STRATEGIC & SPECTRUM MISSIONS ADVANCED RESILIENT TRUSTED SYSTEMS
(S^2MARTS)
REQUEST FOR SOLUTIONS (RFS)

in support of the

Advanced Scanning Optical Microscope (ASOM) Capability Expansion Prototype

PROTOTYPE PROJECT

Project No. 21-11

All prospective respondents must be members of the NSTXL consortium.

1. **Project Title:** Advanced Scanning Optical Microscope (ASOM) Capability Expansion Prototype

2. **Prototype Project Sponsor/Requiring Activity:** Naval Surface Warfare Center, Crane Division

3. **Contracting Activity:** Naval Surface Warfare Center, Crane Division

4. **Project Background & Current Capability:**
   As security becomes an increasing concern for microelectronics, especially from a national security perspective, many security vulnerabilities have been discovered/exploited in the cybersecurity domain. Many of these attacks have been successful because of firmware/software weaknesses, which allow attackers to have open doors into our security posture from the outside. However, as more and more of these attacks are becoming harder to do, hardware exploits are on the rise. Hardware exploits are much harder to develop because the attacker needs physical access to the Integrated Circuit (IC), but successful exploits at the hardware level are devastating due to the wealth of information stored in an IC. This is of great concern to the Department of Defense (DoD) community due to the amount of time and effort the DoD puts into developing state of the art algorithms to keep warfighter advantage.

   A new class of hardware attacks is on the rise and this prototype will incorporate a modular framework where new optics can be changed in and out to increase the speed and efficiency of research and development. This prototype will require a new way to build optical systems for testing ICs for hardware exploits. As the technology node of current ICs keep shrinking, new optical methods need to be created to increase spatial resolution of optical systems. The technology nodes of the current state of the art ICs are approaching 5nm of gate length, which leaves current optical systems struggling to keep up. This new prototype optical system will use a custom Aplanatic Solid Immersion Lens (ASIL) to close the gap. The custom ASIL will be able to incorporate two different wavelengths and be able to focus them in a single plane to increase the capability.

Current optical systems on the market are not built with a modular framework in mind, which greatly diminishes the ability to quickly change optical components for research and development. The incorporation of a modular framework will increase the efficiency of the prototype so research and development can be performed at the speed of changing technology nodes. The ability to work with the performer designing/building the prototype system will help burn down risk so our specifications can ultimately be met. This prototype will incorporate non-linear optical effects, that greatly increase the design complications. No current optical system on the market tries to control non-linear optical effects due to the increased complexity of delivering an operational tool. This is one major difference between current systems and the prototype we are trying to build.

Historically, ICs were initially packaged with the topside of the die exposed and all interconnects were done with bonds out to a lead frame. Also, early ICs were fabricated with minimal metal layers which made probing with an electron beam very viable for doing Failure Analysis (FA). As the packaging of ICs progressed through the years, flip chip style bonding made probing from the front side with an electron beam infeasible. When probing with the electron beam became obsolete, techniques to probe ICs from the backside were developed using Scanning Optical Microscopes (SOMs) with wavelengths that are transparent to silicon. This allowed probing from the backside of the die.

Currently, SOMs have become the workhorse for assessing security and performing FA on today's modern ICs. Most of the SOMs built today are used for FA and typically incorporate only one beam that can be scanned at a time in the Field Of View (FOV).

5. Desired End-State Objective(s) & Success Criteria:

The desired end state would incorporate a total of three beam lines into the prototype. Two of the beam lines would be of different wavelengths (1319nm and 1064nm) capable of being independently steered within a FOV, each with probing capability and the ability to independently focus each beam in a single focal plane within the backside of the IC. The ability to focus both beams at the same focal plane by an operator in real time is critical for the success of the system. The third beam (1319nm) would be used independently of the two probe beams, and it would need the capability of being pulsed. The laser power and the pulse duration will need to be operator controlled. The pulse width will need to be able to be adjusted from a minimum of 1usm to a maximum of 5ms. The laser power will need to be able to be adjusted from 0mW to 300mW with air gap objectives. The third beam line will need to be a different laser due to the increased power and the pulsing requirement.

For this prototype to be considered successful, the vendor needs to demonstrate the ability to focus two different wavelengths (1319nm and 1064nm) at the same focal plane, while maintaining independent beam control for each beam line. Each beam line needs to be independently steered/pointed within the FOV of the objective being used. The other success criteria of this prototype requires that the tool must be able to provide a third beam (1319nm) that has the ability to be pulsed with the operator. The operator should be able to control the peak laser power delivered to the Device Under Test (DUT), while also being able to control

the pulse width. Both of these parameters need independent control from the operator. If these two main criteria are met the prototype will have the functionality to perform much needed research in the area of hardware cybersecurity. While designing the prototype, ease of operation will be taken into consideration, but meeting the two success criteria are required for the prototype to be successful.

This prototype should have the ability to acquire an image of the active region of the IC for navigation purposes. The system should also have the ability to planerize the surface of the IC for ASIL landing purposes. This will allow the best coupling of light with the ASIL and the silicon surface of the IC. The system should also have the ability for stage navigation in the X, Y, Z and tip tilt axes. The laser sources will also need the ability to independently increase/decrease laser power, which is being provided to the IC under test. The main requirements are listed below:

- Two beams of different wavelengths (1064nm and 1319nm) being able to be independently focus and steer within the FOV with probing capability.
- The 1319 probe beam will be the main probe beam and will need to be a very low noise laser in regard to amplitude variation to maximize the Signal to Noise Ratio (SNR).
- The 1064nm beam line will also be a probe beam, but since the wavelength is different, custom optics will need to be incorporated into the system, which will allow the operator to adjust the focal plane independently of the 1319 beam line focal plane. The 1064 beam will need to supply a minimum of 100mW to the Device Under Test though air gap objectives and at a minimum of 30mW through a Solid Immersion Lens (SIL).
- A third beam line (1319nm) will also need to be incorporated into the system with the ability to be pulsed. The pulse width and laser power will need to be controlled by the operator. The pulse width will need to be able to be adjusted from a minimum of 1usm to a maximum of 5ms. The laser power will need to be able to be adjusted from 0mW to 300mW with air gap objectives.
- The system stage should have movement in X, Y, Z and include tip/tilt for sample planarization with using the SIL. The microscope head will need to have an “open” slot for operator-controlled tip/tilt alignment.
- The maximum X, Y translation needs to be 10 cm with microscale adjustments of 5um
- The maximum Z movements need to be 10cm with microscale adjustments of 100nm.
- The drift of the stage and ability to hold the state positions is very important and should be taken into consideration when designing the stage.
- The Microscope Graphical User Interface (GUI) software should be able to do to the following:
    - Create Reflected Light Images with the ability to control brightness and contrast of the image.
    - Perform “region of interest” scanning with the ability of the operator to make the scan size of his choosing.
    - Ability to control X, Y, Z and tip/tilt movement of the stage for navigation.
    - Ability to control the focal plane of the 1319nm and 1064nm independently.

- Ability to lock the 1319nm beam with the 1064 beam while completing a scan.
- Ability to save images of the reflected light view and overlay laser induced frequency images.
- Ability to control and adjust the laser power of each individual beam line.
- Ability to adjust image resolution, scan speed of the laser, digital magnification of each beam line independently.
- Ability of the microscope to create a mosaic image of a large chip by stitching multiple images together.

6. Project Deliverables:

#	Deliverable(s)	Description	Frequency	Delivery Method
1	Monthly Status Report	Provide summary of events/actions completed during the previous month	Monthly	Electronic submission
2	Dual Wavelength Focus Design	Detailed report how system will control focus of dual wavelengths	3/4 Months after Award	Electronic submission
3	Pulse Profile Design (Non-Linear Effect)	Detailed report on how system will control pulse length and Amplitude of pulse	4/5 Months After Award	Electronic submission
4	Microscope	Microscope that incorporates all specifications into a final usable tool	6 Months After Award	Electronic submission
5	Technical Guide/User Guide	User Guide	Upon Delivery of System	Electronic submission

7. **Current Project Budget:** $1 Million

   This value represents what is currently available for the subject project at the time of the RFS release. This value is subject to change but is being provided for planning purposes. Respondents are encouraged to clearly explain how much of their solution can be developed for the advertised amount. Capabilities or project phases that will require additional funding beyond the project budget must be identified as such.

8. **Security Classification, Respondent Restrictions, and other required compliances:**

   This RFS has been released under the following: Approved for public release.

   This project encompasses the following restrictions:

   a. Security Classification: Unclassified

   b. Is ITAR Compliance required? No

   c. Respondent restrictions are limited to domestic companies based in the United States only. Subcontractors/teaming partners may not include foreign entities.

   d. Hazardous Material: No

9. **Level of Data Rights Requested by the Government**:

   Government Purpose Rights: The right to use, modify, reproduce, release, perform, display, or disclose technical data within the Government without restriction. This also includes the rights to 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 technical data for United States government purposes. This level of restriction is set at five-years but may be negotiated & tailored to a specific project. The five-year period, or such other period that may be negotiated, would commence upon execution of the agreement that required development of the items, components, or processes or creation of the data. The performer will have the exclusive right, including the right to license others, to use technical data in which the Government has obtained government purpose rights under this agreement for any commercial purpose during the five-year period. Upon expiration of the five-year period (or other negotiated length of time), the Government will receive unlimited rights in the technical data and computer software.

10. **RFS and Response Process**:

    a. The following is requested from all respondents:

	Technical Response	Price Response
Page Maximum	**20**	**5**

For written submissions, the following formatting guidelines shall be followed by respondents:

- 10-point font (or larger) for all response narratives; smaller type may be used in figures and tables but must be clearly legible.
- Single-spaced, single-sided (8.5 by 11 inches).
- Margins on all sides (top, bottom, left, and right) should be at least 1 inch.
- 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. Price volumes may be submitted in an editable, unlocked Excel file.

b. Each submittal **must include** (i) a Cover Page, (ii) a Technical Response, and (iii) a Price Response that each align to the instructions below:

i. Cover Page: (Not included within page count) 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, business size, and status of U.S. ownership.

Respondents shall also identify the applicable 10 U.S.C. § 2371b eligibility criteria related to the response (*please identify only one*):

- There is at least one nontraditional defense contractor (*defined below*) or nonprofit research institution participating to a significant extent in the project**; OR**

- 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**; OR**

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

Note: A *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 of 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:

Responses should be constructed to align with the order of the instructions below (1 - 8).

1. Solution Narrative:
   Respondents shall describe the approach used to design/deliver a unique prototype solution for the prototype technology objectives defined in RFS Section 5, Desired End-State Objective(s), to include any attachments. While these focus areas are of significant importance, responses will be considered as a whole. No pricing shall be included in the technical response.

   The Solution Narrative must also include a discussion on schedule and the timing of all deliverable(s) to include those outlined within RFS Section 6, Project Deliverables.

2. Explanation Supporting Eligibility for Award of a Prototype OTA:
   Respondents shall provide rationale to support the specific condition that permits award of an OTA to the proposed prime contractor/performer. The onus of proof to support *nontraditional participation to a significant extent; small business or nontraditional defense contractor status;* or any *cost sharing arrangement* lies with the respondent and has a direct correlation to award eligibility.

3. Foreign Owned, Controlled, or Influenced (FOCI) Documentation (if applicable):
   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.

4. Government Furnished Property or Information:
   Respondents must clearly identify if its proposed solution depends on Government Furnished Information (GFI) / Government Furnished Property (GFP) or other forms of Government support (i.e., laboratory or facility access), etc.

   If so, the response must specify the GFI/GFP required. Respondents must clearly identify if its proposed solution depends on GFI/GFP or other forms of Government support be provided, the impact to the solution if the requested information/property/asset is not available and will confirm the details with the respondent prior to any proposal revisions or selection, if applicable.

5. Mandatory Compliance with Restrictions: Respondents must address the restrictions identified within RFS Section 8, Security Classification, Respondent Restrictions, and other Required Compliance, and explain how each regulation or standard is currently, or will be met.

6. Task Description Document (Not Included Within Page Count): Respondents must provide a Task Description Document (TDD) outlining the project tasks to be performed along with schedule milestones and delivery dates required for successful completion. It is anticipated that, if selected, the proposed TDD will be incorporated into the resultant OTA. Respondents are encouraged to be concise but

thorough when outlining their work statements. The TDD may be submitted as an appendix or a separate file as part of the proposal.

7. Summary of Subcontractor Participation (if applicable): Respondents must identify all subcontractors involved and their role within the performance of the proposed concept. The information must include the following:

    a. Subcontractor company name, Commercial and Government Entity (CAGE) Code (if available), level of facility clearance (if available), address, primary point of contact, business size, and status of U.S. ownership.

    b. If the subcontracted company's involvement is considered significant, rationale supporting the significance must be present within the narrative. The onus of proof to support participation to a significant extent or any cost sharing arrangement lies with the respondent and has a direct correlation to award eligibility.

    c. If applicable, Foreign Owned, Controlled, or Influenced (FOCI) Mitigation Documentation shall be provided for subcontractors and will not count towards the page count.

8. 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 rights are being asserted at a level less than the Government's desired level of allocation (see RFS Section 9, Level of Data Rights Requested by the Government), respondents must provide detail explaining the specific rationale for the assertion. Please also review 9(b)(iii)(3) below for additional requirements related to data rights pricing.

    c. Any items previously developed with federal funding (and used for the proposed solution) 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.

iii. Price Response:

The price response shall be submitted as a separate file from the technical response. No pricing details shall be included in the technical response. This project will employ the following Fixed Price with Payable Milestones pricing structure.

1. The overall total price should be divided among severable increments that align to a proposed milestone payment schedule. Milestones are not required to match actual expenditures but should realistically align to the effort expended or products delivered.

2. 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 phases and/or milestones of the Technical Response. At a minimum, key pricing components include Labor Total(s), Other Direct Costs/Material Total(s), License prices and Subcontractor price(s). Data should be segregated by each key objective, milestone, and/or phase proposed.

3. Include a brief narrative that explains your pricing structure and maps the proposed prices to the solution's technical approach.

4. Including a Basis of Estimate to support your pricing may substantially expedite evaluation of your response.

5. If limited or restricted rights are being asserted within the response, a table that includes prices for both Government Purpose Rights and Unlimited Rights for any limited or restricted item must be included.

6. Any additional features or capabilities that extend beyond the currently requested core technical objectives shall be separately priced for the Government's consideration. Pending funding availability and need, the Government may fund these advanced features at a later date.

Evaluation Process and Methodology:

c. 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, and schedule.

d. The Government will evaluate the degree to which the proposed solution provides a thorough, flexible, and sound approach in response to the prototype technical objectives as stated in RFS Section 5, Desired End-State Objectives, as well as the ability to fulfill the objectives in this RFS.

e. The Government will award this project, via S^2MARTS (Agreement No. N00164-19-9-0001), to the respondent(s) whose solution is assessed to be the most advantageous to the Government, when price, schedule, technical risks, the level of data rights, and other factors are considered. The Government reserves the right to award to a respondent that does not meet all the requirements of the RFS.

f. The proposed project price, schedule, and intellectual property/data rights assertions will be considered as aspects of the entire response when weighing risk and reward. 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.

g. 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. Debriefings will not be provided.

11. Follow-On Activity:

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 competitively awarded from this document. The prototype effort will be considered successfully complete upon demonstration of the aforementioned technology 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. Requirements of other potential follow-on activities could involve, though not limited to, continued development and baseline management, fielding, sustainment, training, further scaling of the solution, integration of future capabilities, or integration of the solution with other capabilities.

12. Attachments

a. Section 889 Prohibition and Reporting

b. Section 889 Verification and Representation

13. Important Dates

a. Questions related to this RFS shall be submitted no later than 12 PM EST on Tuesday, May 18, 2021

   To submit any questions, visit the opportunities page at www.nstxl.org/opportunities, select the "Current" tab, locate the respective project, and select "Submit a Question".

b. Proposals submitted in response to this RFS are due no later than 12 PM EST Friday, June 4, 2021.

c. To submit your proposal, visit the opportunities page at www.nstxl.org/opportunities, select the "Current" tab, locate the respective project, and select the "Submit Proposal" link. You must have an active account and be logged-in to submit your response.

d. RFS Respondents must be active members of the consortium at the time of proposal submission.

14. Additional Project Information

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 also reserves the right to not select any of the solutions proposed.

b. Acceptable responses not selected for the immediate award will be retained by NSTXL & the Government for possible future execution and funding. The non-selected proposals will be considered as viable alternatives for up to 36 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 NSTXL 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, specifically Naval Surface Warfare Center, Crane Division, has release authority on any publications related to this prototype project.

d. Unsuccessful respondents will be notified, however, debriefings for this project are not required nor planned at this time.

e. If resource-sharing is proposed 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.

f. Certain types of information submitted to the Department during the RFS, and award process 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.

g. 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.

h. 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 performer 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).