

# Request for Proposals for Nanoelectronics Research Initiative Grants (NERC RFP S200709)

## A. Background

The Nano Electronics Research Corporation (NERC) is soliciting proposals from US Institutions qualified to do research in areas of interest to the Nanoelectronics Research Initiative (NRI). NERC, a not-for-profit research management organization, makes this solicitation on behalf of NRI's collaboration with the National Institute for Standards and Technology (NIST). NERC is a wholly owned but separately managed subsidiary of the Semiconductor Research Corporation (SRC). SRC is a research management consortium that was established in 1982 and sponsors semiconductor research for its members.

As the ultimate limits to the scaling of CMOS (Complementary Metal Oxide Semiconductor) technology are getting closer, new approaches in emerging areas in electronics at the nanoscale need to be explored. The NRI wants to focus research attention and resources on topics that will extend the "emerging technologies" of the International Technology Roadmap for Semiconductors (ITRS), and to encourage the exploration of novel technology opportunities in order to help sustain the historical growth of the electronics industry. The NRI collaboration with NIST is expected to stimulate research that will address long-range semiconductor research needs.

The NRI mission is to discover and demonstrate novel computing devices capable of replacing the CMOS FET as a logic switch in the 2020 timeframe.

- These devices should show significant advantage over ultimate FETs in power, performance, density, and/or cost to enable the semiconductor industry to extend the historical cost and performance trends for information technology.
- To meet these goals, NRI is focused primarily on research directed toward devices utilizing new computational state variables beyond electronic charge. In addition, NRI is interested in new interconnect technologies and novel circuits and architectures, including non-equilibrium systems, for exploiting these devices, as well as improved nanoscale thermal management and novel materials and fabrication methods for these structures and circuits.
- Finally, it is desirable that these technologies be capable of integrating with CMOS, to allow exploitation of their potentially complementary functionality in heterogeneous systems and to enable a smooth transition to a new scaling path.

### A 1 - Research Areas of Interest

The NRI is seeking to encourage research on topics with the potential for maintaining the historical scaling of both computational power and the cost of information processing. To define a well-directed program for new device research, the SRC and the NSF jointly organized a set of industry-academia-government workshops in 2003 and 2005. The workshops defined 13 research vectors that were felt to be essential to make progress in the search for the next switch beyond CMOS. The first five of these vectors currently form the heart of the NRI research program:

- Computational state variables other than electronic charge
- Non-equilibrium systems
- Novel data transfer mechanisms
- Nanoscale phonon / thermal management
- Directed self assembly of new device structures

The next two research vectors in the list are:

- Modeling/Simulation
- Metrology/Characterization

Because these are so intricately linked with all five vectors, they have been interwoven directly into the research programs at all of the NRI centers. However, an increase in the focus on these vectors is strongly desired, and proposals are encouraged to include how they are explicitly linking theory to experiment through metrology to assess potential devices:

Experimentalists: “What modeling is needed to understand and extrapolate the device potential of current materials/structure/phenomena results?”

Theorists: “What experiments are needed to constitute a proof of concept of your theory or analysis? For example, what experimental work is needed to verify key parameters/assumptions in your model?”

Metrologists: “How can we measure the critical parameters to bridge between the experimental and simulation results?”

Ideally, all proposals will address components of each, or will augment existing NRI projects with additional experimental, theoretical, or metrology work. In the nano-metrology area, proposers are encouraged to consider how collaboration with NIST could be beneficial for enabling characterization of materials and devices, particularly if it requires the discovery and development of potentially revolutionary measurement techniques and tools.

The current NRI research portfolio has focused strongly on the first research vector – a non-charge based device – and in particular, on devices based on spin as the computational state vector. It is desired to broaden this work with this RFP, and hence there is particular interest in additional device types with different state variables, and increasing focus on the next two research vectors: non-equilibrium systems and novel data transfer mechanisms. Combining these three to find a computational architecture that can scale further than CMOS is the goal, and work on new architectures, such as associative memory systems, non-volatile logic, and reconfigurable or FPGA-like logic, is desirable. Note these architectures should be designed to efficiently utilize novel devices and local interconnect mechanisms, rather than simply being novel architectures to extend CMOS-based technology.

The last two vectors – thermal management and directed self-assembly – continue to be of interest as well, as long as they are closely linked with specific device and architecture goals. Clearly these areas also show promise for collateral, intermediate results that will hopefully impact current technology, but the main focus of any project in NRI must be on their capability to enable a specific new device or architecture as part of the first three vectors.

Other means for maintaining the historical scaling of computational power and cost are also of interest, and while all stages of the research life cycle are of interest, new high-risk / high-potential-payoff ideas are of exceptional interest, as are functional proof of concept demonstrations of computational technologies with significantly improved computation per unit

power per unit area, as power density is seen to be the primary limiter of ultimate CMOS technology scaling. Proposers are encouraged to reference the NRI website (<http://nri.src.org>) for additional information on the current NRI research centers and projects.

## **A 2 - Proposal Process**

Based on this solicitation, 3 to 5 proposals may be funded. The proposals will be reviewed by the NRI Technical Program Group, which comprises senior researchers from the six participating companies (AMD, Freescale, IBM, Intel, Micron and TI) and NIST. In addition to financial support appropriate to pursuing mutual interests of the investigators and the NRI, there will be an opportunity to collaborate with industrial researchers from NRI participating companies and from NIST. The research results should be widely disseminated, and publication in technical journals and presentations at conferences will be encouraged, as will participation by funded researchers in the NRI reviews and potentially at industry/government sponsored workshops and meetings. There is an annual review of the overall NRI program, as well as annual on-site reviews of each center and semi-annual reports submitted to NERC from each center. All publications, reports and review materials are posted on the NRI website.

Although the general scope of research topics is outlined above, proposals for alternate means of ensuring the long term scaling of computational power and cost are of interest to NERC. Investigators should ensure that their proposals address the following essential attributes:

- The proposal's research plan should contain a compelling and well-articulated vision that complements or supports the NRI's research agenda described in Sec. A1, or makes a compelling argument for an alternate technical candidate. The proposer is expected to identify how the proposed research relates, if at all, to other on-going research in nanoelectronics.
- The proposal should be reasonable, and the research plan should be realistically executable with available resources and in accordance with sound cost management.
- The proposal should also describe the host institute's policy and history of successful industrial collaboration regarding the exchange of staff, recruiting of students, intellectual property agreements and previous successful collaborations with industrial partners.
- A statement addressing the availability of facilities and resources needed to help make the proposed project successful.
- A statement addressing the plans for any matching funds from university, state or federal sources to leverage the funds from NRI is strongly encouraged.

All NRI research will continue to be funded through interdisciplinary, multi-university centers, and hence all proposers are strongly encouraged to submit their proposals through the existing NRI centers: The Western Institute of Nanoelectronics (WIN) headquartered at UCLA in California; The Institute for Nanoelectronics Discovery and Exploration (INDEX) headquartered at SUNY-Albany in New York; and The South West Academy for Nanoelectronics (SWAN) headquartered at UT – Austin in Texas. As part of this RFP process, these centers are expected to grow their programs, both by expanding their current projects and adding in new projects, PIs, and universities as appropriate. Proposers may contact the centers directly, or contact the NRI Director, Jeff Welser ([jeff.welser@src.org](mailto:jeff.welser@src.org)) to facilitate this. If a proposer is unable to submit through an NRI center, individual project proposals may also be submitted directly to NERC for review in response to this RFP, and will be judged on their individual merit.

Evaluation and technical review of the proposals will be done by the NRI Technical Program Group, and the final decision on the awards will be made by the NRI Governing Council.

### **A 3 - Program Scope and Planned Funding Level**

Project proposals are expected to be for three year time periods, with funding allocated on a yearly basis. All funding after the first year will be contingent on successful performance, as evaluated by the NRI-NIST collaboration and availability of funds. Several multi-university awards could be made in the areas identified, with the average award expected to be from \$500,000 - \$1,500,000 per year per center. In addition, individual project proposals are also welcomed, with average funding expected to be from \$100,000 - \$200,000 per year per project. Individual projects that are chosen to be funded will likely be connected to one of the multi-university centers in the long term. Following proposal selection, research agreements will be negotiated with awardees as appropriate, with the research expected to start in the first quarter of 2008. Any potential for additional funds from university, state or federal sources to match the NRI funds should be included in the proposal and will be considered in the review process. Not all areas of interest may necessarily be funded, and the titles of the broad areas of interest are not synonymous with the names of the current or planned research agendas, nor are there any implications that an area of interest cannot accommodate more than one research effort.

## **B. Proposals guidelines and schedules**

### **B.1 Purpose, Format, Content and Length of Solicited Proposals**

#### ***- Solicitation Purpose and Process***

In order to permit selection of the proposals most likely to advance the NRI research goals; proposals are being solicited from investigators to address the NRI agenda in Sec. A1.

The proposals are due electronically by 5:00 p.m. Eastern Standard Time at the Nano Electronics Research Corporation (NERC) on November 30, 2007. The process and address for submitting these proposals is described below.

#### ***- Proposal Format, Content and Length***

For multi-university center proposals, the format is:

1. A cover sheet to include:
  - a) NERC RFP number (S200709);
  - b) Proposal title and center name;
  - c) Investigator(s) name, address and contact information.
  - d) Proposed institution(s) name, address and reference number (if any);
  - e) Names and contact information of any industrial or governmental collaborators
  - f) Proposed institute(s) administrative point of contact to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax and electronic mail;
2. Table of Contents keyed to the page numbers of the proposal sections.
3. An Executive Summary, a one to two page description of the proposal and key features.
4. A Center Research Overview, a description of the center research objectives, themes, project portfolio, and structure, not to exceed 6 pages. This section should show the total center portfolio, including existing NRI projects, detailing which projects will be expanded and what new projects/Pis/universities are being added.

5. Statement of Work, to include a one page table of projects/PIs organized by theme, followed by one-page description of each project including a description of the research, goals, fit to NRI objectives, and a timeline of key milestones.
6. High-level Budget broken down by theme and university for the funding period requested.
7. The availability of the resources necessary should be described in 500 words or less, including opportunities for receiving matching funds from university, state, or federal sources to leverage NRI funding.
8. The institute's industrial collaboration style / plans should be described in 300 words or less.
9. Relevant publication record and references.

For individual proposals, the format is:

1. A cover sheet to include:
  - a) NERC RFP number (S200709);
  - b) NRI Technical area(s); (see Sec A1)
  - c) Proposal title;
  - d) Investigator(s) name, address and contact information.
  - e) Proposed institution(s) name, address and reference number (if any);
  - f) Names and contact information of any industrial or governmental collaborators
  - g) Proposed institute(s) administrative point of contact to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax and electronic mail;
2. Table of Contents keyed to the page numbers of the proposal sections.
3. An Executive Summary, a one page description of the proposal and its key features.
4. A Description of Research should not exceed 4 pages, including figures. It should include the research objectives, fit to NRI objectives, statement of work, description of the specific project(s), and a timeline of key milestones.
5. High-level Budget of proposed projects for the funding period requested.
6. The availability of the resources necessary should be described in 500 words or less, including opportunities for receiving matching funds from university, state, or federal sources to leverage NRI funding.
7. The institute's industrial collaboration style / plans should be described in 300 words or less.
8. Relevant publication record and references.

## **B.2 Proposal Submission Process and Related Information**

### **- *Submission Process***

Electronic submission of all proposals is required. Please submit PDF (preferred) files using Arial, Courier, Times Roman, or Helvetica fonts of 11-point size or larger. Send the PDF files as email attachments to the NRI Director, Jeff Welser ([jeff.welser@src.org](mailto:jeff.welser@src.org)), and cc Allison Hilbert ([allison.hilbert@src.org](mailto:allison.hilbert@src.org)). Please address all questions to Jeff Welser by email.

### **- *Disclosure of Proprietary Information***

All proprietary portions of proposals must be clearly marked. Restrictive notices notwithstanding, proposals may be handled and read for purposes of evaluation by NERC, NRI Participants, NIST officials and selected external reviewers.

### **- *Intellectual Property***

NERC expects proposals to comply with the policies and procedures of NRI concerning Intellectual Property (IP). Certain IP rights will also have to be provided to NIST. NERC may be

available as a resource, to assist awardees strategically and financially, as appropriate, to develop IP rights developed under their awards.

### **B.3 Evaluation Criteria and Selection and Award Process**

#### **- Evaluation Criteria**

The selection criteria used in the technical review of the proposals, in order of relative importance and priority, are:

1. Overall scientific and technical merit, including the likely impact of the proposed work on the NRI research agenda.
2. Ingenuity, novelty, and feasibility of the proposal.
3. Investigator(s) capabilities and related relevant experience.
4. Access to the needed personnel, resources, facilities, equipment, and data to perform the work;
5. The potential for leveraging NRI funds with university, state, and federal funds
6. Quality of the industrial and/or NIST collaboration plan.
7. Intellectual property issues and policies which may preclude timely execution of the contract.

#### **-Selection and Award Process**

Proposals will be evaluated by a Proposal Evaluation and Selection Committee, comprised of a group of senior researchers from NRI participating companies and NIST. The proposer will be notified of selection or non-selection in a timely manner.

All non-selected proposals will be destroyed, except one copy which may be retained for file purposes, unless the applicant has requested that the proposal be made available for consideration of alternate funding by other NRI participating company funding instruments.

Not all proposals submitted in response to the invitation by NERC and selected in the *proposal review* will be funded. Decisions to fund proposals will be based on funds available, scientific and technical merit, and potential contribution and relevance to the NRI goals. All *proposals* selected for award will be funded through NERC and will be subject to oversight by NERC.

Any awards are tentative pending formal agreement of the fellow's host institute to accept and administer the funds in accordance with a research agreement with NERC. The investigator(s) will be expected to facilitate administrative matters if needed.

### **B.4 Solicitation Schedule**

<b>Proposal Timetable</b>	
<b>Event</b>	<b>Deadline</b>
Publication of Request for Proposal	October 1, 2007
Deadline to Submit Proposals to NERC	November 30, 2007
Awards Announced	February 1, 2008
Award Start Date	March, 2008