STRATEGIC & SPECTRUM MISSIONS ADVANCED RESILIENT TRUSTED SYSTEMS (S²MARTS)

REQUEST FOR SOLUTIONS (RFS)

in support of the

RADIATION HARDENED BY DESIGN (RHBD) COMPLEMENTARY METAL-OXIDE SEMICONDUCTOR (CMOS) TECHNOLOGY NODES

PROJECT NO. S2MARTS19-03

1) Requiring Activity/Project Sponsor Seeking Solution

Naval Surface Warfare Center (NSWC) Crane Division in support of the Office of Secretary of Defense (OSD) for Microelectronics Innovation for National Security & Economic Competitiveness (MINSEC).

2) Background (Current State of Technology)

All microcircuits suffer risk of damage caused by radiation effects in space and man-made environments. The need for radiation hardening of microelectronics has become crucial with implementing DoD strategic goals.

A number of research institutions and corporations have demonstrated the basic feasibility of Radiation Hardened By Design (RHBD) using standard commercial foundries; however, to satisfy the military’s need for a wide range of part types and hardness levels, a self-sustaining RHBD infrastructure must be established, and the RHBD approach must be proven robust enough to use without some degree of fabrication process control. To date, radiation effects in certain newer technologies have not been characterized.

Electronic components used in strategic and space missions have unique requirements such as the ability to operate and survive in harsh radiation environments. Current Strategic Radiation Hardened (Rad-Hard) microelectronics available to the Government lag in performance to non Rad-Hard commercial-off-the-shelf (COTS) components. This void in the Defense Industrial Base results in a vast performance gap between the capability of strategic hardware and commercial hardware. The DoD is seeking prototype Rad-Hard microelectronic demonstrations that have the potential to bridge this capability gap.
3) Description of Need (Critical Capability Gaps)

Rad-Hard components meeting the objectives in this Request For Solutions (RFS) are not currently available at or below the 45-nm technology node. The Navy desires a prototype to develop innovative solutions for strategic Rad-Hard by design (RHBD) microcircuits in one of the following: the 45RF technology node currently available from Global Foundries (or equivalent), the 22FDX technology node currently available from Global Foundries (or equivalent), or any state-of-the-art Fin Field Effect Transistor (FinFET) technology based in the United States. This effort will be focused on the design, demonstration and verification of RHBD techniques in advanced Complementary Metal-Oxide-Semiconductor (CMOS) technology nodes.

The Navy desires innovative solutions for prototype Test Characterization Vehicles (TCVs) to characterize radiation effects in advanced technologies at or below the 45-nm technology node. Radiation characterization of TCVs is the first step in enabling the DoD to develop RHBD capabilities in advanced technologies. The DoD’s major technical objective of this project is to determine the feasibility of designing strategic Rad-Hard microcircuits through the use of a prototype TCV.

4) Prototype Technology Objectives (End State Success Criteria)

NSWC Crane is seeking prototype strategic RHBD efforts that can be used for the design of Rad-Hard circuits. For this effort, the performer will design and develop a TCV in a key state-of-the-art process node such as 45RF, 22FDX, and/or any US-based FinFET technology. The performer will also design, develop and fabricate the TCV to support reliability and radiation effects characterization. The prototype(s) will consist of a TCV that will lead to:

- The development of RHBD techniques to enable trusted, commercial processes to meet Rad-Hard levels in advanced CMOS technology nodes
- Implementation of strategic RHBD techniques that include prompt radiation dose, single-event effects (including neutron), total ionizing dose, and neutron displacement damage into commercial computer aided design, modeling and simulation tools
- The design, demonstration and verification of RHBD techniques at or below the 45-nm technology nodes

The performer will conduct electrical testing of the TCV that will include both radiation and reliability testing. The reliability testing includes, but is not limited to, key degradation mechanisms associated with advanced technology nodes:

- Hot Carrier Injection (HCI)
- Electro-migration (EM)
- Time Dependent Dielectric Breakdown (TDBD) and wear-out
- Copper contamination
The performer will conduct radiation effects vulnerability testing on the TCV to include; but not limited to:

- Total Ionizing Dose
- Single Event Effects
- Prompt Dose
- Neutron Displacement Damage

The success criteria of this effort includes the demonstration of the electrical performance and radiation tolerance of the TCV in an advanced technology and meet the radiation objectives in the Table below.

### Table 1. Radiation Objectives for this Prototype Effort

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Ionizing Dose</strong> (Mrad(Si))</td>
<td>&gt;1</td>
</tr>
<tr>
<td><strong>Single-Event-Upset</strong> (errors/bit-day)</td>
<td>&lt;1E-10  \ LET &gt; 30</td>
</tr>
<tr>
<td><strong>Single-Event-Latchup</strong> (LET in MeV-cm²/mg)</td>
<td>&gt;100</td>
</tr>
<tr>
<td><strong>Neutron Irradiation</strong> (1 MeV eq. n/cm²)</td>
<td>&gt;1E13</td>
</tr>
<tr>
<td><strong>Dose-Rate-Upset</strong> (rad(SiO₂)/sec)</td>
<td>&gt;5E10</td>
</tr>
<tr>
<td><strong>Dose-Rate Survivability</strong> (rad(SiO₂)/sec)</td>
<td>1E12</td>
</tr>
</tbody>
</table>

Prototype examples that would meet the success criteria defined by the DoD would include:

- Demonstration that key circuits in an advanced technology node can survive and operate at or exceeding the radiation levels in Table 1.

### 5) Funding Profile

This project is currently budgeted at $2,000,000.00.
6) Deliverables

Table 2. Project Deliverables

<table>
<thead>
<tr>
<th>Description (Reports / Items)</th>
<th>Frequency</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCV Design (Drawings)</td>
<td>Once</td>
<td>End of Project*</td>
</tr>
<tr>
<td>Prototype TCV for Process Characterization (Circuit or Chip)</td>
<td>Once</td>
<td>End of Project*</td>
</tr>
<tr>
<td>Electrical Test Reports</td>
<td>Once</td>
<td>End of Project*</td>
</tr>
<tr>
<td>Radiation Test Reports</td>
<td>Once</td>
<td>End of Project*</td>
</tr>
<tr>
<td>Final Project Report</td>
<td>Once</td>
<td>End of Project*</td>
</tr>
</tbody>
</table>

*Will be finalized at OTA award.

7) Level of Data Rights Desired by the Government

Government Purpose Rights: The right to use, modify, reproduce, perform, display, or disclose technical data within the Government without restriction and release or disclose technical data outside the Government and authorize persons to whom release or disclosure has been made to use, modify, reproduce, release, perform, display, or disclose that data for United States government purposes.

8) General Information

Respondents are solely responsible for all expenses associated with responding to this RFS. Evaluation and selection of the solution(s) will be completed based on the criteria in Sections 9) and 10). Funding for this project is currently available. NSWC Crane intends to competitively issue this effort as an Other Transaction Agreement (OTA) in accordance with 10 U.S.C. 2371b. If an OTA is awarded from this request, the Agreement is not considered a procurement contract and therefore is not subject to the Federal Acquisition Regulation. The following general formatting requirements apply:

- Times New Roman 10 (or larger) single-spaced, single-sided, 21.6 x 27.9 cm (8.5 by 11 inches).
- Smaller type may be used in figures and tables, but must be clearly legible.
- Margins on all sides (top, bottom, left, and right) should be at least 2.5 cm (1 inch).
- Please note that page limitations shall not be circumvented by including inserted text boxes/pop-ups or internet links to additional information. Such inclusions are not acceptable and will not be considered as part of the response.
- Files must be submitted in PDF and/or Microsoft Word formats only.

9) Contents and Format of Response

a) Section 1: Technical Solution and Approach (Page Limit: 15 Pages)
i) **Cover Page:** The cover page does not count in the 15-page limit. The cover page shall include the company’s name, Commercial and Government Entity (CAGE) Code (if available), level of facility clearance (if available), address, primary point of contact, and status of U.S. ownership.

On the cover page, please identify which applicable 10 U.S. C. § 2371b criteria is being met (please identify only one of the following choices):

- There is at least one nontraditional defense contractor or nonprofit research institution participating to a significant extent in the project.

- All significant participants in the transaction other than the Federal Government are small businesses (including small businesses participating in a program described under section 9 of the Small Business Act (15 U.S.C. § 638)) or nontraditional defense contractors.

- At least one third of the total cost of the project is to be provided by sources other than the Federal Government.

*Nontraditional Defense Contractor is defined as an entity that is not currently performing and has not performed, for at least the one-year period preceding the solicitation of sources by the Department of Defense (DoD) for the procurement or transaction, any contract or subcontract for the DoD that is subject to full coverage under the cost accounting standards prescribed pursuant to 41 U.S. Code § 1502 and the regulations implementing such section.*

ii) **Technical Response:**

(1) **Solution Narrative:** Respondents shall describe the approach used to deliver a unique prototype solution for the prototype technology objectives defined in Section 4 of this RFS. While these focus areas are of significant importance, responses will be considered as a whole. No pricing information shall be included in the technical response.

(2) **Government Furnished Property or Information:** Within the technical response, respondents must clearly identify if its proposed solution depends on Government Furnished Information (GFI) / Government Furnished Property (GFP).

If so, the response must specify the GFI / GFP required. If the solution is dependent on GFI / GFP, the Government will determine whether the GFI/GFE can be provided, the impact to the solution if the requested information/property is not available, and will confirm the details with the respondent prior to any proposal revisions or selection, if applicable.
(3) **A Statement of Work (Not Included in Page Count)** outlining the tasks required along with schedule milestones and delivery dates is requested for successful completion. It is anticipated that, if selected, the proposed Statement of Work will be incorporated into the resultant OTA. Respondents are encouraged to be concise but thorough when outlining their work statements.

(4) **Summary of Subcontractor Participation (if applicable):**

   (a) Provide a list of all subcontractors involved and their role within the performance of the proposed concept. If their involvement is considered significant, ensure the rationale is present within the narrative. The onus of proof to support participation to a significant extent or any cost sharing arrangement lies with the respondent.

   (b) Provide the subcontracting company’s name, Commercial and Government Entity (CAGE) Code (if available), level of facility clearance (if available), address, primary point of contact, and status of U.S. ownership.

(5) **Data Rights Assertions and Level of Rights Proposed:**

   (a) The rights offered should be displayed in a manner that allows for ease of discussion in determining trade-offs and potential options for long-term sustainability of the deliverables of this effort.

   (b) If data rights other than those identified in Section 7), Level of Data Rights Desired by the Government, are being asserted within the response, detail supporting the specific rationale for this assertion must be included.

   (c) Any items previously developed with federal funding should clearly identify all individual components funded by the Government and the recipient of the deliverables.

   (d) If commercial software is proposed as part of the prototype solution, all applicable software licenses must be identified and included with the response. Note that any software license term or condition inconsistent with federal law will be negotiated out of the license.

   (e) It is recommended that the proposal consider the rights desired by the Government as identified within Request for Solution, Section 7), Level of Data Rights Desired by the Government.

(6) **Foreign Owned, Controlled, or Influenced (FOCI) Mitigation Documentation (if applicable; not included in page count):** This section shall address both prime
contractors and subcontractors considered to be under FOCI. Documentation may include, but is not limited to: Standard Form 328 (Certificate Pertaining to Foreign Interest); Listing of Key Management Personnel; an Organizational Chart; Security Control Agreements: Special Security Agreements; and Proxy Agreements or Voting Trust Agreements. It is recommended that companies who fall within the FOCI category visit https://www.dss.mil for additional guidance and instruction.

FOCI mitigation documentation will not count towards the technical response page limitation.

b) Section 2: Price (Page Limit: 5 Pages)

i) Pricing Breakdown:

(a) Respondents shall propose a Firm-Fixed-Price for the proposed solution. The overall total price should be divided among severable increments that align to a proposed milestone payment schedule.

(b) In order to support the Government’s evaluation of fair and reasonable pricing, the respondent shall delineate the key pricing components, and show clear traceability to the technical narrative and focus areas and phases described by the Government. At a minimum, key pricing components include Labor Total(s), Material Total(s), and Subcontractor price(s). Each should be outlined for each focus area and/or phase.

(c) If restricted rights are being asserted beyond Government Purpose Rights within the response, a table that prices Government Purpose Rights for any such limited or restricted item must be included.

10) Selection Criteria & Methodology:

(a) Individual responses will be evaluated with consideration given to:

i) Demonstrated expertise and overall technical merit of the response;
ii) Feasibility of implementation; and
iii) Total project risk as it relates to the technical focus areas, price, schedule and level of data rights

The Government will evaluate the degree to which the submission provides a thorough, flexible, and sound approach in response to the prototype technical objectives as stated in Section 4) of this RFS as well as the ability to fulfill the objectives in this RFS.

The Government will award this project, via S²MARTS (Agreement No. N00164-19-9-0001), to the respondent(s) whose solution is assessed to be the most advantageous to the
Government. The Government reserves the right to award to a respondent that does not meet all the objectives of the RFS.

The assessment of risks is subjective and will consider all aspects of the proposed solution. Respondents are responsible for identifying risks within their submissions, as well as providing specific mitigating solutions.

The Government reserves the right to reject a submission and deem it ineligible for consideration if the response is incomplete and/or does not clearly provide the requested information.

11) Follow-On Production

a) Upon successful completion of this prototype effort, the Government anticipates that a follow-on production effort may be awarded via either contract or transaction, without the use of competitive procedures if the participants in this transaction successfully complete the prototype project as awarded from this document. The prototype effort will be considered successfully complete upon delivery of a prototype that meets the identified technical objectives.

b) Successful completion for a specific capability may occur prior to the conclusion of the project to allow the Government to transition that aspect of the prototype project into production while other aspects of the prototype project have yet to be completed.

c) Objectives of other potential follow-on activities could involve, though not limited to, continued development and baseline management, sustainment, further scaling of the solution, integration of future capabilities, or integration of the solution with other capabilities. For planning purposes, follow-on production of the subject capability may include the following outcome(s): the potential objective for additional technology refinement or integration into existing programs of records or the future Strategic or Trusted Microelectronics programs.

12) Response Due Date

a) Proposals: Responses are due no later than 2:00PM Eastern Time on 28 May 2019 and shall be submitted via email to initiatives@nstxl.org. Emails containing the proposal must include S2MARTS19-03 in the subject line.

b) RFS Questions: In order to receive a timely response, all questions must be submitted to the email listed above no later than 12:00PM Eastern Time on 13 May 2019. Email subject lines must include S2MARTS19-03.

13) Additional Information & Disclaimers
a) The Government intends to award one Other Transaction Agreement as a result of this RFS; however, more than one award may be made if determined to be in the Government’s best interest. The Government reserves the right to not select any of the solutions proposed.

b) Acceptable responses not selected for the immediate award will be retained by the Government for possible future execution and funding. The non-selected proposals will be considered as viable alternatives for up to 24 months. If a proposal (that was not previously selected) is determined to be a suitable alternative, the company will be contacted to discuss any proposal updates and details of a subsequent project award.

Respondents whose proposals are not selected for the initial award shall not contact the Government or Consortium Manager to inquire about the status of any ongoing effort as it relates to the likelihood of their company being selected as a future alternative.

c) The United States Navy has release authority on any publications related to this prototype project.

d) If resource-sharing is used, in accordance with 10 U.S. Code § 2371b(d)(1)(C), then the non-Federal amounts counted as provided, or to be provided, by parties other than the Federal Government may not include costs that were incurred before the date on which the OT agreement becomes effective. Costs offered as a resource-share that were incurred for a project after the beginning of negotiations, but prior to the date the OT agreement becomes effective, may be counted as non-Federal amounts if and to the extent that the Agreements Officer determines in writing that: (1) the party other than the Federal Government incurred the costs in anticipation of the OT agreement; and (2) it was appropriate for the entity to incur the costs before the OT agreement became effective in order to ensure the successful implementation of the OT agreement.

e) Certain types of information submitted to the Department in a process having the potential for award of an OT are exempt from disclosure requirements of 5 U.S.C. §552, the Freedom of Information Act or FOIA, for a period of five years from the date the Department receives the information. It is recommended that respondents mark business plans and technical information that are to be protected for five years from FOIA disclosure with a legend identifying the documents as being submitted on a business confidential basis.

f) No classified data shall be submitted within the proposal. To the extent that the project involves DoD controlled unclassified information, respondents must comply with DoDI 8582.01 and DoDM 5200.01 Volume 4. Respondents must implement the security requirements in NIST SP 800-171 for safeguarding the unclassified internal information system; and must report any cyber incidents that affect the controlled unclassified information directly to DoD at https://dibnet.dod.mil.

g) Export controls (if applicable): Research findings and technology developments arising from the resulting proposed solution may constitute a significant enhancement to the
national defense and to the economic vitality of the United States. As such, in the conduct of all work related to this effort, the selected respondent must comply strictly with the International Traffic in Arms Regulation (22 C.F.R. §§ 120-130), the National Industrial Security Program Operating Manual (DoD 5220.22-M) and the Department of Commerce Export Regulation (15 C.F.R. §§ 730-774).