

Questions received during Webinar (WQ)

WQ 1 - In sub-topic #2, do you feel that new sensors and modalities will be required or beneficial to meet the intent of the program?

Answer: The intent is to widely explore approaches for operating in degraded environments with a focus on enabling autonomous navigation; ARL is interested in any proposals to this end, whether proposing new sensors and modalities or proposing new algorithms and techniques for existing ones. Keep in mind that any custom or novel sensor purchases need to be budgeted in the proposal and so cost reasonableness will be considered under evaluation factor #4. With respect to UASs, we are open to any sensors/payloads that can reasonably fit on a Group 1 UAS. However, payloads and sensors must be NDAA compliant.

WQ 2 - What, if any, are the requirements on ROS1 vs ROS2 for any code that is being developed, especially when the code is expected to talk to both the Air Stack and the Ground Stack?

Answer: If proposing to work with UGVs, Applicants should be prepared to integrate into a ROS1 system; if proposing to work with UASs, Applicants should be prepared to integrate into a ROS2 system. If proposing to work with both UGVs and UASs (for example under sub-topic #3), then Applicants should be prepared to integrate with both and work with ARL to integrate across the two systems. Be advised that ROS1 is not supported on ARL UAS. The [MAVericks] air stack can act as a ROS1 multi-master bridge and ROS 1-to-2 bridge when deployed on a ground vehicle.

WQ 3 - Thank you for the detailed presentation and further explaining the FOA. I had a couple of questions from the POV of a perspective new performer for the Cycle 3.

WQ 3a - Are the new proposers going to be competing for funds with the previous cycle proposers who are now applying for an optional 3 year extension?

Answer: The \$2.5M stated in the FOA is for the current Sprint cycle's 12-month seedling / base year. Note that from FOA page 16 that "ARL reserves the right to negotiate with an Applicant to re-scope their proposal or optional proposal technical focus, period of performance, and associated costs in order to maximize the available program funding, balance of research topics across the program, and overall impact to the program."

WQ 3b - Are we required to focus on the perceptual pipelines for both a UAV or UGV or can we focus on only one platform of choice, especially for Sub-topics 1 and 2?

Answer: Applicants are free to pick a particular system type to focus on (or both if they choose) for Sub-topics #1 and #2. Keep in mind there are vast differences between the sensor and compute capabilities on the ARL testbed UGV and UAS.

WQ 3c - Aside from the existing payload on the ARL platform, can we opt for custom sensor payloads to operate in degraded environments as opposed to the suggested long range IR as per the FOA or are we limited to only COTS sensors like those ARL testbeds currently offer?

Answer: The intent is to widely explore approaches for operating in degraded environments with a focus on enabling autonomous navigation; ARL is interested in any proposals to this end, whether proposing new sensors and modalities or proposing new algorithms and techniques for existing ones. Keep in mind that any custom or novel sensor purchases need to be budgeted in the proposal and so cost reasonableness will be considered under evaluation factor #4. With respect to UASs, we are open to any sensors/payloads that can reasonably fit on a Group 1 UAS. However, payloads and sensors must be NDAA compliant.

WQ 3d - We understand that the exact funding size per team would depend on the number and quality of the proposals but is there a ball park budget we can expect so that we can plan our contributions accordingly?

Answer: There is not a typical or target award amount. The FOA states an upper limit on available funds (currently \$2.5M) and indicates multiple awards are expected to be funded out of Cycle 3. In general, budgets should follow from the requirements of the proposed research to answer the topic in accordance with the Applicant's vision. In Sprint 1, Awards ranged from roughly \$100K to over \$700K, and in Sprint 2, Awards ranged from roughly \$200K to over \$600K, dependent on the level of effort proposed, material, equipment, and type and quantity of personnel, among other factors.

WQ 3e - As for the ARL robot testbeds, are we allowed to request integration of additional sensors as power/voltage/current measurement sensors to plan the mission or do we have to stick to external payloads only that do not require low level integration?

Answer: Applicants are free to suggest modifications (e.g., additions, changes) to the ARL UGV and UAS autonomy hardware kits, but equipment and integration costs must be factored into the proposal budget. It is reasonable for Applicants to ask for ARL to undertake specific hardware and software integration tasks as part of the anticipated collaboration, but these requirements must be clearly stated so that ARL can balance them against available resources during the evaluation process. ARL has full configuration control over its own autonomy hardware kits but does not have access to low-level controllers and actuators on the base air and ground vehicle platforms, for example wheel and propeller motor controllers. Note from the FOA page 6 that "Recipients will be required to integrate their solutions into the ARL Autonomy Stack(s) for experimentation events at ARL facilities, on ARL testbeds."

WQ 3f - Is it so that the ARL Air testbed runs ROS2 but ARL Ground testbed perception pipeline is still using ROS1? In other words, would performers be required to use ROS 1 or ROS 2?

Answer: If proposing to work with UGVs, Applicants should be prepared to integrate into a ROS1 system; if proposing to work with UASs, Applicants should be prepared to integrate into a ROS2 system. If proposing to work with both UGVs and UASs (for example under sub-topic #3), then Applicants should be prepared to integrate with both and work with ARL to integrate across the two systems. Be advised that ROS1 is not supported on ARL UAS. The [MAVericks] air stack can act as a ROS1 multi-master bridge and ROS 1-to-2 bridge when deployed on a ground vehicle.

WQ 4 - For sub-topic 2 Environment Degradation, are you interested in mobility condition degradation (flat tires, losing actuation, extremely rough terrain), in contrast to only perception condition degradation?

Answer: The primary focus of Sub-topic 2 is environmental degradation, where the air or ground vehicle is operating in an environment that is not pristine. Over first two SARA Sprint cycles, the autonomy stack (e.g., perception, calibration, mapping, planning, control, etc.) has been exercised in mostly precipitation-free daylight, across ambient temperatures of approx. 50 deg F to 90 deg F, and in complex terrain such as grass-covered and leaf-covered forest floor, gullies, moderate hills, and dry washes. Previously completed SARA efforts in Sprint Cycles 1 and 2 looked at self-reflective and adaptive control, uncertainty-aware navigation, and traversibility costmaps using proprioceptive terrain interaction feedback.

WQ 5 - Thank you for the very informative presentation. If I may ask, some questions that come to mind:

WQ 5a - Could proposers propose a topic that blends the sub-topics, or each proposal must focus on one sub-topic?

Answer: Applicants may propose to a single Sub-topic or multiple Sub-topics at the same time. From FOA page 15, "Proposals will be solicited for innovative solutions that will advance the state-of-art and the provided baseline ARL autonomy capability along the sprint topic focus area(s) and enable new novel maneuver or mobility behaviors for autonomous systems." Proposals must clearly state which Sub-topic or Sub-topics are being addressed. All evaluations will be made against the stated evaluation factors.

WQ 5b - Will all technical details of the ground and air vehicles be provided?

Answer: ARL has provided sufficient technical details for Applicants to scope their efforts. If a proposal relies on specific technical assumptions beyond those given, these assumptions must be clearly stated in the proposal, and any discrepancies will be handled during Award negotiations. After Award, Recipients will be given full access to the technical details of the respective air or ground platform in order to facilitate integration.

WQ 5c - Are there additional constraints on the ground/air vehicle motions? For ex., is there a minimum altitude for the drone to remain?

Answer: Minimum UAS altitude will be dictated by location, for example when flying within or above trees, or above uninhabited structures at the R2C2 Graces Quarters facility. UASs must maintain visual line of sight with personnel during experiment activities. Rotary wing UAS must conform to Group 1 or Group 2. Fixed wing UAS will be evaluated on a case-by-case basis.

WQ 5d - Is there a baseline scenario available in the simulator so the proposers can test how much they are improving the metrics with their new algorithms?

Answer: ARL has representative simulation environments and simple missions that are applicable to this Sprint topic and have been used in previous extramural research efforts, but there is no official scenario for testing the progress of this Sprint topic. Development of virtual and physical experiments to measure progress is anticipated to be a collaborative effort within the scope of the program. ARL and Recipients will together develop appropriate measures and metrics to gauge the improvement of new algorithms over baselines.

WQ 6 – Regarding Sub-topic 2:

WQ 6a – What kind of compute limitations should we keep in mind when designing our solutions?

Answer: The ARL UAS uses a Snapdragon 865 CPU/GPU. If more compute is needed, then the Applicant can add it as a payload that attaches via USB 3/Ethernet. The ARL UGV uses two Intel i7 computers with minimum 32GB RAM, 1TB of onboard SSD storage, 1TB of additional storage, and one NVIDIA T4 GPU with minimum 16GB RAM.

WQ 6b - Are you focusing more on sensor characterization of current sensors for enhancing their capabilities or a new sensor technology?

Answer: The intent is to widely explore approaches for operating in degraded environments with a focus on enabling autonomous navigation; ARL is interested in any proposals to this end, whether proposing new sensors and modalities or proposing new algorithms and techniques for existing ones. Keep in mind that any custom or novel sensor purchases need to be budgeted in the proposal and so cost reasonableness will be considered under evaluation factor #4. With respect to UASs, we are open to any sensors/payloads that can reasonably fit on a Group 1 UAS. However, payloads and sensors must be NDAA compliant.

Questions received via e-mail (EQ)

[Proprietary] EQ 1. [REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]

[Proprietary] Answer:

EQ 2. 31 March. Could you tell me the appropriate level of effort for SARA Cycle 3 proposals?

Answer: There is not a typical or target award amount. The FOA states an upper limit on available funds (currently \$2.5M) and indicates multiple awards are expected to be funded out of Cycle 3. In general, budgets should follow from the requirements of the proposed research to answer the topic in accordance with the Applicant's vision. In Sprint 1, Awards ranged from roughly \$100K to over \$700K, and in Sprint 2, Awards ranged from roughly \$200K to over \$600K, dependent on the level of effort proposed, material, equipment, and type and quantity of personnel, among other factors.

EQ 3. 31 March. Are non-US entities permitted to apply to, and receive an award on, the SARA program?

Answer: The FOA eligibility criteria does not specifically exclude foreign participation. Note, however, that proposals will be evaluated using the process in Section E (Application Review / Evaluation Information) which includes Recipient Qualification, Conflict of Interest, and the Army Research Risk Assessment Protection Program (ARRP). A reproduction of the ARRP matrix from the FOA, along with Q&A specific to the ARRP, can be found here: <https://www.arl.army.mil/resources/arrp/>

EQ 4. 03 April. Is teaming with other universities allowed?

Answer: Applicants are permitted to team with any other eligible entity. From the FOA, "Proposals may consist of teams from any combination of organizations (e.g., prime and subawardees), but this is not a requirement for award and award will only be made to a single entity."

EQ 5. 05 April. Is the "Research and Related Budget" web form meant to be part of the grants.gov package? Currently, it doesn't appear in grants.gov. The solicitation, page 28 says: "The above cost categories are available on the following OMB Form, and are included as part of the submitted grants.gov package: <https://omb.report/icr/202211-1850-001CF/ic/225594>"

Answer: The application package in grants.gov has been updated to include the "Research and Related Budget" form.

EQ 6. 05 April. Would it be possible for you to share what budget ranges from Cycle 2 were awarded?

Answer: There is not a typical or target award amount. The FOA states an upper limit on available funds (currently \$2.5M) and indicates multiple awards are expected to be funded out of Cycle 3. In general, budgets should follow from the requirements of the proposed research to answer the topic in accordance with the Applicant's vision. In Sprint 1, Awards ranged from roughly \$100K to over \$700K, and in Sprint 2, Awards ranged from roughly \$200K to over \$600K, dependent on the level of effort proposed, material, equipment, and type and quantity of personnel, among other factors.

EQ 7.

06 April. In the announcement it says: "All funding is expected to be expended within the cycle period of performance. Available funding will vary from cycle to cycle; for Cycle 3, a total of \$2.5M is expected. Additional Enhanced Research Program funding from ARL or Other Government Agencies (OGAs) may become available during a cycle. Multiple awards are expected to be funded out of Cycle 3. Proposals are expected to be bid at a cost commensurate with the level of effort."

Does the cycle period of performance referenced include just the 12 month seedling effort? Or is it inclusive of the option years as well? Hoping to gain some clarity on how the budget might be spread based on period of performance – will the \$2.5M be spread across multiple awards, funding the first year only at this point?

Answer: The \$2.5M stated in the FOA is for the 12-month seedling / base year only. From FOA page 16, "All funding is expected to be expended within the cycle period of performance. Available funding will vary from cycle to cycle; for Cycle 3, a total of \$2.5M is expected. Additional Enhanced Research Program funding from ARL or Other Government Agencies (OGAs) may become available during a cycle. Multiple awards are expected to be funded out of Cycle 3. Proposals are expected to be bid at a cost commensurate with the level of effort." From FOA page 32, "The Government reserves the right not to make an award should no acceptable Proposal be submitted." From FOA page 25, "Cost Component must include a budget for the seedling year, as well as a budget for the Option Years as applicable."

EQ 8. 07 April. Computational Constrains. Are there any potential computational upgrades on the hardware resources of the testbed, beyond the current configuration described on pages 13-14 of the FOA (for example on GPUs)?

Answer: Applicants are free to suggest modifications (e.g., additions, changes) to the ARL UGV and UAS autonomy hardware kits, but equipment and integration costs must be factored into the proposal budget. It is reasonable for Applicants to ask for ARL to undertake specific hardware and software integration tasks as part of the anticipated collaboration, but these requirements must be clearly stated so that ARL can balance them against available resources during the evaluation process. ARL has full configuration control over its own autonomy hardware kits but does not have access to low-level controllers and actuators on the base air and ground vehicle platforms, for example wheel and propeller motor controllers. Note from the FOA page 6 that "Recipients will be required to integrate their solutions into the ARL Autonomy Stack(s) for experimentation events at ARL facilities, on ARL testbeds."

The ARL UAS uses a Snapdragon 865 CPU/GPU. If more compute is needed, then the Applicant can add it as a payload that attaches via USB 3/Ethernet. The ARL UGV uses two Intel i7 computers with minimum 32GB RAM, 1TB of onboard SSD storage, 1TB of additional storage, and one NVIDIA T4 GPU with minimum 16GB RAM.

EQ 9. 07 April. Sub-topic #2. Does the specific sub-topic encourage efforts proposing new sensing modalities – beyond the ones the testbed currently includes? or puts more emphasis on new algorithms and methods for improved orchestration and robustness of the existing sensing modalities?

Answer: The intent is to widely explore approaches for operating in degraded environments with a focus on enabling autonomous navigation; ARL is interested in any proposals to this end, whether proposing new sensors and modalities or proposing new algorithms and techniques for existing ones. Keep in mind that any custom or novel sensor purchases need to be budgeted in the proposal and so cost reasonableness will be considered under evaluation factor #4. With respect to UASs, we are open to any sensors/payloads that can reasonably fit on a Group 1 UAS. However, payloads and sensors must be NDAA compliant.

EQ 10. 07 April. Sub-topic #3. Is the objective to do innovation and ARL stack improvements for both air and ground robots, or a proposal can focus one platform with multiple instances? In other words, can we propose multiple robots of same type or heterogeneous types of agents are required?

Answer: The Applicant's approach will depend on which Sub-topic(s) are proposed to. Refer to the answers to WQ 1, WQ 3b, and WQ 5a.

EQ 11. 07 April. Sub-topic #1. In the FOA, what does off-line mean in "what can be stored locally, off-line"? Do you envision intermittent 5G or other wireless connectivity to enable computing or to move data to central location – even on a limited basis?

Answer: In context of robotic field experiments in the SARA program, "what can be stored locally, off-line" refers to data that is collected and stored locally on robot-mounted storage drives (i.e., data is there and can be used in autonomy decision-making process). In the latter part of the referenced assumption in the FOA it says "...and what can be forgotten". This "forgotten" data is data that is not available for use in autonomy decision-making process.

Electronics brought to the ARL experimentation facilities (e.g., computers) are not permitted to connect to the ARL testbed platforms or to ARL networks. Experiment data is stored locally on an ARL-owned portable storage drive, controlled by ARL, and uploaded to password-protected cloud-based storage for collaborators to access outside of the ARL experimentation facility. Recipients will be informed of local network access permission and restrictions.

EQ 12. 07 April. What is the SLAM capability in ARL autonomy stack that we can assume to be available at the start of Sprint #3? Does it include 2D, 2.5D, and/or 3D maps?

Answer: Recipients should expect 2.5D maps from the ARL Autonomy Stack. The message format used is the standard `grid_map_msgs::GridMap`. The nominal layers available for navigation are “cost”, “speed”, and “elevation”, but Recipients can also access intermediate topics which contain aggregated semantic confidences.

EQ 13. 07 April. I was wondering if the proposal for the 12-month seedling effort and its potential 36-month option are evaluated together, or if the seedling year can be accepted independently (and/or part of the option years)?

Answer: Applications are evaluated as a full package against the evaluation factors called out in the FOA. From FOA page 19, “ARL reserves the right to negotiate with an Applicant to re-scope their proposal or optional proposal technical focus, period of performance, and associated costs in order to maximize the available program funding, balance of research topics across the program, and overall impact to the program.”

EQ 14. 07 April. Would you be expecting proposals to be confined to a particular sub-topic, or a proposal could potentially address the problems in more than one sub-topic?

Answer: Applicants may propose to a single Sub-topic or multiple Sub-topics at the same time. From FOA page 15, “Proposals will be solicited for innovative solutions that will advance the state-of-art and the provided baseline ARL autonomy capability along the sprint topic focus area(s) and enable new novel maneuver or mobility behaviors for autonomous systems.” Proposals must clearly state which Sub-topic or Sub-topics are being addressed. All evaluations will be made against the stated evaluation factors.

EQ 15. 07 April. Is Cycle 3 designed to award and involve only new teams? Are currently funded teams from Cycles 1-2 eligible to compete in Cycle 3?

Answer: All eligible entities may submit a proposal to SARA Sprint cycle 3. As long as the Applicant meets the eligibility criteria identified in the FOA, their proposal will be accepted for consideration and evaluation.

EQ 16. 07 April. Would the PIs be allowed to bring their novel sensors or vehicles (so long as they are compatible with your autonomy stack), or the proposed research must be constrained to the sensors and/or the vehicles available at the ARL and in the autonomy stack?

Answer: The intent is to widely explore approaches for operating in degraded environments with a focus on enabling autonomous navigation; ARL is interested in any proposals to this end, whether proposing new sensors and modalities or proposing new algorithms and techniques for existing ones. Keep in mind that any custom or novel sensor purchases need to be budgeted in the proposal and so cost reasonableness will be

considered under evaluation factor #4. With respect to UASs, we are open to any sensors/payloads that can reasonably fit on a Group 1 UAS. However, payloads and sensors must be NDAA compliant.

Applicants are free to suggest modifications (e.g., additions, changes) to the ARL UGV and UAS autonomy hardware kits, but equipment and integration costs must be factored into the proposal budget. It is reasonable for Applicants to ask for ARL to undertake specific hardware and software integration tasks as part of the anticipated collaboration, but these requirements must be clearly stated so that ARL can balance them against available resources during the evaluation process. ARL has full configuration control over its own autonomy hardware kits but does not have access to low-level controllers and actuators on the base air and ground vehicle platforms, for example wheel and propeller motor controllers. Note from the FOA page 6 that "Recipients will be required to integrate their solutions into the ARL Autonomy Stack(s) for experimentation events at ARL facilities, on ARL testbeds."

EQ 17. 07 April. Might we know approximately the range of funding (max and min) in Cycle 2?

Answer: There is not a typical or target award amount. The FOA states an upper limit on available funds (currently \$2.5M) and indicates multiple awards are expected to be funded out of Cycle 3. In general, budgets should follow from the requirements of the proposed research to answer the topic in accordance with the Applicant's vision. In Sprint 1, Awards ranged from roughly \$100K to over \$700K, and in Sprint 2, Awards ranged from roughly \$200K to over \$600K, dependent on the level of effort proposed, material, equipment, and type and quantity of personnel, among other factors.

EQ 18. 07 April. Would it be OK if we budgeted hardware in our proposal (e.g. a vehicle similar to ARL warthog or the drone) so that we could do testing at our end before we would transition the know how to ARL vehicles?

Answer: Applicants are free to budget hardware in their proposals so that they may perform local integration and assessment at their own facilities. Note that FOA page 14 says, "It is not a requirement to match this configuration one-for-one; the Recipient is free to conduct development on a surrogate platform. Upon receipt of Award, specifications of the listed hardware can be made available to Recipients upon request, should the Recipient want to closely match the ARL ground vehicle testbed." Refer also to the answers to WQ 1 and WQ 3e.

EQ 19. 07 April. In FOA page 23: Form: Research & Related Other Project Information. This form is not included in the Grants.gov package. I have been unable to obtain this form in a workable format to use for the Attachment form that is in the application. Please advise on a solution.

Answer: This form is included in the application package.

EQ 20. 07 April. Budget in Grants.gov - the G.G application does not include the normal RR Budget section. Is submission of the budget in pdf form within the Proposal - Chapter 3 the only required budget submission?

Answer: The application package in grants.gov has been updated to include the "Research and Related Budget" form.

EQ 21. 07 April. Privacy Act Statement: What is the definition of "Covered Individual"?

Answer: From FOA page 38, "Covered Individual. An individual who contributes in a substantive, meaningful way to the scientific development or execution of a research and development project proposed to be carried out with a research and development award from a Federal research agency; and is designated as a covered individual by the Federal research agency concerned. See 42 U.S.C. § 6605, Definitions... For purposes of this FOA, "Senior/Key Personnel" are all considered "covered individuals.""

EQ 22. 07 April. The ARL stack only accommodates for few sensors (RGB, Lidar, Depth, etc). Can we propose to include other existing sensor modalities, such as Radar, which can enhance the working of ARL stack modules?

Answer: Applicants are free to propose sensors and sensing modalities outside of the baseline ARL autonomy stack. From FOA pages 10 through 13, the ARL autonomy stack will be made available to Recipients as GFE. There are three main ways to contribute to the existing architecture: replace, add, or modify. Refer also to the answers to WQ 1 and WQ 3e.

EQ 23. 07 April. Can we propose solutions combining multiple sub-topics? i.e., a solution that addresses two different topics – sub-topic-2: Environmental Degradation and sub-topic-3: Unified air/ground scene representation?

Answer: Applicants may propose to a single Sub-topic or multiple Sub-topics at the same time. From FOA page 15, "Proposals will be solicited for innovative solutions that will advance the state-of-art and the provided baseline ARL autonomy capability along the sprint topic focus area(s) and enable new novel maneuver or mobility behaviors for autonomous systems." Proposals must clearly state which Sub-topic or Sub-topics are being addressed. All evaluations will be made against the stated evaluation factors.

EQ 24. 07 April. Can we propose solutions that advocate modifying multiple modules of the ARL stack and introducing new modules?

Answer: Applicants are free to propose sensors and sensing modalities outside of the baseline ARL autonomy stack. From FOA pages 10 through 13, the ARL autonomy stack will be made available to Recipients as GFE. There are three main ways to contribute to the existing architecture: replace, add, or modify. Refer also to the answers to WQ 1 and WQ 3e.

EQ 25. 07 April. Do all the devices operate and maneuver autonomously, OR do they operate in a distributed OR hierarchical fashion?

Answer: Applicants are free to propose any of these concepts. It is reasonable to propose an approach where air and/or ground systems operate autonomously or in a distributed or hierarchical fashion. Proposals must be scoped according to the guidelines in the FOA. From the FOA page 17, "Research outcomes in this program must, at the very least, be demonstrated in situated experimentation events in relevant environments on surrogate research testbed platforms."

EQ 26. 07 April. Can air and ground vehicles collaboratively make decisions, OR are they restricted to only taking inputs from each other to make autonomous decisions?

Answer: Applicants are free to propose any of these concepts. It is reasonable to propose an approach where the air and ground agents formulate a joint plan, or formulate individual plans based on siloed information, or formulate individual plans based on information available from the other agents and without agreement with other agents. Proposals must be scoped according to the guidelines in the FOA. From the FOA page 17, "Research outcomes in this program must, at the very least, be demonstrated in situated experimentation events in relevant environments on surrogate research testbed platforms."