

Question and Answers for IARPA-BAA-15-13

03/21/2016

QEO Q&A Set 01

- 1. Question: Is this a follow-on requirement? If so, could you please provide the incumbent contract number for this opportunity? If not, is this a new requirement?**

Answer Q1: QEO is a new requirement. There is no incumbent contract number for this opportunity.

- 2. Question: Is there any interest in trapped ion work?**

Answer Q2: QEO is limited to superconducting qubits.

- 3. Question: Is it advisable that an individual choose to contribute to competing proposals and serve on more than one team, or that teams choose members who also are part of a separate team?**

Answer Q3: IARPA takes no general position as to whether one individual's participation on one or more teams is advisable or not. Review BAA paragraph 3.C.1 which states, IARPA encourages collaborative efforts and teaming arrangements and notes that the specific content, communications, networking and team formations is the responsibility of the participants. Also review BAA sections 4.B.1.3.I. for the expected participation of key personnel and significant contributors as well as the evaluation criteria in section 5.A, particularly section 5.A.2, "Effectiveness of Proposed Work Plan." Note that that per section 5.A.2, "Work plans must also demonstrate that key personnel have sufficient time committed to the Program to accomplish their described Program roles."

- 4. Question: Will slides be provided from the QEO Review, held January 20-22, 2016, in Seattle, to help bidders prepare proposals?**

Answer Q4: No, the slides will not be made available to potential offerors.

- 5. Question: Will IARPA QEO program include specifications that are purely commercial, or will ITAR-controlled specifications be included?**

Answer Q5: IARPA has no expectations regarding the U.S. export controls that will apply to the deliverables, technology, etc. that performers develop. Per the BAA Section 6.B.6., performers are responsible for compliance with U.S. export controls.

- 6. Question: Lincoln Labs currently has a large infrastructure suitable for many of the experimental targets of the BAA. To what extent may proposers rely on Lincoln Labs to build, site, and run testbeds, in particular beyond the Base Period?**

Answer Q6: Please see Amendment 1 which revises Appendix H, Available Government Quantum Annealing Capabilities and the Supporting TEF, to add LL Test Bed Facility capabilities.

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- 7. Question: While room temperature control electronics capabilities furnished by MIT Lincoln Laboratory are in operation at a performer site, may the performer work in concert with MIT Lincoln Laboratory to develop improvements to those capabilities?**

Answer Q7: No. However if the government discovers that improvements to capabilities may provide broad value to the program then the government may, at its discretion, take action to implement those improvements and make them available to all performers.

- 8. Question: Section 1.A.2 of the BAA calls out the fault diagnostic application first, then provides a list of four others. Does this imply that the fault diagnostics application is of highest interest among those five?**

Answer Q8: As communicated publicly since 2014, the IARPA QEO Study served in part to assess the plausibility of a wide range of advanced annealing capabilities to promote enhancement of solutions to application problems of interest. As a result of the QEO Study, and as had been communicated publicly at multiple scientific events and in related publications, some applications have been determined to have less potential for value-added solutions by quantum annealing, per the criteria set forth on page 8 of the BAA in Section 1.A.2. Applications of low interest and removed from consideration in the QEO Study include the design of k-SAT filters, and the Traveling Salesman Problem. Fault Diagnostics remains a high priority application of interest in QEO, as does Machine Learning, since they continue to appear favorable against criteria described in Section 1.A.2. of the BAA. The relative potential of enhanced solutions from QA for other applications such as Scheduling or Circuit Layout, may only be attributable to insufficient research to date, and as described in the BAA, IARPA has interest to discover for what applications and with what annealing capability quantum enhancement may be realized, providing substantial practical value beyond classical solutions.

- 9. Question: Section 1.A.2 of the BAA mentions that proposers can address more than one application problem, but it is not clear whether these may involve more than one applications-focus. Would it be within scope to propose to address more than one applications-focus?**

Answer Q9: Per Section 1.A.2. of the BAA, "Offerors may propose other applications beyond examples above to be included in their applications-focus..." Thus by the language in the BAA, the "applications-focus" of any proposal is at the discretion of the offeror, and includes all applications selected by the offeror.

- 10. Question: On page 15 of the BAA, in the last column (titled 'Month51 Test Bed 3') and row 4, the entry says '>20 for 2 spin couplings, >10 for 3&4 spin couplings', do both of these have to be demonstrated together, or is it one or the other?**

Answer Q10: In the specific case noted, the metrics are stipulated that where 2-spin couplings are employed, the corresponding connectivity metric is as noted. When both 2-spin and 3-spin

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coupling are employed, both corresponding metrics for connectivity are relevant. The proposed and demonstrated implementation of coupling degree determines the relevant metrics for connectivity. The connectivity metrics do not constrain Test Beds to possess both 2-spin and also 3 and or 4-spin couplings. Depending on the degree of coupling employed, connectivity has a corresponding metric. However, metrics for degree of coupling, as noted in the row immediately below metrics for connectivity, do require minimum complexity of coupling degree, and do admit the possibility that offerors propose a path of development for applications employing >2-spin coupling; in which case, the 2-spin connectivity metric does not apply. That the required minimum degree of coupling demonstrated by year 3 is noted as " ≥ 3 " does not preclude the offeror from implementing 2-spin coupling together with ≥ 3 -spin coupling. It only stipulates that the degree of coupling demonstrated employs at minimum the noted complexity in some fashion, if not entirely. Metrics were so constructed to ensure progressively complex architectures to explore the power of more complex coupling and connectivity relative to the state-of-art, but also to provide flexibility in how the top level architecture (AT) may employ a range of coupling and connectivity complexity to achieve the goals for specific applications.

- 11. Question: On page 15 of the BAA, the last row of the last column reads 'Adaptive by real time (in-run) system measurements'. Does this apply to the entire test bed system or only a part of it?**

Answer Q11: The BAA does not restrict, either on page 9 within Sections 1.A.3 or 1.A.4, or page 10 within Section 1.A.5.2, or within metrics or Waypoints, how adaptive annealing may be implemented; by employing select or all qubits. However, the importance of adaptive, intelligent annealing is made clearly evident as a significant metric for demonstration by year 4, and therefore unduly limited demonstration may cloud its full potential as an advantageous path to the program goal, and would conflict with BAA guidance on page 9 in Section 1.A.3: "Proposals must therefore describe how the offeror plans to develop designs and operation for application-scale quantum annealers when combined with classical resources and employing all plausible classical and quantum approaches providing the most advantageous path to the program goal."

- 12. Question: The first paragraph of page 12 says that the TEF will include unitary time evolution and open quantum systems simulations. What size system (i.e., number of qubits) can these simulations handle and are there restrictions on the type of unitaries (e.g. that they come from stoquastic Hamiltonians)?**

Answer Q12: In addition to description of the TEF in Section 1.A.6. of the BAA, including the planned GFI to be provided after contract start, Appendix H further states "The potential Capabilities include but are not limited to ... large-scale numerical simulation, database, and data analysis capabilities via the QEO test and evaluation framework (TEF). This appendix describes existing capabilities, and offerors should engage with corresponding organizations to fully assess details and how capabilities may be employed and further advanced to support the proposed approach. "

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- 13. Question: How involved can Lincoln Labs be in developing or co-developing an entire testbed for potential bidders? Can Lincoln Labs be included beyond providing architectural primitives as stated in the BAA?**

Answer Q13: Please see above responses to Q6 and Q7.