Areas: Conduct basic research in the following areas to establish the science base and infrastructure needed to enable a new class of devices that utilize magnetic spin-mediated processes. The emphasis is on the investigation and modeling of the fundamental phenomena that promise to ultimately control device performance in these systems. Research should include, but is not necessarily limited to the following areas: 1) Investigate spin behavior and magnetic field manipulation in hybrid semiconductor – metal systems with a focus on identifying new phenomena that could lead to new device concepts. 2) Development of a fundamental understanding of the physics involved in spin current generation and control, spin momentum transfer, and multiferroic field generation. Although low-temperature phenomena can be investigated as a means of studying spin effects, there should also be a complementary effort to identify material systems in which the behavior of interest can be expressed at and above room temperature, e.g. nuclear spin polarization at room

temperature. 3) Address issues related to nanoscale fabrication and materials integration to enable the engineering of relevant test structures. 4) Development of a basic theoretical understanding of spin behavior and computer simulations of magnetization behavior that provides insight on the effects of configuration, relaxation processes, and spin dynamics needed to aid in the design and exploration of new concepts, and assist in the eventual fabrication of novel materials and spin-based devices. 5) Design and fabrication of test structures that utilize spin polarization currents and momentum transfer as a means of attaining new functionality and capabilities.

Impact: Micro-magnetics technology represents a critical part of present and future consumer/DoD markets including high-performance computing, high-density and nonvolatile memory, mobile communications and chem.-bio detection. The proposed research also should lead to novel electronic devices that include: circularly polarized light emitting diodes, lasers and detectors, nanoscale microwave and millimeter wave oscillators for signal processing and chip-to-chip communications, reconfigurable circuitry, smart sensors for IED detection, and spin-based logic processing (including quantum computing) for data manipulation and computing.

Research Topic Chief: Dr. John Prater, ARO, 919-549-4259, John.T.Prater@us.army.mil

FY08 MURI Topic #18

Submit white papers and proposals to the Army Research Office

Modeling, Analysis, and Control of Complex Multi-Scale Data Networks

Background: One of the major developments of the last two decades has been the ever-increasing interconnectivity of a whole spectrum of information networks, physical and data network types arising from telecommunication, financial, transportation and energy infrastructures. This interconnectivity has led to immense temporal and spatial complexity in modern networks and a critical need for basic mathematical theory having a strong practical grasp of the multi-scale nature of complex interacting networks. It has been well documented that traffic signals from a wide variety of data networks exhibit self-similarity, burstiness and long-range dependence. Such fractal behavior requires a serious reevaluation of Markovian, short-range dependent, and/or light tailed models that are typically used in classical network theory. There are numerous theoretical and practical challenges associated with complex multi-scale interactive networks in terms of measurement, statistical analysis, modeling, as well as control and optimization. Study of these issues is critical for secure, reliable and efficient operation of such networks.

Objectives: The overarching objective is to develop a rigorous mathematical theory and a deep operational understanding of complex networks with the goal to design more efficient and reliable computer and mobile communication networks for cyber security and information assurance and the Army's future network-centric operations. Some key objectives are 1) parsimonious yet useful modeling of realistic dynamics of network traffic; 2) measurement, visualization and statistical analysis of traffic properties with a view towards inference, protocol development and simulation for these networks; and 3) development of practical decentralized control policies for optimal or near optimal quality of service and resource utilization.

Research Concentration Areas: Strong interdisciplinary research in applied mathematics, statistics, computer science, along with control and communication is needed for investigation and research in the following three areas: 1) Develop mathematical models to quantify the complexity of data networks and their spatial-temporal continuum approximations including the use of fractional space/time diffusion equations, heavy traffic, heavy tail analysis and other non-central limit regime approximations for explaining the self-similar network traffic. 2) Develop robust congestion control mechanisms and theory of optimal stochastic control for processes arising from self-similar traffic, such as fractional Brownian motion and various Levy stable motions. Research tasks include practical decentralized control strategies for better quality of service and resource utilization under nonlinear and noisy environment and with incomplete data. In addition, develop the next generation traffic control protocols for resisting traffic variability, local breakdowns and hostile attacks. 3) Develop new fundamental concepts, methodologies, and metrics for rapid detection of changes in network dynamics for network security and intrusion, recognition of the heavy tailed nature of network components, and for performance evaluation in the absence of finite second statistical moments.

Impact: The research and analysis that results from this topic will lead to deeper understanding and optimal design of information networks for the future. This would significantly enhance cyber security, information assurance, and DoD's ability to build the future combat systems for network-centric operations. It is also anticipated that the techniques and rigorous mathematical structures developed in this research will enable better understanding of very large networks with noisy and incomplete data and will provide a solid foundation for abstracting common

concepts across fields in *Network Science.*

Research Topic Chief: Dr. Harry Chang, ARO, 919-549-4229, mouhsiung.chang@us.army.mil

FY08 MURI Topic #19

Submit white papers and proposals to the Army Research Office

Spray and Combustion of Gelled Hypergolic Propellants for Future Rocket and Missile Engines

Background: Gelled-liquid rocket and missile engines that utilize hypergolic propellants (a fuel and oxidizer which combust on contact in the absence of an external ignition source) represent a technology of enormous importance to Future Combat Systems and DoD for compact munitions that can provide enhancement to lethality, effectiveness, safety, and survivability. Liquid propellants can produce specific impulse that greatly exceeds that of the average solid propellant. Liquid propellants can also be throttled and, as the fuel and oxidizer are stored separately, are recognized paths to insensitive munitions. A gelling agent is added to these liquids to prevent spills and unintentional ignition from tank punctures due to fragment impact or mishandling. There exists however a lack of fundamental understanding in spray atomization of gels, the effect on vapor pressure, and droplet collision dynamics. Much is yet to be understood about mixing, chemical kinetics, ignition, and combustion in both liquid and gelled hypergolic propellants. Understanding these processes is essential for the science-based development of future gelled-hypergolic weapon systems.

Objective: The objective of this effort is to develop a fundamental understanding of the processes and mechanisms that control droplet formation, droplet collision and mixing, ignition, and energy release in gelled hypergolic propellants. A multidisciplinary research initiative is proposed which capitalizes on recent significant breakthroughs such as: ballistic imaging, aerosol shock tubes, and ultra-fast laser diagnostics to capture reaction characteristics, and focusing on: fluid and gas dynamics, chemistry, chemical kinetics and reaction mechanisms, computational fluid dynamics with reactive chemistry, heat transfer, high-performance computing modeling and simulation, and advanced experimental diagnostic methods. The goal is to gain understanding allowing for the science-based design of gelled hypergolic propulsion injector and combustor systems. The pursuit of this research may also yield unexpected paths leading to the discovery of new concepts for hypergolic propulsion.

Research Concentration Areas: Research will focus on gelled-hypergolic propellant spray formation, ignition, and combustion from subcritical through supercritical pressures. This includes, but is not limited to, investigations to characterize (1) fundamental material and constitutive properties and equations of state of selected gelled propellant ingredients and formulations as a function of type, particle size, and polymer properties; (2) gellant-liquid interaction so as to gain science-based gel formulation rules; and (3) the effects of intrinsic and constitutive properties, and ingredients to control such phenomena as surface tension, elasticity, vapor pressure, diffusion, viscoelastic and interfacial stresses, fluid dynamics and instabilities, mixing, ignition, flame spread and energy release rate. Modeling and simulation of the multiphase and multicomponent reactive system at multiple scales will be conducted. Experimental techniques will be developed and applied to determine parameters and coefficients required to calibrate required models at the appropriate length scales.

Impact: Fundamental understanding of gelled hypergolic propellants will lead to significant payoffs in the safety and performance of DoD weapons systems. Better spray patterns, enhanced mixing, shortened ignition times, controlled reaction rate, and enhanced insensitivity will lead to elimination of hard starts, increased efficiency and range, controllability, wider

operating conditions and increased warfighter safety. Better energy coupling to the target will also result. Science based gel formulation rules will allow for energetic gelling agents, which will lead to increased energy density propellants. Design tools developed from this new fundamental understanding will allow for more rapid and rigorous design of rocket and missile engines through the incorporation of reduced chemical kinetic models, and fluid and mixing models into CFD codes.

Research Topic Chief: Dr. Ralph Anthenien, ARO, 919-549-4317, ralph.anthenien1@us.army.mil