Special Notice

Request for Information and Workshop:
Cryogenic Microsystems Thermal Packaging
DARPA-SN-24-106
September 30, 2024

Defense Advanced Research Projects Agency
Microsystems Technology Office
675 North Randolph Street
Arlington, VA 22203-2114

Request for Information (RFI)
Special Notice DARPA-SN-24-106

Cryogenic Microsystems Thermal Packaging
Defense Advanced Research Projects Agency (DARPA)
Microsystems Technology Office (MTO)

Posting Date: September 30, 2024
Responses Due: November 4, 2024, at 5:00 p.m. Eastern Time (ET)
Technical POC: Dr. Yogendra Joshi, MTO Program Manager
E-mail: DARPA-SN-24-106@darpa.mil

RFI DESCRIPTION:
The Defense Advanced Research Projects Agency (DARPA) Microsystems Technology Office (MTO) seeks information on new approaches and technologies for thermal packaging of cryogenic microsystems from 10 mK to 77 K, and the associated interconnects between these temperatures, as well as to room temperature microsystems.

The goals of this Request for Information (RFI) include, but are not limited to:

- Identification of the best-in-class materials, and approaches for cryogenic microsystems packaging from 10 mK to 77 K, and
- Identification of key challenges in scaling up cryogenic thermal packaging to computing systems that can offer transformative advantages in performance per energy use over current high performance computing platforms.

Responses to this RFI will be used to select topics for a Cryogenic Microsystems Thermal Packaging workshop to be held on December 2, 2024, in McLean, VA. See workshop section of this special notice for details.

BACKGROUND:
Interconnections between room temperature electronics and processing elements at cryogenic temperatures in the range of 10 mK to 77 K are needed for various applications including enhanced performance complementary metal oxide semiconductor devices, as well as for various types of superconducting quantum computing techniques. Various approaches for interconnection, integration, and packaging introduce their own unique challenges to scale up, as needed to achieve systems that can outperform current generation high performance computing hardware with same energy usage. The large temperature gradients lead to significant heat leaks (both passive and active) with the state-of-the-art (SOA) interconnects and thermal packaging approaches.

REQUESTED INFORMATION:
DARPA is seeking to identify the current SOA and key technical challenges in cryogenic thermal packaging and interconnects. Responses are welcome from all capable sources including, but not limited to, private or public companies, individuals, universities, university-affiliated research centers, not-for-profit research institutions, and U.S. Government-sponsored labs. Responses must address one or both of the following areas:

1. Recent innovations that have significantly extended the capabilities compared to the prior SOA in acquisition, transmission, and rejection of waste heat (both active and passive) from microsystems, or constituent components deployed in cryogenic environments. These

approaches may be based on heat conduction, phase change (e.g., solid/solid, solid/liquid, liquid/liquid, liquid/vapor), convection, and/or radiation.

2. Recent innovations in interconnection, integration, and packaging for cryogenic microsystems. Of particular interest are thermal insulation materials for interconnections across a range of cryogenic temperatures.

Approaches already well explored in the published literature, or those that promise incremental benefits, are not of interest.

SUBMISSION INSTRUCTIONS:
Responses to this RFI should be submitted no later than 5:00 p.m. ET on November 4, 2024.

Unclassified responses to this RFI should be submitted to DARPA-SN-24-106@darpa.mil. NO CLASSIFIED INFORMATION SHOULD BE SENT TO DARPA-SN-24-106@darpa.mil.

To the maximum extent possible, respondents should submit non-proprietary information. If proprietary information is submitted, it must be appropriately and specifically marked. It is the respondent's responsibility to clearly define to the Government what is considered proprietary data. Any proprietary information should be clearly labeled as "Proprietary." DARPA will disclose submission contents only for the purpose of review by DARPA staff, other Government agencies, or DARPA Support Contractors/SETAs.

FORMAT INSTRUCTIONS:
Responses to the RFI should be concise. Respondents should submit a single integrated response addressing one or both of the areas described above. DARPA will only review responses submitted as an unprotected Microsoft Word/PowerPoint document or PDF file. Each response is limited to no more than **14** pages using 10-point font and 1-inch margins on 8.5-inch by 11-inch page size. Effective responses that can be provided in fewer than **14** pages are encouraged. Any submitted material in excess of these limits will not be reviewed.

Responses should adhere to the following formatting instructions:

1. Cover page (1 page)
    a. Title
    b. Organization(s)
    c. Respondent's technical and administrative points of contact (names, addresses, phone and fax numbers, and email addresses)
2. Technical areas (4 pages maximum per technical area)
    a. A discussion of the current capabilities, and challenges to be addressed (from your perspective)
    b. Theoretical, simulation, and experimental discussion
    c. Scale-up strategy
    d. Identification of current data (if any)
    e. Estimated time to availability and risk assessment (technical and other)
3. References (1 page)
    a. All references to previously published work should be contained within this space.
4. Summary slides (1 summary slide and 1 technical description slide per technical area)
    a. Responses are requested to include slides that summarizes the main idea and development strategy. The purpose of these slides is to visually and succinctly indicate

the new insights, main objectives, underlying technical mechanisms, fundamental assumptions and limitations, key innovations, expected impact, and/or other unique aspects of the response.

ADMINISTRATIVE:

This announcement contains all information required to submit a response. No additional forms, kits, or other materials are needed. All administrative and technical questions should be directed to DARPA-SN-24-106@darpa.mil. Please refer to the Special Notice number (DARPA-SN-24-106) in all correspondence.

This RFI is issued solely for information and program planning purposes and does not constitute a formal solicitation for proposals or proposal abstracts; any so sent will be disregarded. In accordance with FAR 15.201(e), responses to this notice are not offers and cannot be accepted by the Government to form a binding contract. Submission of a response is strictly voluntary and is not required to propose to subsequent Announcements (if any) or Solicitations (if any) on this topic. DARPA will not provide reimbursement for costs incurred in responding to this RFI. Respondents are advised that DARPA is under no obligation to acknowledge receipt of the information received or provide feedback to respondents with respect to any information submitted under this RFI.

Workshop
Special Notice DARPA-SN-24-106

Cryogenic Microsystems Thermal Packaging
Defense Advanced Research Projects Agency (DARPA)
Microsystems Technology Office (MTO)

Posting Date: September 30, 2024
Event Date: December 2, 2024, at 8:00 a.m. Eastern Time (ET)
Registration Deadline: November 18, 2024, at 4:00 p.m. Eastern Time (ET)
Registration Website: https://cvent.me/d0zbno
Technical POC: Dr. Yogendra Joshi, MTO Program Manager
E-mail: DARPA-SN-24-106@darpa.mil

WORKSHOP DESCRIPTION:
The Defense Advanced Research Projects Agency (DARPA) will host an in-person workshop to explore the current state-of-the-art (SOA) and emerging approaches and technologies for cryogenic microsystems packaging in the range of 10 mK to 77 K. The workshop will be held on December 2, 2024, at Booz Allen Hamilton, 8283 Greensboro Drive, McLean, VA 22102 from 8:00 a.m. to 5:00 p.m. ET.

The goals of the workshop are to:
(1) Bring together key stakeholders to assess SOA and technology challenges related to cryogenic microsystems thermal packaging and interconnections to enable energy efficient, massively scaled up systems.
(2) Explore recent innovations that have significantly extended the capabilities compared to the SOA in acquisition, transmission, and rejection of waste heat (both active and passive) under cryogenic conditions. These approaches may be based on heat conduction, phase change (e.g., solid/solid, solid/liquid, liquid/liquid, liquid/vapor), convection, and radiation.
(3) Explore recent innovations in interconnection, integration, and packaging of cryogenic microsystems. Of particular interest are cryogenic thermal insulation materials for interconnections.

The workshop will include overview presentations by government, industry, and academic personnel selected on the basis of the submitted abstracts. See presentations section of this special notice for instructions. Also, there will be time allotted for discussions and team building among the participants.

The workshop seeks to facilitate cross-community cooperation between fundamental physics, optics, electrical engineering, mechanical and thermal engineering, microelectronic and photonics fabrication methods, and system integration to better understand the opportunities and limitations imposed by the different building blocks in the development of novel methods for thermal packaging of cryogenic microsystems

This meeting will be held at the UNCLASSIFIED level. All attendees are required to present government-issued photo identification upon entry to the event.

REGISTRATION INFORMATION:
Workshop participation is limited by venue capacity and early registration is strongly recommended. A maximum of **2 participants per organization** will be allowed. The determination as to what constitutes an organization will be made by the DARPA Program Manager. The registration cutoff date is November 18, 2024, at 4:00 p.m. ET, or once attendance capacity is met, whichever comes first. Any change to the registration deadline will be captured in an amendment to this Special Notice and an update to the registration website.

The workshop is open only to registered attendees. The event is closed to the general public and media. An online registration form, preliminary agenda, citizenship verification form, foreign national visit request form, meeting details, and (when applicable) hotel information for the workshop can be found at the registration website.

A completed DARPA Form 104, "DARPA Conference Center Visitor Requirements for Unclassified Meetings" must be filled out by all in-person attendees and submitted via email to DARPA-SN-24-106@darpa.mil. For additional information and link to the latest DARPA Form 104, please refer to the Visitor Information page on the DARPA website (http://www.darpa.mil/policy/visitor-information).

Additionally, all meeting registrants who are not U.S. Citizens must complete and submit one of the following:

- All U.S. Permanent Residents and Foreign Nationals not representing a foreign government must submit a DARPA Form 60 "U.S. Permanent Resident and Foreign National Visit Request", which can be submitted via the following link: https://dtsn.darpa.mil/eform60/.
- Foreign government personnel who are representing a foreign government in an official capacity must submit an official Foreign Visit Request (FVR) via their respective Embassy based in Washington, DC.

All forms must be submitted no later than November 18, 2024, at 4:00 p.m. ET. Failure to complete and submit the required forms prior to the date and time noted above may result in the cancellation of existing registration.

PRESENTATIONS:
There will be an opportunity for individual, 10-minute presentations at the workshop. No template for the presentation will be provided; however, presentations should highlight emerging challenges and novel approaches to thermal packaging of cryogenic microsystems. There is a limit of one presentation per organization, and presentations will be limited to ten minutes each. Registrants must indicate their intent to participate in the presentation session and submit an unclassified abstract during registration.

All presentations must be in Microsoft PowerPoint or PDF format. Unclassified presentations should be emailed to DARPA-SN-24-106@darpa.mil no later than November 18, 2024, at 4:00 p.m. ET. Presentations should not contain any Controlled Unclassified Information (CUI) or classified information and must be suitable for unlimited public release. NO CLASSIFIED INFORMATION SHOULD BE SENT TO DARPA-SN-24-106@darpa.mil.

The agenda will be finalized and registrants chosen to present will be notified no later than November 20, 2024, at 4:00 p.m. ET. Any questions regarding presentations should be directed to the email address listed above.

DARPACONNECT:
Entities who have not worked with DARPA before are encouraged to learn more about DARPAConnect, an initiative established to facilitate collaboration between DARPA and potential performers. The DARPAConnect team offers customized support, resources, and guidance on how to prepare your ideas for high-impact conversations with DARPA program managers. Please visit DARPAConnect.us to access a digital hub of online resources, including a curriculum for self-paced learning, personalized support, and in-person and virtual events. In addition to the self-paced online materials, the DARPAConnect team is able to schedule one-on-one conversations to discuss your specific ideas, questions, and paths to DARPA. You can use the contact form at DARPAConnect.us or email the DARPAConnect team directly at darpaconnect@darpa.mil to request assistance.

ADMINISTRATIVE:
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