

U.S. ARMY RESEARCH OFFICE
BROAD AGENCY ANNOUNCEMENT FOR
QUANTUM COMPUTING in the SOLID STATE with SPIN
and SUPERCONDUCTING SYSTEMS (QC-S⁵)



W911NF-22-S-0006

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I. OVERVIEW OF THE FUNDING OPPORTUNITY:	4
A. Required Overview Content	4
1. Federal Agency Name(s):	4
2. Funding Opportunity Title: Quantum Computing in the Solid State with Spin and Superconducting Systems (QC-S ⁵).....	4
3. Announcement Type	4
4. Research Opportunity Number: W911NF-22-S-0006	4
5. Catalog of Federal Domestic Assistance (CFDA) Number:.....	4
6. Response Dates:.....	4
B. Additional Overview Information	4
II. DETAILED INFORMATION ABOUT THE FUNDING OPPORTUNITY	5
A. Funding Opportunity Description	5
A.1 Brief Topic Overviews.....	6
A.2 Detailed Topic Descriptions	7
A.2.1 Topic A: Modular Quantum Gates (ModQ).....	7
A.2.2 Topic B: Gates on Advanced qubits with Superior Performance (GASP)	11
A.2.3 Topic C: Fast Control And Readout Schemes (FastCARS)	14
A.2.4 Topic D: Noise in Solid-State Superconducting and Spin Systems (NS ⁵).....	20
B. Federal Award Information	25
C. Eligibility Information	27
1. Eligible Applicants:.....	27
2. Cost Sharing or Matching:	28
3. Federally Funded Research and Development Centers (FFRDCs):.....	28
D. Application and Submission Information	28
1. Address to View Broad Agency Announcement.....	28
2. Content and Form of Application Submission.....	28
3. Unique Entity Identifier and System for Award Management (SAM).....	40
4. Submission Dates and Times:.....	41
5. Intergovernmental Review	42
6. Funding Restrictions:	42
7. Other Submission Requirements:.....	43
E. Application Review Information:	43
1. Criteria:.....	43
2. Review and Selection Process:.....	44
3. Recipient Qualification	44
F. Award Administration Information:	47
1. Award Notices:.....	47
2. Administrative and National Policy Requirements:	47
3. Reporting:.....	54

G. Agency Contacts:..... 55

H. Other Information:..... 56

1. CONTRACT Proposals:..... 56

2. GRANT and COOPERATIVE AGREEMENT Proposals:..... 65

I. OVERVIEW OF THE FUNDING OPPORTUNITY:

A. Required Overview Content

1. Federal Agency Name(s):

U.S. Army Research Office

Issuing Acquisition Office:

U.S. Army Contracting Command-Aberdeen Proving Ground, Research Triangle Park Division (ACC-APG RTP Division)

2. Funding Opportunity Title: Quantum Computing in the Solid State with Spin and Superconducting Systems (QC-S⁵)

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5. Catalog of Federal Domestic Assistance (CFDA) Number:

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6. Response Dates:

White Papers: 4:00 PM Eastern Daylight Savings Time on: 15 July 2022

Proposals: 4:00 PM Eastern Daylight Savings Time on: 30 September 2022

See Section II. D. 4 for additional information.

B. Additional Overview Information

This Broad Agency Announcement (BAA) which sets forth research areas of interest to the Army Research Laboratory- Army Research Office (ARL-ARO) and the National Security Agency (NSA) is issued under paragraph 6.102(d)(2) of the Federal Acquisition Regulation (FAR), and 10 USC 2358 which provides for the competitive selection of basic research proposals. Proposals submitted in response to this BAA and selected for award are considered to be the result of full and open competition and in full compliance with the provision of Public Law 98-369, "The Competition in Contracting Act of 1984" and subsequent amendments.

The Department of Defense agencies involved in this program reserve the right to select for award; all, some, or none of the proposals submitted in response to this announcement. The participating DoD agencies will provide no funding for direct reimbursement of proposal development costs. Technical and cost proposals (or any other material) submitted in response to this BAA will not be returned. It is the policy of participating DoD agencies to treat all proposals

as sensitive, competitive information and to disclose their contents only for the purposes of evaluation.

II. DETAILED INFORMATION ABOUT THE FUNDING OPPORTUNITY

A. Funding Opportunity Description

The U.S. Army Research Office (ARO), in collaboration with the Laboratory for Physical Sciences (LPS), is soliciting proposals for research in four research topic areas in the field of gate-based Quantum Computing (QC) in the Solid State with Spin and Superconducting qubit Systems (QC-S⁵).

The topic areas are as follows:

- (A) Modular Quantum Gates (ModQ)
- (B) Gates on Advanced qubits with Superior Performance (GASP)
- (C) Fast control and readout schemes (FastCARS)
- (D) Noise in solid-state spin and superconducting systems (NS⁵)

Responses to these topics must address the circuit gate-based model of quantum computation (QC) and must be suitable for universal control in multi-qubit architectures. Topics A, C, and D require the use of high fidelity, multi-qubit devices, such as gate-defined SiGe or MOS quantum dots or high fidelity multi-qubit superconducting qubit devices to achieve their objectives. Such qubits can be available in-house by the proposing team, via collaborations funded as part of this BAA and/or sourced from a suitable proven qubit foundry. High fidelity refers to the demonstrated ability to implement state-of-the-art low error universal quantum gates and low error readout. Using such qubits, these topics explore novel control techniques (C), noise (D), and information distribution schemes (A).

In contrast, topic B focuses on new spin and superconducting qubits which have a demonstrated superior performance metric when compared to standard leading gate-based qubits. Superior may be defined in relation to a particular performance metric, without sacrificing other important performance metrics (e.g., T_1 , T_2 , valley splitting, environmental requirements, etc.). The goal of topic B is to develop high fidelity multi-qubit gate schemes for such qubits.

Following topics which fall outside this call and will not be considered for award:

- 1) Atomic and molecular systems (e.g., neutral atoms, trapped ions)
- 2) Optical photon-based QC
- 3) Systems without a path to universal 1 and 2 qubit gates
- 4) Immature qubits which have yet to demonstrate a superior performance metric in leading solid-state qubit approaches, without sacrificing performance in other metrics relevant to gate-based quantum computing
- 5) Quantum simulators or simulations

- 6) Quantum annealing, measurement-based QC or other non-gate-based QC approaches (exceptions may be granted for specific application areas, e.g. entanglement generation)

Multi-disciplinary teams are encouraged in response to each topic area. Examples of expertise which should be considered as part of each team includes theory, simulation, materials, fabrication and experimental.

Below each topic area is briefly introduced. Much more detail follows, with separate sections dedicated to each topic area.

A.1 Brief Topic Overviews

Topic A: The *Modular Quantum Gates (ModQ)* topic focuses on distributed quantum computing proof-of-concept demonstrations. For both Si-spin and superconducting qubit devices, the end goal of this topic is to demonstrate high fidelity and high speed two-qubit gates between separate quantum computing modules.

Topic B: The *Gates on Advanced qubits with Superior Performance (GASP)* topic aims to develop quantum gate protocols optimized for recently demonstrated, potentially superior, qubit approaches in both superconducting and leading semiconductor-spin systems. Superiority can be quantified in several ways such as longer lifetimes, less sensitivity to noise, ease of fabrication, relaxed environmental requirements etc. Superior performance on a particular metric must be achieved without sacrificing performance on other qubit metrics. The focus will be on high fidelity 1 & 2 qubit gates and readout for such promising new qubit designs.

Topic C: The *Fast Control And Readout Schemes (FastCARS)* topic is focused on novel qubit control and readout schemes. In particular, this topic addresses concepts for implementing closed loop control feedback for quantum operations, stabilization of quantum operation calibration against on-chip fluctuations through classical or autonomous mechanisms, quantization of control signal amplitude, or improved or novel readout schemes. Proposals must target a qubit system with a demonstrated universal gate set, well-understood two qubit gate operations, and with sufficient scale to understand the limitations imposed by multi-qubit operations.

Topic D: *Noise in Solid-State Superconducting and Spin qubit Systems (NS⁵)*. The objective of the NS⁵ program is to improve qubit gate fidelities by finding techniques, materials and processes that substantially and consistently reduce noise in at least one of solid-state superconducting and spin systems. There are five subject areas of interest. The first subject area relates to reducing externally induced thermal noise that causes excess qubit excitation and decoherence. The second subject area is focused on reducing noise generated by materials causing excess qubit excitation and decoherence. The third subject area uses multiple qubit correlated noise to learn more about noise sources. The fourth subject is very similar to the third, but uses qubit sensors in combination with alternate environment sensors to learn more about

noise sources. The final subject area concerns the injection of well characterized artificial noise and the correlation of that injected noise with qubit performance.

More detail on each of these topic areas is provided below.

Teams may submit to multiple topic areas, with the primary topic of focus identified and a full description of any leveraging across topics included.

A.2 Detailed Topic Descriptions

A.2.1 Topic A: Modular Quantum Gates (ModQ)

This topic aims to demonstrate high-fidelity gates between spatially separated solid-state qubit technologies in a distributed, or modular, network. Modular quantum computing is based on the concept of small, high-fidelity, reproducible nodes, linked together in a larger distributed quantum information network. Module-to-module interactions are typically slower and lower quality when compared with intra-module interactions. There are currently many different approaches aimed at realizing these links such as transduction to flying qubits, coupling to specialized communication qubits, measurement-based entanglement, phonon coupling, quantum state transfer, spin shuttling or waveguide coupling. Superconducting qubit technology is highly amenable to long-distance transduction schemes. Thus, there are many examples in the literature of entanglement generation over long distances, even between separate packages, albeit to-date with fidelities much lower than intra-chip gates. In contrast, spin qubits built from Si-heterostructures have interactions which are typically limited to very local qubit-qubit separations by the exchange interaction. There has been some recent pioneering work aimed at enabling long distance interactions via coupling to microwave photons, surface acoustic waves or spin shuttling.

The goal of this topic is to explore such distributed quantum information schemes for both spin and superconducting technologies. Initially the focus will be on demonstrating 2-qubit gates between distant qubits, perhaps on the same chip, with spacing \gg characteristic qubit sizes. By program end, the program target is to demonstrate high speed and high fidelity 2-qubit gates between distant modules.

ModQ is a four-year program and is broken-up into two phases, each 2 years in length.

1. Phase I: Proof-of-concept long-distance intra-module 2-qubit gates:

Phase I is focused on demonstrating the basic physics of the remote coupling scheme. This demo can be implemented on the same chip, or within the same module, but the qubits involved in the gate must have a separation \gg the typical qubit size-scale. The fidelity of the entanglement generation operation must be characterized, and the major

sources of error tabulated. Finally, experimental results should inform plans for demonstrating 2-qubit gates between separate chips or modules in phase II.

Note, some long-distance gate schemes inherently involve coupling off-chip, e.g., microwave-to-optical transduction via mechanical resonators. For such cases, phase I should focus on demonstrating bi-directional transfer at the fidelities and rates required for the phase II demo.

Each team should propose quantitative milestones relevant to their approach for each year-end, with an emphasis on the end-of-phase milestones. These milestones should support the program goals.

While proposing teams are free to propose yearly goals relevant to their approach and maturity-level, guidance on yearly goals of phase I include:

a. Year 1 goals:

1. Proof-of-concept demonstration of intra-module remote entanglement scheme (low fidelity, low rates). Demonstration must be chosen to inform long-term approach to remote qubit entanglement. Two qubits are minimally required for this demonstration and/or a demonstration of high fidelity and high rate bi-directional transduction to flying qubits.
2. Characterization of dominant error sources in entangled state generation.
3. Begin planning inter-module remote entanglement generation scheme and detailing of expected challenges, limitations and additional technology development needed.

b. Year 2 goals:

1. Reduction of error sources and demonstration of high-fidelity intra-module remote entanglement schemes. Nominally, each group of separated qubits should have 2 or more qubits with a universal gate set and readout.
2. Demonstration of a basic quantum algorithm utilizing both groups of qubits and comparison with performance either expected from qubit characterization or simulated within a single module.
3. Deliver end-of-phase report: Refine plan detailing inter-module remote entanglement generation scheme and prediction of performance based on phase I proof-of-concept demonstrations, characterizations and simulations.

Teams focused on approaches that are already more advanced (e.g., already have a proof-of-concept demo of remote entanglement generation scheme) may skip year 1 and propose suitable new year 2 goals.

The algorithm proposed in year 2 should be chosen to gain insight into the effects of multiple ‘weak-spots’ in the qubit array, i.e., the goal is to understand if the module-to-module links are ‘bottle-necks’ or the dominant source of performance limitations in algorithm performance. The primary purpose of this algorithm task is to perform a rigorous test of the device. Hence, demonstration of an algorithm with practical application isn’t the focus, but algorithms designed to push the limits of the qubit array. For example, such algorithms may even consist of a random sequence of gates. The proposal should motivate the choice of algorithm and estimate the effects of the remote entanglement generation metrics on the algorithm output.

2. Phase II: Demonstration of high-fidelity inter-module 2-qubit gates:

Phase II is focused on taking the basic physics demos from phase I and implementing the remote-entanglement plan from end-of-year-2. This demo must be between two or more modules, with a universal set of 1 and 2 qubit gates and readout in each module (i.e., min of 2 qubits in each module). The fidelity of the entanglement generation operation must be characterized, and the major sources of error tabulated. Finally, entanglement generation between modules must be used either directly to perform 2-qubit gates between modules or used for teleported 2-qubit gates between qubits not involved in the inter-module communications.

Note, while some long-distance gate schemes inherently involve exiting to room temperature after transduction to flying qubits (e.g., microwave-to-optical transduction), only a single cryostat is required for the ModQ program. No cryostat-to-cryostat communications are required. Modules (or chips) maybe housed in the same cryogenic package, or within separate packages in the same cryostat.

Results from phase II demonstrations will be used to inform a scheme for arraying multiple modules, to be delivered in the final year of the program. While only two-module demonstrations are required in ModQ, three-module communication maybe a suitable goal for the more advanced approaches (e.g., those that skipped year 1 goals).

Each team should propose quantitative milestones relevant to their approach for each year-end, with an emphasis on the end-of-phase milestones. These milestones should support the program goals.

Specific guidance on goals of phase-II is:

c. Year 3 goals:

1. Proof-of-concept demonstration of inter-module remote entanglement scheme (low fidelity, low rates).
2. Characterization of dominant error sources in entangled state generation

3. Initial designs/plans for 3-10 modules and identification of any gate modifications required or any supporting technology developments required.

d. Year 4 goals:

1. Reduction of error sources and demonstration of high-fidelity remote entanglement schemes (inter-module). Each module must have 2 or more qubits with a universal gate-set.
2. Demonstration of a basic inter-module algorithm (from phase I) and comparison with performance from phase I proof-of-concept demonstrations.
3. Deliver end-of-phase report: Refine plan detailing multi-module (3-10 modules) remote entanglement generation scheme and prediction of performance based on proof-of-concept demonstrations

Teams focused on approaches that are already more advanced (e.g., already have a proof-of-concept demo of remote entanglement generation scheme) may propose more advanced year 4 goals such as implementation of a distributed network of 3 or more modules.

White papers and proposals should provide quantitative metrics for gate fidelities, gate speeds for each year and should detail algorithms, supporting technology development, or other demos to be demonstrated.

Possible approaches to meet program goals include (but not limited to):

1. Resonant microwave photon coupling
2. Phonon-mediated transduction, e.g., surface acoustic wave
3. Measurement-induced entanglement
4. Waveguide coupling
5. Hybrid schemes with entanglement generation via specialized communication qubit, e.g., hole spin or charge qubit
6. Continuously driven entanglement generation schemes
7. Quantum-state-transfer
8. Spin shuttling
9. Transduction to flying qubit via quantum intermediary, e.g., mechanical resonators, atomic or atomic-like element
10. Transduction to flying qubit via resonant electro-optics

Approaches outside the scope of this topic and will not be considered for award:

1. Qubit technologies without prior demonstrations of multi-qubit “modules” with high fidelity 1-qubit gates, 2-qubit gates and readout.
2. Schemes with only classical communication between modules
3. Modules only focused on I/O
4. Long-distance communication schemes limited to intra-module implementation

A.2.2 Topic B: Gates on Advanced qubits with Superior Performance (GASP)

The Gates on Advanced qubits with Superior Performance (GASP) topic aims to advance new promising and potentially superior qubit approaches beyond basic demonstrations, and focus on high fidelity gate operations. Well-studied, standard qubit approaches are now the mainstay of modern commercial and academic quantum computing efforts. For example, transmon qubits are the workhorse for many online cloud quantum computing services. Thus, such systems are becoming highly optimized and reproducible as part of these offerings. However, these qubits can only be pushed so far. Again, for example, transmon qubits can be limited by dielectric losses due to surfaces or two-level systems. Similarly, electron-spin encodings in SiGe or MOS devices can be limited by charge noise or uncontrolled valley-splitting.

Alternatively, new qubit designs are currently being explored by many research groups which promise to overcome these limitations, and thus potentially offer superior performance. For example, hole spins in Ge quantum wells can offer qubits without valley states, a low effective mass enabling simplified fabrication and low disorder for reproducible fabrication. Such superior properties can be potentially attained without sacrificing other important metrics such as nuclear spin noise, spurious energy levels, and detrimental charge noise levels. Up to 4-hole-spin qubit devices have been demonstrated to date. Similarly, bosonic encodings in superconducting cavities are actively being explored as alternatives to transmon qubits. Such encodings can have inherent error correction capabilities and can benefit from high quality factor resonant modes. These advantages can be attained without sacrificing other important properties such as immunity to charge noise and high-fidelity readout.

Gate fidelity is the key metric of the GASP program. Superior performance demonstrations such as reduced valley splitting or enhanced qubit coherence are insufficient without corresponding demonstrations of state-of-the-art gate and readout fidelities. For example, transmon 1-qubit gate fidelities regularly perform beyond 99.9%, while 2-qubit performance is fast approaching 99.9%. Spin qubits in silicon also have single qubit fidelities demonstrations beyond 99.9% and recent 2-qubit demos are already exceeding 99%. The overarching goal of GASP is to demonstrate gate fidelities reaching and/or exceeding these state-of-the-art results in a 4-qubit device architecture, but using advanced qubit approaches.

Proposal submissions to the GASP program may pursue a qubit approach that has been demoed in the literature, but not yet demoed by the proposing team. However, the team must show basic T_1 , T_2^* , and T_2 performance within the first year of the program, coupled with a demonstration of the desired superior property, e.g., insensitivity to valley splitting, longer lifetimes, reduced sensitivity to noise, reduced environmental requirements, etc. Proposals must use published or unpublished results to clearly support and articulate promised performance levels beyond standard qubit approaches. This proof may rely on theoretical analyses; backed up by compelling experimental evidence.

GASP is a four-year program and is broken-up into two phases, each 2 years in length:

1. Phase I: High fidelity 1-qubit gates and readout:

Phase I is focused on demonstrating basic qubit performance and high fidelity 1-qubit gates, including readout. Limitations on gate performance shall be carefully characterized using an appropriate characterization method and predictions for 2-qubit gates derived. The characterization methods to be implemented should be described clearly in the proposal. The landscape for various types of 2-qubit gates shall be theoretically explored and the leading candidates chosen for exploration during phase II.

Each team should propose quantitative milestones relevant to their approach for each year-end, with an emphasis on the end-of-phase milestones. These milestones should support the program goals.

Guidance for goals of phase I are:

Year 1 goals:

1. Coherence times (T_1 , T_2^* , T_2) basic demo coupled with a demonstration of the superior property of the chosen qubit approach
2. Initial demonstration of universal 1-qubit gates and readout
3. Careful characterization of limiting noise sources
4. Theoretically compare various approaches to 2-qubit gate implementations
5. Develop designs for a device with up to 4 coupled qubits

Year 2 goals:

1. Coherence time (T_1 , T_2^* , T_2) enhancement via elimination of dominating noise sources and/or design or control enhancements
2. Demonstration of 1-qubit gates and readout gate fidelities approaching or surpassing traditional qubit approaches and demonstration of reproducibility on 3 or more devices
3. Re-design if necessary
4. Fabricate initial 2-qubit gate phase II devices with up to 4 coupled qubits
5. Deliver end-of-phase report: Update of 2-qubit gate performance predictions based on 1-qubit characterizations and simulations

Teams focused on approaches that are already more advanced (e.g., already have basic gate schemes) may propose more ambitious yearly goals.

2. Phase II: Demonstrations of high-fidelity 2-qubit gates:

Phase II is focused on maintaining 1-qubit gate and readout performance in at least a 4-qubit device while approaching or exceeding state-of-the-art 2-qubit gate performance.

Year 3 will focus on initial 2-qubit demonstrations to inform optimum design for year 4. Ideally multiple 2-qubit gate protocols shall be explored and compared for optimum performance levels.

Results from phase II demonstrations will be used to inform a scheme for arraying to a 10-qubit device and results will inform predictions on performance levels.

Guidance for goals of phase II is:

Year 3 goals:

1. Demo initial 2-qubit gate types in device with up to 4 coupled qubits
2. Characterize dominant error sources in gate implementation using appropriate tomographic techniques
3. Re-design if necessary and begin design and simulation of 10-qubit processor

Year 4 goals:

1. Reduce error sources and demonstrate high fidelity 2-qubit gates. Devices must be capable of high fidelity 1-qubit gates, 2-qubit gates and readout. Goal is to reach or surpass gate and readout fidelities of traditional qubit approaches while simultaneously maintaining the qubits superior performance metric
2. Understand issues such as crosstalk and correlated noise
3. Compare performance of gates, noise limitations and control complexity to traditional qubit approaches
4. Deliver end-of-phase report: Finalize designs and simulations of a 10-qubit processor using this new approach or a modified plan based on experimental feedback. Include discussions of any identified research gaps and future possible novel research directions

Teams focused on approaches that are already more advanced (e.g., already have single qubit gates on single qubit devices) may propose more advanced year 4 goals such as the demonstration of basic quantum algorithms on a multi-qubit device.

Each team should propose quantitative milestones relevant to their approach for each year-end, with an emphasis on the end-of-phase milestones. These milestones should support the program goals.

White papers and proposals should provide quantitative metrics for gate fidelities, gate speeds for each year and should detail algorithms or other demos to be demonstrated.

Possible approaches to meet program goals include (but are not limited to):

1. Bosonic encodings in resonant cavities

2. Hole-spin encodings
3. High spin nuclear dopants in Si
4. Fluxonium qubits, or other protected qubit designs
5. Hybrid electron/donor/hole-spin devices
6. Driven, autonomous and/or dissipative systems
7. Hybrid spin-superconducting devices

Approaches outside the scope of this topic and will not be considered for award:

1. Gate optimization using standard well understood qubit designs, e.g., transmon qubits, 1-3 electron spin encodings in SiGe or MOS
2. Qubits which are still exploratory in nature, i.e., qubits with no demonstrations to support claims of improved/superior performance (e.g., qubits based on 2D materials, Majorana Fermion)
3. Qubit approaches without a clear path to scaling to multi-qubit devices with universal gate sets

A.2.3 Topic C: Fast Control And Readout Schemes (FastCARS)

Systems with high accuracy and repeatability often incorporate precision control feedback loops, either open loop using periodic re-calibration of processes, or closed loop. In this context closed loop refers to online continuously updated control processes requiring no user interaction, while open loop refers to using stored, user estimated, or periodically updated control parameters. Coherent single-quanta systems such as qubits pose challenging constraints that stymie many classical closed-loop feedback methods, leading to open loop schemes [Khaneja2005, Teske2019, Harper2020]. Nevertheless, innovative approaches to feedback exist which exploit either the semi-classical nature of the control fields themselves [Nakajima2021] or which engineer truly quantum mechanical and coherent feedback loops using auxiliary quantum systems or coherent probe fields [Kerckhoff2010, Kapit2016, Gross2021].

All approaches to control signal feedback require fast and accurate readout of very small analog signals such as single RF photons, single electron movements, or single flux quanta. The very small signal levels and challenging amplification chain requirements make state readout one of the most expensive quantum operations, leading many calibration and benchmarking protocols to specifically minimize the number of measurements [Knill2008, Nielsen2020] or to use machine learning approaches to reduce measurement overhead [Seif2018]. Readout times which are a sizeable fraction of the inhomogeneous coherence time of idle qubits pose a significant challenge to state stabilization through parity checking. Finally, many existing readout schemes require considerable chip and refrigerator cold plate area, and have significant wiring and power loads, limiting their implementation on multi-qubit devices.

The FastCARS topic, calls for proposals to address concepts for implementing closed loop control feedback for quantum operations, stabilization of quantum operation calibration against on-chip fluctuations through classical or autonomous mechanisms, quantization of control signal amplitude, or improved or novel readout schemes. Proposals may either be purely theoretical or contain both experimental and theoretical work. Proposals must target a qubit system with a demonstrated universal gate set, well-understood two qubit gate operations, and with sufficient scale to understand the limitations imposed by multi-qubit operations. Proposals must place the proposed work in its proper context by citing related experimental and theoretical results. Proposals need not address all research areas in this topic, though we welcome those which incorporate multiple areas.

FastCARS Research Area 1: Feedback for calibration, drift control, and stabilization

As qubit and quantum control experiments increase in scale, complexity, and time, sources of drift in either qubit parameters or control signals can dominate observed errors in benchmarking, tomography, or even the outcomes of long sequences of quantum gates. Hence, such systems would benefit from efficient and autonomous routines for drift or error control. Drift may arise from intrinsic mechanisms such as changes in the microscopic charge or magnetic environment experienced by the qubits, or extrinsic mechanisms such as temperature fluctuations or uncompensated changes in control signals.

Multiple approaches exist to address lower frequency qubit error terms, normally by implementing some form of feedback either to control signals or other qubit tuning parameters such as flux bias lines or gate electrode voltages, corrected or insensitive quantum gates, and optimal control. Ancillary quantum systems near the qubit could experience a similar local environment or control signals, and form part of a classical or quantum coherent feedback loop. Error terms arising from white noise or high frequency mechanisms may need reduction through improvements in materials, fabrication processes, or protected encodings, which are outside the scope of this research area.

For this research area, we seek novel proposals to stabilize quantum operations by implementing forms of closed-loop feedback and stabilization, either through classical feedback loops or adding autonomous quantum feedback loops. The ideal feedback/stabilization technique does not measure or project the quantum state of the qubit or cause additional decoherence directly through measurement backaction, which may imply the use of an auxiliary quantum system or sensor coupled to or nearby the qubit. We particularly focus on three related areas:

1. In-situ calibration or compensation of control signals at a point very near the qubits
2. Sensing the local qubit environment and compensating for fluctuations by adjusting control fields

3. Autonomous quantum feedback, directly implementing corrections to errors such as leakage through the action of auxiliary quantum systems or coherent probe fields without classical feedback loops

Proposal structure:

Proposals are sought for four years of work addressing the goals of this research area. Proposals must describe the approach to adding feedback, the types of fluctuations or drift to be compensated for, estimates of the bandwidth that may be practically achieved, and any limitations this approach places on single and two qubit gates. Key metrics for understanding the successful implementation feedback should be proposed. Proposers must include yearly milestones with sufficient detail to understand how the work relates to the goals of this research area, and be specific enough to assess the likelihood of success.

FastCARS Research Area 2: Readout

Fast, accurate, and scalable readout of qubit states is one of the key requirements of any future quantum computer. Readout must be faster than the dynamical processes being studied directly. Furthermore, fast high-fidelity readout is required for standard quantum error correction codes and any readout approach must be scalable to handle large qubit arrays and the resulting crosstalk complexity.

For superconducting qubits, the research community has largely coalesced around dispersive readout with a cavity, in conjunction with a quantum limited amplifier. For semiconducting qubits, it was recently demonstrated that readout could be done in the same manner [Borjans2021]. This is in addition to two other well-established semiconductor qubit readout methods [Elzerman2004, Barthel2010], both of which involve the readout of charge in a quantum dot. It is presently unclear which readout method for semiconductor qubits will scale favorably and remain suitable for closed loop feedback. In addition to the methods mentioned above, there are several other readout approaches currently under investigation, including optical readout [Gehl2017, Lecoq2021] and quantum flux parametrons [Grover2020]. There are several approaches to improving readout in superconducting and semiconducting platforms. Examples include improvements of the amplification chain, engineering of the single-electron transistor or cavity, machine-learning assisted readout and multiplexing. Improvement in readout that may arise from the qubit fabrication process or material considerations is beyond the scope of this research area.

For this research area, we seek novel proposals on improving the readout of qubits in superconducting and semiconducting quantum computing platforms. We particularly seek proposals which focus on the following areas:

1. In-situ improvement of readout methods and amplification chain
2. Reducing or accounting for measurement backaction
3. Novel approaches to readout. Examples include, but are not limited to, optical readout

The ideal proposal addresses speed, fidelity and scalability of readout in tandem and has minimal backaction.

Proposal structure:

Proposals are sought for four years of work addressing the goals of this research area. Proposals must describe the readout method and why it is expected to out-perform current readout methods. This must include realistically achievable estimates for readout metrics, i.e. signal-to-noise ratio, bandwidth, and fidelity, and a discussion on the scalability of the proposed method to ten qubits. We welcome proposals that address simultaneous readout of qubits. Proposals involving dispersive readout in semiconducting systems should incorporate best practices from readout of superconducting qubits when appropriate. Proposers must include yearly milestones with sufficient detail to understand how the work relates to the goals of this research area, and be specific enough to assess the likelihood of success.

FastCARS Research Area 3: Qubit Control

In superconducting and semiconducting quantum computing platforms, typically coaxial cables deliver classical (i.e., mean field) signals from signal generators that are kept at room temperature. At a scale dependent on qubit and control signal type, this method becomes impracticable due to the size of the coaxial cables and the heat load the coaxial cables place on the cryostat. Electrical non-idealities due to factors such as thermalization impact control of the amplitude and phase of these classical signals, which introduces additional control errors on top of intrinsic qubit relaxation or decoherence. Taken together, these issues place potential roadblocks on the development of quantum computers. Investigations into possible solutions are still in the beginning stages, and the practical limits of each technique to reduce qubit control error are unclear.

To overcome these challenges, this research area seeks novel proposals on improving qubit control in superconducting and semiconducting quantum computing platforms in the following two areas:

1. Delivery of qubit control signals via optical elements, with or without conversion to electrical signals in-situ
2. Control signals at the quantum limit, which improve the fidelity of control signals through quantization (e.g. counted control quanta such as photons, flux quanta, electrons, etc.)

Optical signal delivery has the potential to enable multiplexing of high bandwidth signals with minimal thermal leakage and enable single point cold grounding schemes. A proof-of-concept experiment illustrating this approach was recently achieved [Lecocq2021]. Challenges to implementing optical signal delivery include efficient

signal conversion to voltage or RF pulses, stable optical alignment inside cryostats, proper functioning of active optical elements such as diodes or interferometers at cryogenic temperatures, and strict power limits. Proposals are sought which address these and other challenges, particularly those proposals which include coherent control of qubits using control signals delivered optically. Proposals for optical readout (either directly or using driven optical modulators) should focus on research area 2.

Control signals at the quantum limit may improve qubit control error by suppressing small fluctuations in signal amplitude, though this may lead to additional constraints on control signal duration and timing. Classical implementations of this concept already exist, such as magnetic flux logic and single electron transistor logic. Challenges to this approach include very small signal levels (and hence slower operations more prone to other decoherence mechanisms), generating and counting signal quanta, and reducing control signal dissipation mechanisms not relevant for large signal levels. Generating these control signals likely must take place inside the cryostat or even on chip with the qubits. Proposals are sought which address these and other challenges, particularly those proposals which include coherent control of qubits using such a mechanism.

Proposal structure:

Proposals may either be purely theoretical or contain both experimental and theoretical work. Proposals must describe the control method and why it is expected to out-perform current methods. This includes realistically achievable estimates for footprint and power use, improvements in control fidelity, and a discussion on possible noise introduced by the new control method. Proposals should be implementable with commonly available tools and equipment. Proposals must place the proposed work in its proper context by citing related experimental and theoretical results. Experimental implementations should be proposed to be implemented on a relatively well-understood qubit system. Proposals are sought for three years of work, with the option of extending successful proposals for an additional year. Proposers must include yearly milestones with sufficient detail to understand how the work relates to the goals of this research area, and be specific enough to assess the likelihood of success.

Approaches outside the scope of this topic and will not be considered for award:

1. Open-loop control improvements such as compensated gates, dynamically corrected gates, or optimal control
2. Quantum error correction or state stabilization through parity checking
3. Improvements in coaxial cables
4. Dynamically corrected gates
5. Replacing coaxial cables with superconducting ribbons
6. Cryogenic electronics such as AWGs, though smaller active or passive primarily analog circuits may be included in proposals.
7. Improving automated inversion kernels for pulse predistortion

Citations:

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[Gehl2017] Gehl, Michael et al., Operation of high-speed silicon photonic micro-disk modulators at cryogenic temperatures, *Optica* 4, 374 (2017).

[Seif2018] Seif, Alireza et al., Machine learning assisted readout of trapped-ion qubits, *J. Phys. B: At. Mol. Opt. Phys.* 51, 174006 (2018).

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[Harper2020] Harper, Robin et al., Efficient learning of quantum noise, *Nature Physics* 16, 1184 (2020).

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[Gross2021] Gross, Jonathan et al., Hardware-efficient error-correcting codes for large nuclear spins, arXiv:2103.08548 (2021).

[Borjans2021] Borjans, Felix et al., Spin digitizer for high-fidelity readout of a cavity-coupled silicon triple quantum dot, arXiv: 2104.03862 (2021).

[Lecocq2021] Lecocq, F. et al., Control and readout of a superconducting qubit using a photonic link, Nature 591, 575 (2021).

A.2.4 Topic D: Noise in Solid-State Superconducting and Spin Systems (NS⁵)

The Objective of the Noise in Solid-State Superconducting and Spin Systems (NS⁵) program is to improve qubit gate fidelities by finding techniques, materials and processes that substantially and consistently reduce noise in at least one of the Solid-State Superconducting and Spin Systems. To achieve the above objective requires that the noise sources are understood and characterized. Superconducting and spin qubits are reaching new levels of performance due to a combination of novel device design, material optimization and noise reduction. As a result, superconducting qubits are now regularly exceeding 100 micro-seconds lifetimes and coherence times while spin qubits in Si-based heterostructures regularly reach 99.9% 1-qubit gate fidelities. At this level of performance, it is time to re-examine noise sources and the effects of noise sources on qubit performance to shed light on issues which may have been previously hidden by poor qubit performance levels. Further, although there is still likely much more noise immunity to be gained by qubit design, progress can also be made with all designs by reducing the underlying noise. Thus, tackling the noise head-on may be highly beneficial.

Solid-state superconducting and spin qubit systems are highly sensitive to external perturbations. Hence careful filtering, shielding and device design needs to be considered when developing high performance qubit experiments. Furthermore, comparisons between both systems often reveal common noise issues such as charge noise and noise on control lines. The goal of this topic is to characterize deleterious noise sources, develop methods for reducing these noise levels and demonstrating resulting enhanced qubit performance levels. Scope includes both time and space variation of the qubit environment.

This topic has 5 specific research areas: excess thermal noise, noise due to materials making up the qubit devices, correlated noise, local sensors, and precisely controlled artificial noise sources. Teams proposing to these topics should include sufficient expertise for both device and noise theory and modelling as well as design, fab and test.

In each research area, 4-year proposals are sought and each proposal must provide well-defined quantitative metrics for each year-end with most detail expected for the first 2 years of the proposal. In most of the focus areas below, we provide general guidance on the minimum yearly expectations of proposals. Proposals may choose more aggressive or parallel paths if deemed appropriate by the proposing team. Further, combinations of more than one of the research areas are also acceptable as long as the proposal is clear regarding how separate objectives for each separate research area will be delivered. An example is the combination of research areas 4 and 5 as detailed in research area 5 below.

NS⁵ Research Area 1: Externally induced-thermal noise causing excess qubit excitation and decoherence

Solid-state qubit devices are often limited by the anomalous temperatures of baths of particles around the qubits. These baths of particles appear to be elevated compared to the measured temperature of the dilution fridge standard-thermometry, with possibly non-thermal distributions. Understanding these effects, mitigating them, and showing benefits to qubit performance would be highly impactful to the field. Prototypical examples include excess quasiparticles in superconducting films and anomalous electron bath temperatures in solid-state qubits. Proposals to this focus area need to specify and model the effect addressed, outline experiments to understand the cause of the anomalous temperatures and propose ideas for mitigation that are testable. Examples of potential causes of anomalous temperatures may include coupling to external sources of energy such as IR radiation in the qubit environment, energy due to insufficient filtering on I/O lines, coupling to sources of mechanical vibration, other electromagnetic radiation from outside the fridge or ionizing radiation.

Guidance for yearly goals:

Year 1 goals:

1. Show a reliable means to measure the temperature of the anomalous excitations selected and that this is an accurate measure of their temperature. Show how this anomalous bath correlates with the mixing chamber temperature of the fridge.
2. Perform theory and modelling of the sources of this excess noise and its effect on qubit performance
3. Begin design of experiment for elucidating sources of “excess energy”

Year 2 goals:

1. Refine models for sources of “excess” energy in the selected bath and on its effect on qubit performance
2. Implement experiments aimed at discovering these sources

Year 3 and 4 goals:

1. Demonstrate methods, supported by appropriate modelling, to reduce the temperature of the selected bath and demonstrate the effect on qubit performance.

NS⁵ Research Area 2: Material noise causing excess qubit excitation and decoherence

Examples of particular interest include dielectric loss, charge noise, two level systems/two level fluctuating states, or spin and/or magnetic noise. Much beautiful physics has been carried out in this area on characterizing such noise, but this focus area aims to characterize the noise of interest while varying either the specific materials involved, their deposition techniques and parameters or material and/or surface preparation techniques. For these reasons we expect proposals in this space to be specific regarding the particular system in which this kind of noise is to be addressed and to quantitatively motivate rational for at least a first set of materials or process steps to be explored. Furthermore, such proposals must include a description of how experiments performed will separate out the effects of material or process changes from other less well controlled effects in the system. Ultimately, even proven null results are as valuable as proven positive improvements in qubit performance. While precision control of large qubit arrays is not a focus on this topic area, work is encouraged on developing efficient measurement techniques on multi-qubit arrays (perhaps uncoupled) in order to gather sufficient statistics on the effect of changes in the qubit materials, deposition techniques and/or preparation techniques.

A subject of particular interest is spectroscopy of material with semiconductor devices. Spectroscopy with superconducting devices is well known, producing beautiful plots of, for example, local TLS systems. We are interested in proposals to enable similar studies to be carried out in semiconductor systems.

Guidance for yearly goals:

Year 1 goals:

1. Set up and demonstrate controlled deposition and/or novel preparation techniques of the selected material. Show that the properties and the nature of the material and/or interfaces can be manipulated in controllable ways.
2. Begin work on theory and modelling of how chosen material properties may affect qubit performance
3. Design and build-up efficient measurement techniques aimed at acquiring sufficient statistics on the qubit property of interest.

Year 2 goals:

1. Demonstrate and characterize qubits made with the selected materials and compare with theoretical models

Year 3 goals:

1. Demonstrate the correlations between the noise and the selected material with changes to materials, deposition techniques and or preparation techniques

Year 4 goals:

1. Search for conditions that minimize identified noise and compare results to theoretical modelling.

NS⁵ Research Area 3: Multiple qubit correlated noise

Recently the use of simultaneous qubit measurement on multiple qubits has been used to tease out the noise effects of ionizing radiation on superconducting qubits (see, for example, <https://arxiv.org/abs/2104.05219> , *Resolving catastrophic error bursts from cosmic rays in large arrays of superconducting qubits. (2021)*). This research area focuses on proposals that use similar techniques to examine noise from other sources. Proposal scope can vary from arrays of similar qubits or arrays of quite different qubits even to the extent of a chip with both superconducting and semiconducting qubits. Furthermore, arrays of similar qubits that are coupled to structures designed to couple with noise phenomena in different ways are also of interest. Important for such proposals is a clear explanation of how any particular array proposed might inform us about noise sources that cannot be determined using a single qubit. Proposals need to explain how measurements will be done to capture the expected bandwidth, spatial and temporal, and signal level of the noise that the array is looking for. As in the previous research area, precision control of large qubit arrays is not a focus for this research area. However, if the correlated noise of interest could be introduced by qubit-qubit coupling circuits, such work will be considered if properly motivated.

Guidance for yearly goals:

Years 1 and 2 goals:

1. Fabricate arrays of selected qubits and set up the equipment required to measure the qubits in the arrays simultaneously at the bandwidth and signal to noise required to examine the noise of interest.
2. Alternatively, or in parallel, develop auxiliary techniques, perhaps using supplementary in-situ sensors (see research area 4) or artificial noise sources (see research area 5), to independently verify sources of correlated noise.
3. Begin collecting statistically significant amount of noise data.

Years 3 and 4 goals:

1. Continue to use the qubit arrays and/or auxiliary techniques to collect statistically significant amounts of noise data.

2. Analyze the data to determine the correlated and uncorrelated noise and further determine as much as possible about, for example, the spectrum of the noise, the source of the noise etc.
3. Develop and implement noise mitigation techniques aimed at reducing identified correlated noise sources

NS⁵ Research Area 4: Qubit sensors in combination with alternate environment sensors

Research area 4 seeks proposals for systems with a combination of qubits with sensors in close proximity. Such combinations may be able to identify noise sources that qubits alone cannot and may allow qubit fluctuations to be linked with noise sources such as magnetic fields, mechanical vibration and charge. Proposals must provide a clear description of the proposed sensor qubit combination and why such a combination will inform us about noise sources that cannot be determined using qubits optimized for quantum computing alone. Proposals must also describe the measurements techniques involved and the expected bandwidth, spatial and temporal, and signal level of the targeted noise that the combination is looking for.

Guidance for yearly goals:

Years 1 and 2 goals:

1. Fabricate selected qubits with selected environmental sensors and set up the equipment required to measure the qubits and environmental sensor simultaneously at the required bandwidth and signal to noise
2. Begin measurements of environmental noise and compare with modelling expectations on qubit performance levels

Years 3 and 4 goals:

1. Use the selected qubits with environmental sensors and measurement equipment to collect statistically significant amounts of noise data
2. Analyze the data to determine the noise correlation between the qubit and elected alternate environment sensor
3. Using this information, produce a spectral plot of the response of the qubit to the noise detected by selected alternate environment sensor and further determine as much as possible about the spectrum of the noise, the source of the noise, it's spatial properties etc.
4. Explore the possibility of using data from the sensor to actively (in real-time) or passively (sensor data may point to qubit and or I/O improvements) reduce the noise level affecting qubit performance. Characterize improved qubit performance levels.

NS⁵ Research Area 5: Injection of well characterized artificial noise

In general, qubit systems suffer from multiple noise sources simultaneously so it may be difficult to separate the effects from each source. To address this issue, one may deliberately generate a particular noise source to overwhelm other noise sources affecting the qubits. Alternatively, auto correlation with a modulated artificial noise source could be used to separate out the effects of that particular source on the qubits. This research area seeks such proposals, in particular if combined with an alternate environment sensor as in part 4 above. Such environmental sensors would preferably be calibrated and close to the qubit, so that the noise at the qubit can be inferred. Artificial noise might include, for example: noise deliberately added to signal lines such as GHz, THz and IR signals, mechanical vibration added to some portion of the system, EM radiation injected into the system, quasiparticle noise generators, phonon noise generators, or ionizing radiation noise generators.

Guidance for yearly goals:

Years 1 and 2 goals:

1. Fabricate selected qubits and investigate methods to inject selected noise components.
2. Collect noise data from a statistically significant number of qubits over a range of powers and frequencies. Characterize the effect of injected noise on qubit performance.
3. Analyze and model the data collected to explain the pathway the noise takes to the qubits and the effect on qubit performance.

Years 3 and 4 goals:

1. Suggest how that noise path might be suppressed w.r.t. qubit performance levels.
2. Devise and perform experiments to test those suppression methods.
3. Explain and model the results.

Approaches outside the scope of this topic and will not be considered for award:

1. Development of fundamentally new candidate qubit systems
2. Optimal control theory
3. Data processing or heralding to remove noisy data

B. Federal Award Information

Anticipated awards will be made in the form of procurement contracts, grants, or cooperative agreements, and are subject to the availability of appropriations. Funding for

the second year and beyond will be contingent upon satisfactory performance and the availability of funds.

The ACC-APG RTP Division has the authority to award a variety of instruments on behalf of ARL-ARO. The ACC-APG RTP Division reserves the right to use the type of instrument most appropriate for the effort proposed. Applicants should familiarize themselves with these instrument types and the applicable regulations before submitting a proposal. Following are brief descriptions of the possible award instruments.

1. Procurement Contract. A legal instrument, consistent with 31 U.S.C. 6303, which reflects a relationship between the Federal Government and a State Government, a local government, or other entity/contractor when the principal purpose of the instrument is to acquire property or services for the direct benefit or use of the Federal Government.

Contracts are primarily governed by the following regulations:

- a. Federal Acquisition Regulation (FAR) <https://www.acquisition.gov/browse/index/far>
 - b. Defense Federal Acquisition Regulation Supplement (DFARS) <https://www.federalregister.gov/defense-federal-acquisition-regulation-supplement-dfars->
 - c. Army Federal Acquisition Regulation Supplement (AFARS) <https://www.acquisition.gov/afars>
2. Grant - A legal instrument that, consistent with 31 U.S.C. 6304, is used to enter into a relationship:
 - a. The principal purpose of which is to transfer a thing of value to the recipient to carry out a public purpose of support or stimulation authorized by a law or the United States, rather than to acquire property or services for the DoD's direct benefit or use.
 - b. In which substantial involvement is not expected between the DoD and the recipient when carrying out the activity contemplated by the grant.
 - c. No fee or profit is allowed.
 3. Cooperative Agreement. A legal instrument which, consistent with 31 U.S.C. 6305, is used to enter into the same kind of relationship as a grant (see definition "grant"), except that substantial involvement is expected between the DoD and the recipient when carrying out the activity contemplated by the cooperative agreement. The term does not include "cooperative research and development agreements" as defined in 15 U.S.C. 3710a. No fee or profit is allowed.

4. Grants and cooperative agreements for Institutions of Higher Education and nonprofit organizations are primary governed by the following:
 - A. Federal statutes
 - B. Federal regulations
 - C. 2 CFR part 200, as modified and supplemented by DoD's interim Implementation found in 2 CFR part 1103
 - D. 32 CFR Parts 21, 22, 26, and 28.
 - E. DoD R&D General Terms and Conditions dated September 2021
 - F. ACC-APG-RTP Division Assistance, Research General Terms and Conditions dated December 2020, hereinafter referred to as “Agency Specific Requirements”
 - G. Award-specific terms and conditions
5. Grants and cooperative agreements for for-profit and nonprofit organizations exempted from Subpart E—cost principles of part 200, are primary governed by the following:
 - a. Federal statutes
 - b. Federal regulations
 - c. 32 CFR Parts 21, 22, 26, and 28.
 - d. DOD 3210.6-R, Part 34 - Administrative Requirements for Grants and Agreements with For-Profit Organizations

Copies of OMB regulations may be obtained from:

Executive Office of the President
Publications Service
New Executive Office Building
725 17th Street, N.W., Room 2200
Washington, DC 20503

Telephone: (202) 395-7332
FAX Requests: (202) 395-9068
<https://www.whitehouse.gov/omb/information-for-agencies/circulars/>

An electronic copy of the DoDGARs may be found at <http://www.ecfr.gov> (Title 32: National Defense, Subchapter C – DoD Grant and Agreement Regulations)

C. Eligibility Information

1. Eligible Applicants:

Eligible applicants under this BAA include Institutions of higher education (foreign and domestic), nonprofit organizations, and for-profit concerns (large and small businesses). Proposals are encouraged from Historically Black Colleges and Universities (as determined by the Secretary of Education to meet requirements of Title III of the Higher Education Act of 1965, as amended (20 U.S.C. §1061)) and from Minority Institutions defined as institutions “whose enrollment of a single minority or a combination of minorities exceeds 50

percent of the total enrollment.” [20 U.S.C. § 1067k(3) and 10 U.S.C. § 2362]. However, no funds are specifically allocated for HBCU/MI participation.

2. Cost Sharing or Matching:

There is no requirement for cost sharing, matching, or cost participation to be eligible for award under this BAA and cost sharing and matching is not an evaluation factor used under this BAA.

3. Federally Funded Research and Development Centers (FFRDCs):

Federally Funded Research & Development Centers (FFRDCs), including Department of Energy National Laboratories, are not eligible to receive awards under this BAA. However, teaming arrangements between FFRDCs and eligible principal offerors are allowed so long as such arrangements are permitted under the sponsoring agreement between the Government and the specific FFRDC, and no funds from the award flow to the FFRDC.

D. Application and Submission Information

1. Address to View Broad Agency Announcement

This BAA may be accessed from the following:

- 1) Grants.gov (www.grants.gov)
- 2) SAM (<https://www.SAM.gov>)
- 3) ARL website (<https://www.arl.army.mil/business/broad-agency-announcements/>)

Amendments, if any, to this BAA will be posted to these websites when they occur. Interested parties are encouraged to periodically check these websites for updates and amendments.

The following information is for those wishing to respond to the BAA:

2. Content and Form of Application Submission

a. General Information

A proposal submitted under this BAA must address unclassified fundamental research. Proposal submissions will be protected from unauthorized disclosure in accordance with applicable laws and DoD regulations. Applicants are expected to appropriately mark each page of their submission that contains proprietary information. The participating DoD agencies will provide no funding for direct reimbursement of

proposal development costs. Technical and cost proposals (or any other material) submitted in response to this BAA will not be returned. It is the policy of participating DoD agencies to treat all proposals as sensitive, competitive information and to disclose their contents only for the purposes of evaluation.

Post-Employment Conflict of Interest: There are certain post-employment restrictions on former federal officers and employees, including special government employees (Section 207 of Title 18, U.S.C.). If an applicant believes a conflict of interest may exist, the situation should be discussed with Point of Contact listed in Section G: Agency Contacts, who will then coordinate with appropriate ARO/ARL legal personnel prior to having applicant expend time and effort in preparing a white paper or proposal.

Statement of Disclosure Preference: Please complete ARO Form 52 or 52A stating your preference for release of information contained in your white paper or proposal. Copies of these forms are available at

<https://www.arl.army.mil/business/broad-agency-announcements/baa-forms/>

NOTE: A white paper or proposal may be handled for administrative purposes by support contractors. These support contractors are prohibited from competing on BAA proposals and are bound by appropriate non-disclosure requirements.

Equipment: Normally, title to equipment or other tangible property purchased with Government funds vests with nonprofit institutions of higher education or with nonprofit research organizations if vesting will facilitate scientific research performed for the Government. For profit organizations are expected to possess the necessary plant and equipment to conduct the proposed research. Deviations may be made on a case-by-case basis to allow commercial organizations to purchase equipment but disposition instructions must be followed.

b. Submission of a White Paper

Stage 1 White Papers – Prospective applicants **are strongly encouraged** to submit White Papers. The purpose of requesting a White Paper is to minimize the labor and cost associated with the production of a detailed proposal that has very little chance of being selected for funding. Based on assessment of the White Papers, feedback will be provided to an applicant to enable that applicant to make a determination as to whether they should submit a proposal. If offerors have not submitted White Papers under Stage I of the BAA, offerors may still submit full proposals for consideration for funding.

White Paper Format and Content:

- White Papers must be submitted electronically to usarmy.rtp.devcom-arl.mesg.qcbox@army.mil in the following format:
- Single PDF file as an email attachment
- Page Size: 8 ½ x 11 inches
- Margins – 1 inch
- Font – No smaller than Times New Roman, 12 point
- Number of Pages – no more than ten (10) single-sided pages. Any pages exceeding the ten-page limit will not be evaluated.

White Papers must contain the following:

- Title page. The title page should be labeled “QC-S5 BAA White Paper” and should include the BAA number, proposed title, program goal being addressed, Principal Investigator (PI) with telephone number and email address, and an executive summary. (Not to exceed one page.)
- Expected expenditures and justifications. (Not to exceed one page.)
- Curriculum vitae sketches. (Not to exceed one page.)
- Technical portion including all references and figures. Introduce the problem to be addressed, briefly survey related work, identify key obstacles, outline the proposed solution and well-defined objective, outline the yearly research plan with milestones, and state the impact if successful. (Not to exceed seven pages.)

c. Preparing an Application

Stage 2 Proposal - After Stage 1 reviews are completed, interested offerors should submit proposals in accordance with the requirements set forth in this BAA.

This format applies to all proposals submitted via email and via Grants.gov. Offerors' proposals should show the location of each section of the proposal, as well as major subdivisions of the project description.

COVER PAGE ARO FORM 51: for Contract proposals submitted by email. The Form SF 424 (R&R) is for all proposals submitted through Grants.gov (Assistance Instruments must submit through Grants.gov):

1. A Cover Page is required. Proposals will not be processed without either: (1) a signed Cover Page, ARO Form 51, or (2) an SF 424 R & R Form.

2. Should the project be carried out at a branch campus or other component of the submitting organization, that branch campus or component should be identified in the space provided (Block 11 on the ARO Form 51 and Block 12 on the SF424 R&R).
3. The title of the proposed project should be brief, scientifically representative, intelligible to a scientifically literate reader, and suitable for use in the public domain.
4. The proposed duration for which support is requested should be consistent with the program duration of forty-eight months.
5. Specification of a desired starting date for the project is important and helpful however, requested effective dates cannot be guaranteed.
6. To evaluate compliance with Title IX of the Education Amendments of 1972 {20 U.S.C. A§ 1681 Et. Seq.}, the Department of Defense is collecting certain demographic and career information to be able to assess the success rates of women who are proposed for key roles in applications in STEM disciplines. To enable this assessment, each application must include the following forms completed as indicated.

Research and Related Senior/Key Person Profile (Expanded) form:

The Degree Type and Degree Year fields on the Research and Related Senior/Key Person Profile {Expanded} form will be used by DoD as the source for career information. In addition to the required fields on the form, applicants must complete these two fields for all individuals that are identified as having the project role of PD/PI or Co-PD/PI on the form. Additional senior/key persons can be added by selecting the "Next Person" button.

Research and Related Personal Data form:

This form will be used by DoD as the source of demographic information, such as gender, race, ethnicity, and disability information for the Project Director/Principal Investigator and all other persons identified as Co-Project Director(s)/Co-Principal Investigator(s). Each application must include this form with the name fields of the Project Director/Principal Investigator and any Co-Project Director(s)/Co-Principal Investigator(s) completed; however, provision of the demographic information in the form is voluntary. If completing the form for multiple individuals, each Co-Project Director/Co-Principal Investigator can be added by selecting the "Next Person" button. The demographic information, if provided, will be used for statistical purposes only and will not be made available to merit reviewers. Applicants who do not wish to provide some or all of the information should check or select the "Do not wish to provide" option.

7. Pursuant to 31 U.S.C. 7701, as amended by the Debt Collection Improvement Act of 1996 [Section 31001(I)(1), Public Law 104-134], federal agencies shall obtain each awardees' Taxpayer Identification Number (TIN). This number may be the Employer Identification Number for a business or non-profit entity or the Social Security Number for an individual. The TIN is being obtained for purposes of collecting and reporting on any delinquent amounts that may arise out of an awardees' relationship with the Government.

8. Offerors shall provide their organization's Unique Entity Identifier (formerly DUNS). This number is a nine-digit number assigned by Dun and Bradstreet Information Services. See Section II.D.3 of this BAA for requirements pertaining to the Unique Entity Identifier.

9. Offerors shall provide their assigned Commercial and Government Entity (CAGE) Code. The CAGE Code is a 5-character code assigned and maintained by the Defense Logistics Service Center (DLSC) to identify a commercial plant or establishment.

TABLE OF CONTENTS: Use the following Format for the Proposal Table of Contents, Forms are available at

<https://www.arl.army.mil/business/broad-agency-announcements/baa-forms/>

SECTION	PAGE NUMBER
Table of Contents	A-1
Statement of Disclosure Preference (Form 52 or 52A)	B-1
Research & Related Other Project Information	B-2
Project Abstract	C-1
Project Description (Technical Proposal)	D-1 - D-□
Biographical Sketch	E-1 - E-□
Bibliography	F-1 - F-□
Current and Pending Support	G-1 - G-□
Facilities, Equipment, and Other Resources	H-1 - H-□
Proposal Budget	I-1 - I-□
Contract Facilities Capital Cost of Money (DD Form 1861)	J-1
Appendices	K-□
List Appendix Items: _____	

This format applies to proposals submitted via email and via Grants.gov. Offerors' proposals should show the location of each section of the proposal, as well as major subdivisions of the project description.

STATEMENT OF DISCLOSURE PREFERENCE (FORM 52 OR 52A): Complete and sign ARO Form 52 (Industrial Contractors) or ARO Form 52A (Educational and Nonprofit Organizations), form can be found at the following website:
<https://www.arl.army.mil/business/broad-agency-announcements/baa-forms/> .

RESEARCH AND RELATED Other Project Information: The form entitled “Research and Related Other Project Information” found at the following website:
<https://www.arl.army.mil/business/broad-agency-announcements/baa-forms/>, shall be completed and signed by all organizations.

PROJECT ABSTRACT:

1. The Project Abstract shall be completed on the form entitled “Publicly Releasable Abstract” found at the following website: <https://www.arl.army.mil/business/broad-agency-announcements/baa-forms/>
2. Unless otherwise instructed in this BAA, the Project Abstract shall include a concise statement of work and basic approaches to be used in the proposed effort. The abstract should include a statement of scientific objectives, methods to be employed, and the significance of the proposed effort to the advancement of knowledge.
3. The abstract should be no longer than one (1) page (maximum 4,000 characters).
4. The project abstract shall be marked by the applicant as publicly releasable. By submission of the project abstract, the applicant confirms that the abstract is releasable to the public. For a proposal that results in a grant award, the project abstract will be posted to a searchable website available to the general public to meet the requirements of Title VII (General Provisions), Section 8123, of the Department of Defense Appropriations Act, 2015. (Division C of the Consolidated and Further Continuing Appropriations Act, Public Law 113-235) The website address is <https://dodgrantawards.dtic.mil/grants>

TECHNICAL PROPOSAL (PROJECT DESCRIPTION): The technical portion of the proposal shall be no longer than 20 pages including tables and figures, single spaced text, size 12 Times New Roman font with one inch page margins, and shall contain the following:

1. Technical Approach: Introduce the problem to be addressed, survey related work, identify key obstacles, and outline the proposed solution and well-defined objective. Proposals should describe an approach to all technical areas with unambiguous and quantitative milestones. Proposers must justify the utility of the proposed work and highlight its benefits over the current state-of-the-art. Proposals should clearly address

the expected key challenges and proposed methods to overcome these difficulties taking into consideration the current state of field. Proposers should set aggressive yearly quantitative milestones that define a path toward the end-of-the-program goals and analyze the impact if successful.

2. **Project Schedule, Milestones, and Deliverables:** A summary of the schedule of events, milestones, and a detailed description of the results and products to be delivered.
3. **Management Approach:** A discussion of the overall approach to the management of this effort, including brief discussions of: required facilities; relationships with any subawardees and with other organizations; availability of personnel; and planning, scheduling, and control procedures. A brief description of your organization, including if the offeror has extensive government contracting experience. If this information has been previously provided to the ARL/ARO, the information need not be provided again. A statement setting forth this condition should be made.
4. The names of other federal, state, local agencies, or other parties receiving the proposal and/or funding the proposed effort. If none, so state. Concurrent or later submission of the proposal to other organizations will not prejudice its review by the ARL/ARO if we are kept informed of the situation.
5. A statement regarding possible impact, if any, of the proposed effort on the environment considering as a minimum its effect upon water, atmosphere, natural resources, human resources, and any other values.
6. The offeror shall provide a statement regarding the use of Class I and Class II ozone- depleting substances. Ozone-depleting substances mean any substance designated as Class I by EPA, including but not limited chlorofluorocarbons, halons, carbon tetrachloride, and methyl chloroform and any substance designated as Class II by EPA, including but not limited to hydrochlorofluorocarbons. See 40 C.F.R. Part 82 for detailed information. If Class I or II substances are to be utilized, a list shall be provided as part of the offeror's proposal. If none, so state.
7. The type of additional support, if any, requested (e.g., facilities, equipment, and materials). Government Furnished Information or Equipment (GFI/GFE) available to all proposers is described in A.2.4.

BIOGRAPHICAL SKETCHES:

1. This Section shall contain the biographical sketches for senior and key personnel only.

- a. Primary Principal Investigator: The “Primary” PI provides a single or initial point of communication between the sponsoring agency(s) and the awardee organization(s) about scientific matters. If not otherwise designated, the first PI listed will serve as the “Primary” PI. This individual can be changed with approval of the agency. The sponsoring agency(s) does not infer any additional scientific stature to this role among collaborating investigators.
 - b. Co-Principal Investigators: The individual(s) a research organization designates as having an appropriate level of authority and responsibility for the proper conduct of the research and submission of required reports to the agency. When an organization designates more than one PI, it identifies them as individuals who share the authority and responsibility for leading and directing the research, intellectually and logistically. The sponsoring agency(s) does not infer any distinction among multiple PIs.
 - c. Key personnel: The individual(s) a research organization designates as having a high level of technical expertise in the topics proposed to be researched and who will both play an active role in the research and supervise the work of more junior personnel on a daily basis.
2. The following information is required:
- a. Relevant experience and employment history including a description of any prior Federal employment within one year preceding the date of proposal submission.
 - b. List of up to five (5) publications most closely related to the proposed project and up to five (5) other significant publications, including those being printed. Patents, copyrights, or software systems developed may be substituted for publications.
 - c. List of persons, other than those cited in the publications list, who have collaborated on a project or a book, article, report or paper within the last four (4) years. Include pending publications and submissions. Otherwise, state "None."
 - d. Names of each investigator's own graduate or post graduate advisors and advisees. The information provided in "c" and "d" is used to help identify potential conflicts or bias in the selection of reviewers.
 - e. The time commitment of each senior or key person to this project.
3. For the personnel categories of postdoctoral associates, other professionals, and

students (research assistants), the proposal may include information on exceptional qualifications of these individuals that merit consideration in the evaluation of the proposal.

4. The biographical sketches are limited to three (3) pages per investigator and other individuals that merit consideration.

BIBLIOGRAPHY: A bibliography of pertinent literature is required. Citations must be complete (including full name of author(s), title, and location in the literature).

CURRENT AND PENDING SUPPORT:

1. All project support from whatever source must be listed. The list must include all projects requiring a portion of the principal investigator's and other senior personnel's time, even if they receive no salary support from the project(s) including Cooperative Research and Development Agreements (CRADAs) or other technology transfer agreements with federal labs. Funding provided under any award resulting from this BAA may only be used in support of the effort funded by that award, and not for any other project or purpose.

2. The information should include, as a minimum:

- (a) the project/proposal title and brief description,
- (b) the name and location of the organization or agency presently funding the work or requested to fund such work,
- (c) the award amount or annual dollar volume of the effort,
- (d) the period of performance, and
- (e) a breakdown of the time required of the principal investigator and/or other senior personnel.

FACILITIES, EQUIPMENT, AND OTHER RESOURCES: The offeror should include in the proposal a listing of facilities, equipment, and other resources already available to perform the research proposed.

BUDGET PROPOSAL (including DD Form 1861):

1. Each proposal must contain a budget for each year of support requested and a cumulative budget for the full term of requested support. The budget form (Form 99) may be reproduced as needed. Locally produced versions may be used, but you may not make substitutions in prescribed budget categories nor alter or rearrange the cost categories as they appear on the form. The proposal may request funds under any of the categories listed so long as the item is considered necessary to perform the proposed

work and is not precluded by applicable cost principles. Additionally, a budget by major proposed research tasks using the same budget categories must be included.

2. A signed summary budget page must be included. The documentation pages should be titled "Budget Explanation Page" and numbered chronologically starting with the budget form. The need for each item should be explained clearly.

3. All cost data must be current and complete. Costs proposed must conform to the following principles and procedures:

Educational Institutions: 2 CFR Part 200 (formerly OMB Circular A-21)

Nonprofit Organizations: 2 CFR Part 200 (formerly OMB Circular A-122*)

Commercial Organizations: FAR Part 31, DFARS Part 231, FAR Subsection 15.403-5, and DFARS Subsection 215.403-5.

*For those nonprofit organizations specifically exempt from the provisions of 2 CFR Part 230, FAR Part 31 and DFARS Part 231 shall apply.

4. Sample itemized budgets and the information they must include for a contract and for grants and cooperative agreements can be found at Section II. H. (Other Information). Before award it must be established that an approved accounting system and financial management system exist.

APPENDICES: Some situations require that special information and supporting documents be included in the proposal before funding can be approved. Such information and documentation should be included by appendix to the proposal.

e. Submission of Complete Research Proposals

Proposals must be submitted through the offeror's organizational office having responsibility for Government business relations. All signatures must be that of an official authorized to commit the organization in business and financial affairs. Proposals must be submitted electronically using one of the two following formats, based on award type sought. The content will remain the same whether using email or Grants.gov.

EMAIL SUBMISSION (for **Contracts only**):

1. Proposal requesting award of a contract must be emailed directly to usarmy.rtp.devcom-arl.mesg.qcbox@mail.mil

Do not email full proposals to the LQC Program Point of Contact. All e-mailed proposals must contain the information outlined in Section II, D, 2, entitled “*Table of Contents*” including the electronic forms as follows:

- (a) ARO Form 51, Proposal Cover Page;
- (b) ARO Form 99, Summary Proposal Budget or equivalent,
- (c) ARO Current and Pending Support (unnumbered form),
- (d) ARO Form 52 or ARO Form 52a.
- (e) "FAR 52.209-11 – Representation by Corporations Regarding Delinquent Tax Liability or a Felony Conviction under any Federal Law (Feb 2016). See Note below."

These forms may be accessed at <https://www.arl.army.mil/business/broad-agency-announcements/baa-forms/> under BAA Forms. The fillable PDF forms may be saved to a working directory on a computer and opened and filled in using the latest compatible Adobe Reader software application found at this Grants.Gov: <https://www.grants.gov/web/grants/applicants/adobe-software-compatibility.html>

Note: A completed 52.209-11 – Representation by Corporations Regarding Delinquent Tax Liability or a Felony Conviction under any Federal Law (Feb 2016), is not required if the offeror's SAM Certifications and Representations have been updated annually since 2016. If the offeror's SAM has not be updated since March 2016, the completed representation must be submitted and include POC information and signature of the authorized representative.

2. All forms requiring signature must be completed, printed, signed, and scanned into a PDF document. All documents must be combined into a single PDF formatted file to be attached to the e-mail.
3. Proposal documents (excluding required forms) must use the following format:
 - Page Size – 8 ½ x 11 inches
 - Margins – 1 inch
 - Spacing – single
 - Font – Times New Roman, 12 point, single-sided pages

GRANTS.GOV SUBMISSION (For all Assistance Instruments):

1. Grants.gov Registration (See *Section II.D.2.f. Grants.gov Registration* below) must be accomplished prior to application through this process. Note- All web links referenced in this section and “*Grants.gov Registration*” (below) are subject to change by grants.gov and may not be updated here.
2. Specific forms are required for submission of a proposal. The forms are contained

in the Application Package available through the Grants.gov application process. To access these materials, go to <https://www.grants.gov/>, select "Apply for Grants," and then select "Get Application Package." A Grant Application Package and Application Instructions are available for through the Grants.Gov Apply portal under CFDA Number 12.431/Funding Opportunity Number **W911NF-22-S-0006**. Select "Apply" and then "Apply Now Using Workspace." The following documents are mandatory: (1) Application for Federal Assistance (Research and Related) (SF 424 (R&R)), and (2) Attachments form.

(a) The SF 424 (R&R) form is to be used as the cover page for all proposals.

Authorized Organization Representative (AOR) usernames and passwords serve as "electronic signatures" when your organization submits applications through Grants.gov. By using the SF 424 (R&R), proposers are providing the certification required by 32 CFR Part 28 regarding lobbying. The SF 424 (R&R) must be fully completed.

(b) The Attachments form must contain the information outlined in Section II, D, 2 (*b. Preparing an Application*), entitled "Table of Contents" of this BAA including the electronic forms as follows:

- (1) Research and Related Other Project Information;
- (2) ARO Form 99, Summary Proposal Budget;
- (3) ARO Current and Pending Support (unnumbered form)
- (4) Representation by Corporations Regarding conviction of a Felony Criminal Violation under any Federal or State Law and Representation by Corporations Regarding an Unpaid Delinquent Tax Liability

Items (1)-(4) forms may be accessed at <https://www.arl.army.mil/business/broad-agency-announcements/baa-forms/> Item (4) "Representation relating to Tax Liability and Felony Convictions" may be submitted on a word document and attached to available field within the attachments form. The fillable PDF forms may be saved to a working directory on a computer and opened and filled in using the latest compatible Adobe Reader software application found at this Grants.Gov:

<https://www.grants.gov/web/grants/applicants/adobe-software-compatibility.html>

Note: Representation by Corporations Regarding Conviction of a Felony Criminal Violation and Unpaid Delinquent Tax Liability require POC information and signature of the authorized representative.

(c) All documents must be combined into separate and single PDF formatted files titled using the Table of Contents names listed in "*Section II.D.2.b. Preparing an Application*": Preparation of complete Research Proposals". Include "**W911NF-22-S-0006**" in title so the proposal will be distinguished from other BAA submissions and upload using the

mandatory Attachments form.

(d) The training demonstration at <https://www.grants.gov/web/grants/applicants/applicant-training.html?inheritRedirect=true> will assist AORs in the application process. Remember that you must open and complete the Application for Federal Assistance (Research and Related) (SF 424 (R&R)) first, as this form will automatically populate data fields in other forms. If you encounter any problems, contact customer support at 1-800-518-4726 or at support@grants.gov. If you forget your user name or password, follow the instructions provided in the Credential Provider tutorial. Tutorials may be printed by right-clicking on the tutorial and selecting “Print”.

(e) As it is possible for grants.gov to reject the proposal during this process, it is strongly recommended that proposals be uploaded **at least two days** before any established deadline in the BAA so that they will not be received late and be ineligible for award consideration. It is also recommended to start uploading proposals at least two days before the deadline to plan ahead for any potential technical and/or input problems involving the applicant’s own equipment.

f. Grants.Gov Registration

Registration. Each organization that desires to submit applications via Grants.Gov must complete a one-time registration. There are several one-time actions your organization must complete in order to submit applications through Grants.gov (e.g., obtain a Dun and Bradstreet Data Universal Numbering System (DUNS) number, register with the System for Award Management (SAM), register with the credential provider, register with Grants.gov and obtain approval for an Authorized Organization Representative (AOR) to submit applications on behalf of the organization). To registered please see <https://www.grants.gov/web/grants/applicants/organization-registration.html>.

Please note the registration process for an Organization or an Individual can take between three to five business days or as long as four weeks if all steps are not completed in a timely manner.

Questions relating to the registration process, system requirements, how an application form works, or the submittal process should be directed to Grants.gov at 1-800-518-4726 or support@grants.gov.

3. Unique Entity Identifier and System for Award Management (SAM)

Each applicant (unless the applicant is an individual or Federal awarding agency that is exempt from those requirements under 2 CFR §25.110(b) or (c), or has an exception approved by the Federal awarding agency under 2 CFR §25.110(d)) is required to:

- (i) Be registered in SAM before submitting its application;
- (ii) Provide a valid unique entity identifier in its application; and
- (iii) Continue to maintain an active SAM registration with current information at all times during which it has an active Federal award or an application or plan under consideration by a Federal awarding agency.

The Federal awarding agency may not make a Federal award to an applicant until the applicant has complied with all applicable unique entity identifier and SAM requirements. If an applicant has not fully complied with the requirements by the time the Federal awarding agency is ready to make a Federal award, the Federal awarding agency may determine that the applicant is not qualified to receive a Federal award and use that determination as a basis for making a Federal award to another applicant.

4. Submission Dates and Times:

White Papers:

White Papers must be submitted electronically via e-mail to usarmy.rtp.devcom-arl.mesg.qcbox@army.mil and received at the Army Research Office **by 4:00 PM Eastern Time on 15 July 2022.**

The email subject line should contain the following: **W911NF-22-S-0006 QC-S5 White Paper**. White Papers received after the deadline will not be reviewed. Feedback on the White Papers will be emailed directly to the proposed principal investigators in approximately four week intervals starting 15 February 2022 and ending 15 August 2022, depending on the submission date of the White Paper and completion of evaluations (about 30 days). Early submission of White Papers is encouraged.

Proposals:

Proposals transmitted to be considered for award must be received by Grants.gov **no later than 4:00 PM Eastern Time on 30 September 2022.**

Applicants are responsible for submitting electronic proposals in sufficient time to insure Grants.gov receives it by the time specified in this BAA. If the electronic proposal is received by Grants.gov after the exact time and date specified for receipt of offers, it will be considered “late” and will not be considered for award. Acceptable evidence to establish the time of receipt by Grants.gov includes documentary evidence of receipt maintained by Grants.gov.

Because of potential problems involving the applicants' own equipment, to avoid the possibility of late receipt and resulting in ineligibility for award consideration, it is strongly recommended that proposals be uploaded at least two business days before the deadline established in the BAA.

If an emergency or unanticipated event interrupts normal Government processes so that proposals cannot be received at grants.gov by the exact time specified in the solicitation, and urgent Government requirements preclude amendment of the solicitation closing date, the time specified for receipt of proposals will be deemed to be extended to the same time of day specified in the solicitation on the first work day on which normal Government processes resume.

Proposal Receipt Notices – After a proposal is submitted to Grants.gov, the AOR will receive a series of three emails from Grants.gov. The first two emails will be received within 24 to 48 hours after submission. The first email will confirm time of receipt of the application by the Grants.gov system and the second will indicate that the application has either been successfully validated by the system prior to transmission to the grantor agency or has been rejected due to errors. A third email will be received once the agency has confirmed receipt of the proposal. The document, Tracking Your Application Package, located at <https://www.grants.gov/web/grants/applicants/track-my-application.html?inheritRedirect=true> explains this process. The proposal is not considered received until the AOR receives email #3.

5. Intergovernmental Review

Not Applicable

6. Funding Guidance:

Multiple awards are anticipated. Funding guidance is provided in the table below for the research topic being proposed. Year 1 guidance is larger than Years 2-4 to provide the opportunity to setup experimental infrastructure for the proposed research early in the project. Projects requesting larger than the maximum guidance must provide strong justification based on the scope of the proposed research.

Topic	Maximum Year 1	Maximum Years 2-4	Minimum
ModQ	\$2500K	\$1800K	\$500K
GASP	\$5000K	\$3500K	\$500K
FastCARS	\$1800K	\$1300K	None
NS⁵	\$1800K	\$1300K	None

The actual amount of each award will be contingent on availability of funds and the scope of the proposed work. Depending on the results of the proposal evaluation, there is no guarantee that any of the proposals submitted in response to a particular program goal will be recommended for funding. Proposals may be funded in part.

7. Other Submission Requirements:

Information to Be Requested from Successful Offerors- Offerors whose proposals are accepted for funding will be contacted before award to provide additional information required for award. The required information is normally limited to clarifying budget explanations, representations, certifications, and some technical aspects.

For Contracts Only- Performance Work Statements (PWS) - prior to award the Contracting Officer may request that the contractor submit a PWS for the effort to be performed, which will be incorporated into the contract at the time of award.

An applicant may withdraw a proposal at any time before award by written notice or by email. Notice of withdrawal shall be sent to the Contracting/Grants Officer identified in Section G, of this BAA. Withdrawals are effective upon receipt of notice by the Contracting/Grants Officer.

E. Application Review Information:

1. Criteria:

- a. Proposals submitted in response to this BAA will be evaluated and a recommendation for selection be made on the following criteria:
 - (i) Scientific and technical merits of the proposed research; and
 - (ii) Potential contribution of the research, if successful, to significantly enhance the feasibility of quantum computing.
 - (iii) Experience and qualifications of the principal investigator, other key research personnel, management approach, and the institution sponsoring the proposal; and
 - (iv) The realism and reasonableness of cost.
 - (v) Availability of funding.

NOTE: Cost sharing will not be considered in the evaluation.

2. Review and Selection Process:

The proposal selection process will be conducted based upon a technical review by a panel of government scientists according to the evaluation criteria specified in Section E.1 (*Criteria*). Each proposal will be evaluated based on the merit and relevance of the specific proposal as it relates to the research topic rather than against other proposals for research in the same general area.

For clarification, this solicitation will be conducted as an ‘other competitive procedure,’ in accordance with FAR 6.102 and FAR 35.016, and will not be conducted as a negotiated procurement under FAR Part 15. The Government will not conduct a comparative analysis or trade-off analysis among proposals, and discussions under FAR Part 15 will not be conducted.

While it is the Government’s intention to make awards based on submitted proposals, the contracting officer, in his or her discretion, may choose to conduct post-selection negotiations with a specific offeror on any topic deemed necessary for the purpose of allowing that offeror to revise and improve its proposal.

3. Recipient Qualification

a. For Grant, Cooperative Agreement:

In accordance with OMB guidance in parts 180 and 200 of Title 2, CFR, it is DoD policy that DoD Components must report and use integrity and performance information in the Federal Awardee Performance and Integrity Information System (FAPIIS), or any successor system designated by OMB, concerning grants, cooperative agreements, and TIAs as follows:

(i) If the total Federal share will be greater than the simplified acquisition threshold on any Federal award under a notice of funding opportunity (see §200.88 Simplified Acquisition Threshold):

(a) The Federal awarding agency, prior to making a Federal award with a total amount of Federal share greater than the simplified acquisition threshold, will review and consider any information about the applicant that is in the designated integrity and performance system accessible through SAM (currently FAPIIS) (see 41 U.S.C. 2313);

(b) An applicant, at its option, may review information in the designated integrity and performance systems accessible through SAM and comment on any information

about itself that a Federal awarding agency previously entered and is currently in the designated integrity and performance system accessible through SAM;

(c) The Federal awarding agency will consider any comments by the applicant, in addition to the other information in the designated integrity and performance system, in making a judgment about the applicant's integrity, business ethics, and record of performance under Federal awards when completing the review of risk posed by applicants as described in §200.205 Federal awarding agency review of risk posed by applicants.

b. For Assistance awards recipients will be required to submit the following representation prior to award:

Representations under DoD Assistance Agreements: Appropriations Provisions on Tax Delinquency and Felony Convictions

The applicant is () is not () a “Corporation” meaning any entity, including any institution of higher education, other nonprofit organization, or for-profit entity that has filed articles of incorporation.

If the applicant is a “Corporation” please complete the following representations:

(1) The applicant represents that it is () is not () a corporation that has any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

(2) The applicant represents that it is () is not () is not a corporation that was convicted of a criminal violation under any Federal law within the preceding 24 months.

The “Representation relating to Tax Liability and Felony Convictions”, the form may be accessed at <https://www.arl.army.mil/business/broad-agency-announcements/baa-forms/>

NOTE: If an applicant responds in the affirmative to either of the above representations, the applicant is ineligible to receive an award unless the agency suspension and debarment official (SDO) has considered suspension or debarment and determined that further action is not required to protect the Government’s interests. The applicant therefore should provide information about its tax liability or conviction to the agency’s SDO as soon as it can do so, to facilitate completion of the required

considerations before award decisions are made. Applicant's authorized representative must sign and date form.

c. For CONTRACT Proposals:

(i) The Federal Awardee Performance and Integrity Information System (FAPIIS) will be checked prior to making an award. The web address is: <https://www.fapiis.gov/fapiis> The applicant representing the entity may comment in this system on any information about itself that a Federal Government Official entered. The information in FAPIIS will be used in making a judgment about the entity's integrity, business ethics, and record of performance under Federal awards that may affect the official's determination that the applicant is qualified to receive an award.

(ii) For contracts, the following representation must be submitted prior to award if the offeror's SAM Representations and Certifications are not dated after March 2016. If the offeror's SAM Representations and Certifications have been updated after March 2016, this representation is not required to be submitted separately.

FAR 52.209-11: Representation by Corporations Regarding Delinquent Tax Liability or a Felony Conviction under any Federal Law (Feb 2016)

(a) As required by sections 744 and 745 of Division E of the Consolidated and Further Continuing Appropriations Act, 2015 (Pub. L 113-235), and similar provisions, if contained in subsequent appropriations acts, the Government will not enter into a contract with any corporation that--

(1) Has any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability, where the awarding agency is aware of the unpaid tax liability, unless an agency has considered suspension or debarment of the corporation and made a determination that suspension or debarment is not necessary to protect the interests of the Government; or

(2) Was convicted of a felony criminal violation under any Federal law within the preceding 24 months, where the awarding agency is aware of the conviction, unless an agency has considered suspension or debarment of the corporation and made a determination that this action is not necessary to protect the interests of the Government.

(b) The Offeror represents that—

(1) It is is not a corporation that has any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability; and

(2) It is is not a corporation that was convicted of a felony criminal violation under a Federal law within the preceding 24 months.

F. Award Administration Information:

1. Award Notices:

Initial notification of selection of proposals for funding will be e-mailed by ARO to successful offerors before 30 December 2022.

The notification e-mail of selection for funding must not be regarded as an authorization to commit or expend funds. The Government is not obligated to provide any funding until a Government Contracting/Grants Officer signs the grant, cooperative agreement or contract award document.

Applicants whose proposals are recommended for negotiation of award will be contacted by a Contract/Grant Specialist to discuss additional information required for award. This may include representations and certifications, revised budgets or budget explanations, certificate of current cost or pricing data, subcontracting plan for small businesses, and other information as applicable to the proposed award.

2. Administrative and National Policy Requirements:

a. Required Certifications

(i) For CONTRACT Proposals:

Certifications Required for Contract Awards. Certifications and representations shall be completed by successful offerors prior to award. Federal Acquisition Regulation (FAR) Online Representations and Certifications are to be completed through SAM at website <https://www.SAM.gov>. Defense FAR Supplement and contract specific certification packages will be provided to the contractor for completion prior to award.

FAR 52.203-18, PROHIBITION ON CONTRACTING WITH ENTITIES THAT REQUIRE CERTAIN CONFIDENTIALITY AGREEMENTS OR STATEMENTS—REPRESENTATION (JAN 2017)

(ii) For GRANT and COOPERATIVE AGREEMENT Proposals:

Grant awards greater than \$100,000 require a certification of compliance with a national policy mandate concerning lobbying. Statutes and Government-wide regulations require the certification to be submitted prior to award. The certification is set forth at Appendix A to 32 CFR 28 regarding lobbying. When submitting your grant through Grants.gov, by completing blocks 18 and 19 of the Standard Form 424 Research and Related (R&R) Form, the grant applicant is providing the certification on lobbying required by 32 CFR Part 28, otherwise a signed copy by the authorized representative must be provided. Below is the required certification:

(a). CERTIFICATION AT APPENDIX A TO 32 CFR PART 28 REGARDING LOBBYING: Certification for Contracts, Grants, Loans, and Cooperative Agreements The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be

subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

(b). PROHIBITION ON CONTRACTING WITH ENTITIES THAT REQUIRED CERTAIN INTERNAL CONFIDENTIALITY AGREEMENTS – REPRESENTATION

Agreement with the representation below will be affirmed by checking the “I agree” box in block 17 of the SF424 (R&R) as part of the electronic proposal submitted via Grants.gov. The representation reads as follows:

By submission of its proposal or application, the applicant represents that it does not require any of its employees, contractors, or subrecipients seeking to report fraud, waste, or abuse to sign or comply with internal confidentiality agreements or statements prohibiting or otherwise restricting those employees, contractors, subrecipients from lawfully reporting that waste, fraud, or abuse to a designated investigative or law enforcement representative of a Federal department or agency authorized to receive such information.

Note that: (1) the basis for this representation is a prohibition in section 743 of the Financial Services and General Government Appropriations Act, 2015, Pub. L. 113-235) on provision of funds through grants and cooperative agreements to entities with certain internal confidentiality agreements or statements; and 2) section 743 states that it does not contravene requirements applicable to Standard Form 312, Form 4414, or any other form issued by a Federal department or agency governing the nondisclosure of classified information.

b. Policy Requirements

i. PROTECTION OF HUMAN SUBJECTS:

(1) Assistance Instruments:

(a) The recipient must protect the rights and welfare of individuals who participate as human subjects in research under this award and comply with the requirements at 32 CFR part 219, Department of Defense Instruction (DoDI) 3216.02, 10 U.S.C. 980, and when applicable, Food and Drug Administration (FDA) regulations.

(b) The recipient must not begin performance of research involving human subjects, also known as human subjects research (HSR), that is covered under 32 CFR part 219, or that meets exemption criteria under 32 CFR 219.101(b), until you receive a formal notification of approval from a DoD Human Research Protection Official

(HRPO). Approval to perform HSR under this award is received after the HRPO has performed a review of the recipient's documentation of planned HSR activities and has officially furnished a concurrence with the recipient's determination as presented in the documentation.

(c) In order for the HRPO to accomplish this concurrence review, the recipient must provide sufficient documentation to enable his or her assessment as follows:

(i) If the HSR meets an exemption criteria under 32 CFR 219.101(b), the documentation must include a citation of the exemption category under 32 CFR 219.101(b) and a rationale statement.

(ii) If the recipient's activity is determined as "non-exempt research involving human subjects", the documentation must include:

- Assurance of Compliance (i.e., Department of Health and Human Services Office for Human Research Protections (OHRP) Federal Wide Assurance (FWA)) appropriate for the scope of work or program plan; and

- Institutional Review Board (IRB) approval, as well as all documentation reviewed by the IRB to make their determination.

(d) The HRPO retains final judgment on what activities constitute HSR, whether an exempt category applies, whether the risk determination is appropriate, and whether the planned HSR activities comply with the requirements in paragraph (a) of this section.

(e) The recipient must notify the HRPO immediately of any suspensions or terminations of the Assurance of Compliance.

(f) DoD staff, consultants, and advisory groups may independently review and inspect the recipient's research and research procedures involving human subjects and, based on such findings, DoD may prohibit research that presents unacceptable hazards or otherwise fails to comply with DoD requirements.

(g) Definitions for terms used in this article are found in DoDI 3216.02.

(2) Contracts: The appropriate clauses shall be added to the award.

ii. ANIMAL USE:

(1) Assistance Instruments:

(a) Prior to initiating any animal work under the award, the recipient must:

(i) Register the recipient's research, development, test, and evaluation or training facility with the Secretary of Agriculture in accordance with 7 U.S.C. 2136 and 9 CFR section 2.30, unless otherwise exempt from this requirement by meeting the conditions in 7 U.S.C. 2136 and 9 CFR parts 1-4 for the duration of the activity.

(ii) Have the recipient's proposed animal use approved in accordance with DoDI 3216.01, Use of Animals in DoD Programs by a DoD Component Headquarters Oversight Office.

(iii) Furnish evidence of such registration and approval to the grants officer.

(b) The recipient must make the animals on which the research is being conducted, and all premises, facilities, vehicles, equipment, and records that support animal care and use available during business hours and at other times mutually agreeable to the recipient, the United States Department of Agriculture Office of Animal and Plant Health Inspection Service (USDA/APHIS) representative, personnel representing the DoD component oversight offices, as well as the grants officer, to ascertain that the recipient is compliant with 7 U.S.C. 2131 et seq., 9 CFR parts 1-4, and DoDI 3216.01.

(c) The recipient's care and use of animals must conform with the pertinent laws of the United States, regulations of the Department of Agriculture, and regulations, policies, and procedures of the DoD (see 7 U.S.C. 2131 et seq., 9 CFR parts 1-4, and DoDI 3216.01).

(d) The recipient must acquire animals in accordance with DoDI 3216.01.

(2) Contracts: The appropriate clauses shall be added to the award.

(iii) BIOLOGICAL DEFENSE SAFETY PROGRAM REQUIREMENTS: For All Awards. Successful offerors whose Principal Investigators are conducting research with Bio-safety Levels 3 and 4 material must prepare a Facility Safety Plan in accordance with 32 Code of Federal Regulations (CFR) 626.18. See URL: <https://www.gpo.gov/fdsys/search/pagedetails.action?collectionCode=CFR&searchPath=Title+32%2FChapter+V%2FSubchapter+H%2FPart+626&granuleId=CFR-2002-title32-vol3-part626&packageId=CFR-2002-title32-vol3&oldPath=Title+32%2FChapter+V%2FSubchapter+H%2FPart+626&fromPageDetails=true&collapse=false&ycord=2178> for a copy of 32 CFR 626.18, Biological Defense Safety Program.

(iv) **MILITARY RECRUITING: For Assistance Instruments Only.** This is to notify potential offerors that each grant or cooperative agreement awarded under this announcement to an institution of higher education must include the following term and condition:

"As a condition for receipt of funds available to the Department of Defense (DOD) under this award, the recipient agrees that it is not an institution of higher education (as defined in 32 CFR part 216) that has a policy of denying, and that it is not an institution of higher education that effectively prevents, the Secretary of Defense from obtaining for military recruiting purposes: (A) entry to campuses or access to students on campuses or (B) access to directory information pertaining to students. If the recipient is determined, using the procedures in 32 CFR part 216, to be such an institution of higher education during the period of performance of this agreement, and therefore to be in breach of this clause, the Government will cease all payments of DOD funds under this agreement and all other DOD grants and cooperative agreements to the recipient, and it may suspend or terminate such grants and agreements unilaterally for material failure to comply with the terms and conditions of award."

If your institution has been identified under the procedures established by the Secretary of Defense to implement Section 558, then: (1) no funds available to DOD may be provided to your institution through any grant, including any existing grant, (2) as a matter of policy, this restriction also applies to any cooperative agreement, and (3) your institution is not eligible to receive a grant or cooperative agreement in response to this solicitation.

(v) **MILITARY RECRUITING: For Contracts Only.** This is to notify potential offerors that each contract awarded under this announcement to an institution of higher education shall include the following clause: Defense Federal Acquisition Regulation Supplement (DFARS) clause 252.209-7005, Military Recruiting on Campus.

(vi) **SUBCONTRACTING: For Contracts Only.** This section is applicable to contracts where the dollar threshold is expected to exceed to \$750,000.00. Pursuant to Section 8(d) of the Small Business Act [15 U.S.C. 637(d)], it is the policy of the Government to enable small business concerns to be considered fairly as subcontractors under all research agreements awarded to prime contractors. The required elements of the Subcontracting Plan are set forth by FAR 52.219-9 (DEVIATION 2013-O0014) and DFARS 252.219-7003.

Subcontracting Plan Goals. Small business subcontracting goals are established on an individual contract basis. The applicant is requested to consider, when appropriate,

the Governments' subcontracting goals. When applied to R&D the small business-subcontractor plan should result in the best mix of cost schedule and performance.

(vi) EXPORT CONTROL LAWS:

Applicants should be aware of current export control laws and are responsible for ensuring compliance with all International Traffic in Arms Regulation (ITAR) (22 CFR 120 et. Seq.) requirements, as applicable. In some cases, developmental items funded by the Department of Defense are now included on the United States Munition List (USML) and are therefore subject to ITAR jurisdiction. Applicants should address in their proposals whether ITAR restrictions apply or do not apply, such as in the case when research products would have both civil and military application, to the work they are proposing to perform for the Department of Defense. The USML is available online at <https://www.ecfr.gov/cgi-bin/text-idx?node=pt22.1.121> Additional information regarding the President's Export Control Reform Initiative can be found at <http://export.gov/ecr/index.asp>

vii. DRUG-FREE WORKPLACE:

- (1) Assistance Instruments: The recipient must comply with drug-free workplace requirements in Subpart B of 2 CFR part 26, which is the DoD implementation of 41 U.S.C. chapter 81, "Drug-Free Workplace."
- (2) Contracts: The appropriate clause(s) shall be added to the award.

viii. DEBARMENT AND SUSPENSION:

- (1) Assistance Instruments: The recipient must comply with requirements regarding debarment and suspension in Subpart C of 2 CFR part 180, as adopted by DoD at 2 CFR part 1125. This includes requirements concerning the recipient's principals under an award, as well as requirements concerning the recipient's procurement transactions and subawards that are implemented in DoD Research and Development General Terms and Conditions PROC Articles I through III and SUB Article II.
- (2) Contracts: The appropriate clause(s) shall be added to the award.

ix. REPORTING SUBAWARDS AND EXECUTIVE COMPENSATION:

- (1) Assistance Instruments: The recipient must report information about subawards and

executive compensation as specified in the award term in Appendix A to 2 CFR part 170, "Reporting subaward and executive compensation information," modified as follows: (a) To accommodate any future designation of a different Government wide Web site for reporting subaward information, the Web site "http://www.fsr.gov" cited in paragraphs a.2.i. and a.3 of the award provision is replaced by the phrase "http://www.fsr.gov or successor OMB designated Web site for reporting subaward information"; (b) To accommodate any future designation of a different Government wide Web site for reporting executive compensation information, the Web site "http://www.sam.gov" cited in paragraph b.2.i. of the award provision is replaced by the phrase "https://www.sam.gov or successor OMB-designated Web site for reporting information on total compensation"; and 106 (c) The reference to "Sec. ____ .210 of the

attachment to OMB Circular A-133, "Audits of States, Local Governments, and Non-Profit Organizations" in paragraph e.3.ii of the award term is replaced by "2 CFR 200.330, as implemented in DoD Research and Development General Terms and Conditions SUB Article I of this award."

(2) Contracts: The appropriate clause(s) shall be added to the award.

3. Reporting:

Reports including number and types will be specified in the award document, but will include as a minimum quarterly technical and financial status reports. The reports shall be prepared and submitted in accordance with the procedures contained in the award document and mutually agreed upon before award. Reports and briefing material will also be required as appropriate to document progress in accomplishing program metrics.

MANPOWER CONTRACTOR REPORTING: For Contracts Only. The Office of the Assistant Secretary of the Army (Manpower & Reserve Affairs) operates and maintains a secure Army data collection site where the contractor will report ALL contractor manpower (including subcontractor manpower) required for performance of this contract. The contractor is required to completely fill in all the information in the format using the following web address: www.sam.gov . The required information includes:

- (1) Contracting Office, Contracting Officer, Contracting Officer's Technical Representative;
- (2) Contract number, including task and delivery order number;
- (3) Beginning and ending dates covered by reporting period;
- (4) Contractor name, address, phone number, e-mail address, identity of contractor employee entering data;
- (5) Estimated direct labor hours (including sub-contractors);
- (6) Estimated direct labor dollars paid this reporting period (including sub- contractors);
- (7) Total payments (including sub-contractors);

- (8) Predominate Federal Service Code (FSC) reflecting services provided by contractor (and separate predominant FSC for each sub-contractor if different);
- (9) Estimated data collection cost;
- (10) Organizational title associated with the Unit Identification Code (UIC) for the Army Requiring Activity (the Army Requiring Activity is responsible for providing the contractor with its UIC for the purposes of reporting this information);
- (11) Locations where contractor and sub-contractors perform the work (specified by zip code in the United States and nearest city, country, when in an overseas location, using standardized nomenclature provided on website);
- (12) Presence of deployment or contingency contract language; and
- (13) Number of contractor and sub-contractor employees deployed in theater this reporting period (by country).

As part of its submission, the contractor will also provide the estimated total cost (if any) incurred to comply with this reporting requirement. Reporting period will be the period of performance not to exceed 12 months ending 30 September of each government fiscal year and must be reported by 31 October of each calendar year.

Contractors may use a direct XML data transfer to the database server or fill in the fields on the website. The XML direct transfer is a format for transferring files from a contractor's systems to the secure web site without the need for separate data entries for each required data element at the web site. The specific formats for the XML direct transfer may be downloaded from the web site.

If the total Federal share exceeds \$500,000 on any Federal award under a notice of funding opportunity, the post-award reporting requirements reflected in Appendix XII to Part 200 of Title 2 CFR will be included in the award document. This requirement also applies to modifications of awards that: 1) increase the scope of the award, 2) are issued on or after January 1, 2016, and 3) increase the federal share of the award's total value to an amount that exceeds \$500,000.

G. Agency Contacts:

Questions of a technical nature or a programmatic nature shall be directed as specified below:

Technical Program Point of Contact (ARO):

Dr. T.R. Govindan
Army Research Office
Email Address: t.r.govindan.civ@army.mil

Questions of a business nature shall be directed to the contact info, as specified below:

Email address: usarmy.rtp.devcom-arl.mesg.qcbox@army.mil

Comments or questions submitted should be concise and to the point, eliminating any unnecessary verbiage. In addition, the relevant part and paragraph of the Broad Agency Announcement (BAA) should be referenced.

H. Other Information:

Below are 2 separate outlines of the informational requirements for a sample cost proposal. H.1. is for a procurement contract and H.2 for grants and cooperative agreements.

1. CONTRACT Proposals:

Cost Proposal – {No Page Limit} Cover sheet to include:

- (1) BAA number;
- (2) Technical area;
- (3) Lead Organization submitting proposal;
- (4) Type of business, selected among the following categories: “LARGE BUSINESS”, “SMALL DISADVANTAGED BUSINESS”, “OTHER SMALL BUSINESS”, “HBCU”, “MI”, “OTHER EDUCATIONAL”, OR “OTHER NONPROFIT”;
- (5) Contractor’s reference number (if any);
- (6) Other team members (if applicable) and type of business for each;
- (7) Proposal title;
- (8) Technical point of contact to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax (if available), electronic mail (if available);
- (9) Administrative point of contact to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax (if available), and electronic mail (if available);
- (10) Award instrument requested: cost-plus-fixed-fee (CPFF), cost-contract—no fee, cost sharing contract – no fee, or other type of procurement contract (specify).
- (11) Place(s) and period(s) of performance;
- (12) Total proposed cost separated by basic award and option(s) (if any);
- (13) Name, address, and telephone number of the proposer’s cognizant Defense Contract Management Agency (DCMA) administration office (if known);
- (14) Name, address, and telephone number of the proposer’s cognizant Defense Contract

Audit Agency (DCAA) audit office (if known);

(15) Date proposal was prepared;

(16) DUNS number;

(17) TIN number; and

(18) Cage Code;

(19) Subcontractor Information; and

(20) Proposal validity period

(21) Any Forward Pricing Rate Agreement, other such approved rate information, or such other documentation that may assist in expediting negotiations (if available).

I. Reasoning for Submitting a Strong Cost Proposal

The ultimate responsibility of the Contracting Officer is to ensure that all prices offered in a proposal are fair and reasonable before contract award [FAR 15.4]. To establish the reasonableness of the offered prices, the Contracting Officer may ask the offeror to provide various supporting documentation that assists in this determination. The offeror's ability to be responsive to the Contracting Officer's requests can expedite contract award. As specified in Section 808 of Public Law 105-261, an offeror who does not comply with a requirement to submit information for a contract or subcontract in accordance with paragraph (a)(1) of FAR 15.403-3 may be ineligible for award.

II. DCAA-Accepted Accounting System

- A) Before a contract can be awarded, the Contracting Officer must confirm that the offeror has a Defense Contract Audit Agency (DCAA)-accepted accounting system in place for accumulating and billing costs under Government contracts [FAR 53.209-1(f)]. If the offeror has DCAA correspondence, which documents the acceptance of their accounting system, this should be provided to the Contracting Officer (i.e. attached or referenced in the proposal). Otherwise, the Contracting Officer will submit an inquiry directly to the appropriate DCAA office and request a review of the offeror's accounting system.
- B) If an offeror does not have a DCAA-accepted accounting system in place, the DCAA review process can take several months depending upon the availability of the DCAA auditors and the offeror's internal processes. This will cause a delay in contract award.
- C) For more information about cost proposals and accounting standards, view the link titled "Information for Contractors" on the main menu on their website.

III. Field Pricing Assistance

During the pre-award cost audit process, the Contracting Officer will solicit support from

DCAA to determine commerciality and price reasonableness of the proposal [FAR 15.404-2]. Any proprietary information or reports obtained from DCAA field audits will be appropriately identified and protected within the Government.

IV. Sample Cost Proposal – “Piece by Piece”

- A) To help guide offerors through the pre-award cost audit process, a sample cost proposal is detailed below. This sample also allows the offeror to see exactly what the Government is looking for; therefore, all cost and pricing back-up data can be provided to the Government in the first cost proposal submission. Review each cost element within the proposal, and take note of the types of documentation that the Contracting Officer will require from the offeror.

- B) Direct Labor: The first cost element included in the cost proposal is Direct Labor. The Department of Defense (DoD) requires each proposed employee to be listed by name and labor category.

Below is the Direct Labor as proposed by our sample offeror:

DIRECT LABOR		YEAR 1			YEAR 2		
Employee Name	Labor Category	Direct Hourly Rate	Hours	Total Direct Labor	Direct Hourly Rate	Hours	Total Direct Labor
Andy Smith	Program Manager	\$55.00	720.00	\$39,600.00	\$56.65	720.00	\$40,788.00
Bryan Andrew	Senior Engineer	\$40.00	672.00	\$26,880.00	\$41.20	672.00	\$27,686.40
Cindy Thomas	Principal Engineer	\$50.00	512.00	\$25,600.00	\$51.50	512.00	\$26,368.00
David Porter	Entry Level Engineer	\$10.00	400.00	\$4,000.00	\$10.30	400.00	\$4,120.00
Edward Bean	Project Administrator	\$25.00	48.00	\$1,200.00	\$25.75	48.00	\$1,236.00
Subtotal Direct Labor (DL)				\$97,280.00			\$100,198.40

- 1) For this cost element, the Contracting Officer requires the offeror to provide adequate documentation in order to determine that each labor rate for each employee/labor category is fair and reasonable. The documentation will need to explain how these

labor rates were derived. For example, if the rates are DCAA- approved labor rates, provide the Contracting Officer with copies of the DCAA documents stating the approval. This is the most acceptable means of documentation to determine the rates fair and reasonable. Other types of supporting documentation may include General Service Administration (GSA) contract price lists, actual payroll journals, or Salary.com research. If an employee listed in a cost proposal is not a current employee (maybe a new employee, or one contingent upon the award of this contract), a copy of the offer letter stating the hourly rate - signed and accepted by the employee - may be provided as adequate documentation. Sometimes the hourly rates listed in a proposal are derived through subjective processes, i.e., blending of multiple employees in one labor category, or averaged over the course of the year to include scheduled payroll increases, etc. These situations should be clearly documented for the Contracting Officer.

- 2) Another cost element in Direct Labor is labor escalation, or the increase in labor rates from Year 1 to Year 2. In the example above, the proposed labor escalation is 3% (ex., Andy Smith increased from \$55.00/hr in Year 1, by 3% to \$56.65/hr in Year 2). Often times, an offeror may not propose escalation on labor rates during a 24-month period. Whatever the proposed escalation rate is, please be prepared to explain why it is fair and reasonable [ex., A sufficient explanation for our sample escalation rate would be the Government's General Schedule Increase and Locality Pay for the same time period (name FY) in the same location (name location) was published as 3.5%, therefore a 3% increase is fair and reasonable].

C) Other Direct Costs (ODCs): This section of the cost proposal includes all other directly related costs required in support of the effort i.e., materials, subcontractors, consultants, travel, etc. Any cost element that includes various items will need to be detailed in a cost breakdown to the Contracting Officer.

- 1) Direct Material Costs: This subsection of the cost proposal will include any special tooling, test equipment, and material costs necessary to perform the project. Items included in this section will be carefully reviewed relative to need and appropriateness for the work proposed, and must, in the opinion of the Contracting Officer, be advantageous to the Government and directly related to the specific topic.
 - a) The Contracting Officer will require adequate documentation from the offeror to determine the cost reasonableness for each material cost proposed. The following methods are ways in which the Contracting Officer can determine this [FAR 15.403-1].

- i) Adequate Price Competition. A price is based on adequate price competition when the offeror solicits and receives quotes from two or more responsible vendors for the same or similar items or services. Based on these quotes, the offeror selects the vendor who represents the best value to the Government. The offeror will be required to provide copies of all vendor quotes received to the Contracting Officer.

Note: Price competition is not required for items at or below the micropurchase threshold (\$5,000) [FAR 15.403-1]. If an item’s unit cost is less than or equal to \$5,000 price competition is not necessary. However, if an item’s total cost over the period of performance (unit cost * quantity is higher than \$5,000, two or more quotes must be obtained by the offeror.

- ii) Commercial Prices. Commercial prices are those published on current price lists, catalogs, or market prices. This includes vendors who have prices published on a GSA-schedule contract. The offeror will be required to provide copies of such price lists to the Contracting Officer.
- iii) Prices set by law or regulation. If a price is mandated by the Government (i.e. pronouncements in the form of periodic rulings, reviews, or similar actions of a governmental body, or embodied in the laws) that is sufficient to set a price.

- b) Below is the list of Direct Material costs included in our sample proposal:

- i)

DIRECT MATERIAL COSTS:	YEAR 1	YEAR 2
Raw Materials	\$35,000.00	\$12,000.00
Computer for experiments	\$4,215.00	\$0.00
Cable (item #12-3657, 300 ft)	\$1,275.00	\$0.00
Software	\$1,825.00	\$1,825.00
Subtotal Direct Materials Costs (DM):	\$42,315.00	\$13,825.00

- ii) “Raw Materials”: This is a generic label used to group many material items into one cost item within the proposal. The Contracts Officer will require a detailed breakout of all the items that make up this cost. For each separate item

over \$3,000 (total for Year 1 + Year 2), the offeror must be able to provide either competitive quotes received, or show that published pricing was used.

- iii) “Computer for experiments”: Again, this item is most likely a grouping of several components that make up one system. The Contracts Officer will require a detailed breakout of all the items that make up this cost. For each separate item over \$3,000 (total for Year 1 + Year 2), the offeror must be able to provide either competitive quotes received, or show that published pricing was used.
 - iv) “Cable”: Since this item is under the micro purchase threshold of \$5,000, competitive quotes or published pricing are not required. Simply provide documentation to show the Contracting Officer where this price came from.
 - v) “Software”: This cost item could include either one software product, or multiple products. If this includes a price for multiple items, please provide the detailed cost breakdown. Note: The price for Year 1 (\$1,825) is below the micro purchase threshold; however, in total (Year 1 + Year 2) the price is over \$5,000, so competitive quotes or published pricing documentation must be provided.
- c) Due to the specialized types of products and services necessary to perform these projects, it may not always be possible to obtain competitive quotes from more than one reliable source. Each cost element over the simplified acquisition threshold (\$5,000) must be substantiated. There is always an explanation for HOW the cost of an item was derived; show us how you came up with that price!
- d) When it is not possible for an offeror to obtain a vendor price through competitive quotes or published price lists, a Contracting Officer may accept other methods to determine cost reasonableness. Below are some examples of other documentation, which the Contracting Officer may accept to substantiate costs:
- i) Evidence that a vendor/supplier charged another offeror a similar price for similar services. Has the vendor charged someone else for the same product? (Two (2) to three (3) invoices from that vendor to different customers may be used as evidence.)
 - ii) Previous contract prices. Has the offeror charged the Government a similar price under another Government contract for similar services? If the

Government has already paid a certain price for services, then that price may already be considered fair and reasonable. (Provide the contract number, and billing rates for reference.)

iii) DCAA approved. Has DCAA already accepted or verified specific cost items included in your proposal? (Provide a copy of DCAA correspondence that addressed these costs.)

2) Below is the remaining ODC portion of our proposal including equipment, subcontractors, consultants, and travel. Assume in this scenario that competitive quotes or catalog prices were not available for these items:

OTHER DIRECT COSTS:	YEAR 1	YEAR 2
Equipment Rental for Analysis	\$5,500.00	\$5,600.00
Subcontractor – Lockheed	\$25,000.00	\$0.00
Consultant: John Bowers	\$0.00	\$12,000.00
Travel	\$1,250.00	\$1,250.00
Subtotal Other Direct Costs (ODC):	\$31,750.00	\$18,850.00

- a) “Equipment Rental for Analysis”: The offeror explains that the Year 1 cost of \$5,500 is based upon 250 hours of equipment rental at an hourly rate of \$22.00/hr. One (1) invoice from the vendor charging another vendor the same price for the same service is provided to the Contracting Officer as evidence. Since this cost is over the simplified acquisition threshold, further documentation to determine cost reasonableness is required. The offeror is able to furnish another invoice charging a second vendor the same price for the same service.
- b) “Subcontractor – Widget, Inc.”: The offeror provides a copy of the subcontractor quote to the Contracting Officer in support of the \$25,000 cost. This subcontractor quote must include sufficient detailed information (equivalent to the data included in the prime’s proposal to the Government), so that the Contracting Officer can make a determination of cost reasonableness.
 - i) As stated in Section 3.5(c)(6) of the DoD Cost Proposal guidance, “All subcontractor costs and consultant costs must be detailed at the same level as prime contractor costs in regards to labor, travel, equipment, etc. Provide detailed substantiation of subcontractor costs in your cost proposal.”
 - ii) In accordance with FAR 15.404-3, “the Contracting Officer is responsible for the determination of price reasonableness for the prime contract,

including subcontracting costs”. This means that the subcontractor’s quote/proposal may be subject to the same scrutiny by the Contracting Officer as the cost proposal submitted by the prime. The Contracting Officer will need to determine whether the subcontractor has an accepted purchasing system in place and/or conduct appropriate cost or price analyses to establish the reasonableness of proposed subcontract prices. Due to the proprietary nature of cost data, the Subcontractor may choose to submit their pricing information directly to the Contracting Officer and not through the prime. This is understood and encouraged.

iii) When a subcontractor is selected to provide support under the prime contract due to their specialized experience, the Contracting Officer may request sole source justification from the offeror.

c) “Consultant – John Bowers”: Again, the offeror shall provide a copy of the consultant’s quote to the Contracting Officer as evidence. In this example, the consultant will be charging an hourly rate of \$125 an hour for 96 hours of support. The offeror indicates to the Contracting Officer that this particular consultant was used on a previous contract with the Government (provide contract number), and will be charging the same rate. A copy of the consultant’s invoice to the offeror under the prior contract is available as supporting evidence. Since the Government has paid this price for the same services in the past, determination has already been made that the price is fair.

d) “Travel”: The Contracting Officer will require a detailed cost breakdown for travel expenses to determine whether the total cost is reasonable based on Government per diem and mileage rates. This breakdown shall include the number of trips, the destinations, and the number of travelers. It will also need to include the estimated airfare per round trip, estimated car rental, lodging rate per trip, tax on lodging, and per diem rate per trip. The lodging and per diem rates must coincide with the Joint Travel Regulations. Please see the following website to determine the appropriate lodging and per diem rates:
<http://www.defensetravel.dod.mil/site/perdiemCalc.cfm>
 Additionally, the offeror must provide why the airfare is fair and reasonable as well. Sufficient back up for both airfare and car rental would include print outs of online research at the various travel search engines (Expedia, Travelocity, etc.) documenting the prices for airfare and car rentals thus proving why your chosen rate is fair and reasonable.

i) Below is a sample of the travel portion:

TRAVEL		Trips	Travelers	Nights	Days	Unit Cost	Total Travel
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Airfare	per roundtrip	1	1			\$996.00	\$996.00
Lodging	per day	1	1	1		\$75.00	\$75.00
Tax on Lodging							
(12%)	per day	1	1	1		\$9.00	\$9.00
Per Diem	per day	1	1		2	\$44.00	\$88.00
Automobile Rental					2		
	per day	1	1			\$41.00	\$82.00
Subtotal Travel							\$1,250.00

D) Indirect Rates: Indirect rates include elements such as Fringe Benefits, General & Administrative (G&A), Overhead, and Material Handling costs. The offeror shall indicate in the cost proposal both the indirect rates (as a percentage) as well as how those rates are allocated to the costs in the proposal.

INDIRECTS	YEAR 1	YEAR 2
Subtotal Direct Labor (DL):	\$97,280.00	\$100,198.40
Fringe Benefits, if not included in Overhead, rate (15.0000 %) X DL =	\$14,592.00	\$15,029.76
Labor Overhead (rate 45.0000 %) X (DL + Fringe) =	\$50,342.40	\$51,852.67
Total Direct Labor (TDL):	\$162,214.40	\$167,080.83

- 1) In this example, the offeror includes a Fringe Benefit rate of 15.00% that is allocated to the Direct Labor costs. They also propose a Labor Overhead rate of 45.00% that is allocated to the Direct Labor costs plus the Fringe Benefits.
- 2) All indirect rates and the allocation methods of those rates must be verified by the Contracting Officer. In most cases, DCAA documentation supporting the indirect rates and allocation methods can be obtained through a DCAA field audit or proposal review. Many offerors have already completed such reviews and have this documentation readily available. If an offeror is unable to participate in a DCAA

review to substantiate indirect rates, the Contracting Officer may request other accounting data from the offeror to make a determination.

E.) Cost of Money (COM): If Cost of Money (an imputed cost that is not a form of interest on borrowings (see FAR 31.205-20); an “incurred cost” for cost-reimbursement purposes under applicable cost-reimbursement contracts and for progress payment purposes under fixed-price contracts; and refers to— (1) Facilities capital cost of money (48 CFR 9904.414); and (2) Cost of money as an element of the cost of capital assets under construction (48 CFR 9904.417)) is proposed in accordance with FAR 31.205-10, a DD Form 1861 is required to be completed and submitted with the contractor’s proposal.

F.) Fee/Profit: The proposed fee percentage will be analyzed in accordance with DFARS 215.404, the Weighted Guidelines Method.

G.) Subcontracting Plan: If the total amount of the proposal exceeds \$750,000 and the offeror is a large business or an institute of higher education (other than HBCU/MI) and the resultant award is a contract, the offeror shall be prepared to submit a subcontracting plan for small business and small disadvantaged business concerns. A mutually agreeable plan will be included in and made a part of the contract (see the goals listed at Section II, F, 2, b).

2. GRANT and COOPERATIVE AGREEMENT Proposals:

Before award it must be established that an approved accounting system and financial management system exist.

A.) Direct Labor: Show the current and projected salary amounts in terms of man-hours, man-months, or annual salary to be charged by the principal investigator(s), faculty, research associates, postdoctoral associates, graduate and undergraduate students, secretarial, clerical, and other technical personnel either by personnel or position. State the number of man-hours used to calculate a man-month or man-year. For proposals from universities, research during the academic term is deemed part of regular academic duties, not an extra function for which additional compensation or compensation at a higher rate is warranted. Consequently, academic term salaries shall not be augmented either in rate or in total amount for research performed during the academic term. Rates of compensation for research conducted during non-academic (summer) terms shall not exceed the rate for the academic terms. When part or all of a person's services are to be charged as project costs, it is expected that the person will be relieved of an equal part or all of his or her regular teaching or other obligations. For each person or position, provide the following information:

- 1) The basis for the direct labor hours or percentage of effort (e.g., historical hours or estimates).

- 2) The basis for the direct labor rates or salaries. Labor costs should be predicted upon current labor rates or salaries. These rates may be adjusted upward for forecast salary or wage cost-of-living increases that will occur during the agreement period. The cost proposal should separately identify the rationale applied to base salary/wage for cost-of-living adjustments and merit increases. Each must be fully explained.
- 3) The portion of time to be devoted to the proposed research, divided between academic and non-academic (summer) terms, when applicable.
- 4) The total annual salary charged to the research project.
- 5) Any details that may affect the salary during the project, such as plans for leave and/or remuneration while on leave.

B.) Fringe Benefits and Indirect Costs (Overhead, General and Administrative, and Other): The most recent rates, dates of negotiation, the base(s) and periods to which the rates apply must be disclosed and a statement included identifying whether the proposed rates are provisional or fixed. If the rates have been negotiated by a Government agency, state when and by which agency. A copy of the negotiation memorandum should be provided. If negotiated forecast rates do not exist, offerors must provide sufficient detail to enable a determination to be made that the costs included in the forecast rate are allocable according to applicable OMB Circulars or FAR/DFARS provisions. Offerors' disclosure should be sufficient to permit a full understanding of the content of the rate(s) and how it was established. As a minimum, the submission should identify:

- 1) All individual cost elements included in the forecast rate(s);
- 2) Bases used to prorate indirect expenses to cost pools, if any;
- 3) How the rate(s) was calculated;
- 4) Distribution basis of the developed rate(s);
- 5) Bases on which the overhead rate is calculated, such as "salaries and wages" or "total costs," and
- 6) The period of the offeror's fiscal year.

C.) Permanent Equipment: If facilities or equipment are required, a justification why this property should be furnished by the Government must be submitted. State the organization's inability or unwillingness to furnish the facilities or equipment. Offerors must provide an

itemized list of permanent equipment showing the cost for each item. Permanent equipment is any article or tangible nonexpendable property having a useful life of more than one year and an acquisition cost of \$5,000 or more per unit. The basis for the cost of each item of permanent equipment included in the budget must be disclosed, such as:

- 1) Vendor Quote: Show name of vendor, number of quotes received and justification, if intended award is to other than lowest bidder.
- 2) Historical Cost: Identify vendor, date of purchase, and whether or not cost represents lowest bid. Include reason(s) for not soliciting current quotes.
- 3) Engineering Estimate: Include rationale for quote and reason for not soliciting current quotes. If applicable, the following additional information shall be disclosed in the offeror's cost proposal:
- 4) Special test equipment to be fabricated by the awardee for specific research purposes and its cost.
- 5) Standard equipment to be acquired and modified to meet specific requirements, including acquisition and modification costs, listed separately.
- 6) Existing equipment to be modified to meet specific research requirements, including modification costs. Do not include equipment the organization will purchase with its funds if the equipment will be capitalized for Federal income tax purposes. Proposed permanent equipment purchases during the final year of an award shall be limited and fully justified.
- 7) Grants and cooperative agreements may convey title to an institution for equipment purchased with project funds. At the discretion of the contracting/grants officer, the agreement may provide for retention of the title by the Government or may impose conditions governing the equipment conveyed to the organization per the governing laws and regulations.

D.) Travel: Forecasts of travel expenditures (domestic and foreign) that identify the destination and the various cost elements (airfare, mileage, per diem rates, etc.) must be submitted. The costs should be in sufficient detail to determine the reasonableness of such costs. Allowance for air travel normally will not exceed the cost of round-trip, economy air accommodations. Specify the type of travel and its relationship to the research project. Requests for domestic travel must not exceed \$3,000 per year per principal investigator. Separate, prior approval by the ARL is required for all foreign travel (i.e., travel outside the continental U.S., its possessions and

Canada). Foreign travel requests must not exceed \$1,800 each per year per principal investigator. Special justification will be required for travel requests in excess of the amounts stated above and for travel by individuals other than the principal investigator(s). Individuals other than the principal investigator(s) are considered postdoctoral associates, research associates, graduate and undergraduate students, secretarial, clerical, and other technical personnel. Additional travel may be requested for travel to Army laboratories and facilities to enhance agreement objectives and to achieve technology transfer.

E.) Participant Support Costs: This budget category refers to costs of transportation, per diem, stipends, and other related costs for participants or trainees (but not employees) in connection with ARL-sponsored conferences, meetings, symposia, training activities, and workshops (see the "Other Programs" section as described earlier in this BAA). Generally, indirect costs are not allowed on participant support costs. The number of participants to be supported should be entered in the parentheses on the budget form. These costs should also be justified in the budget justification page(s) attached to the cost proposal.

F.) Materials, Supplies, and Consumables: A general description and total estimated cost of expendable equipment and supplies are required. The basis for developing the cost estimate (vendor quotes, invoice prices, engineering estimate, purchase order history, etc.) must be included. If possible, provide a material list.

G.) Publication, Documentation, and Dissemination: The budget may request funds for the costs of preparing, publishing, or otherwise making available to others the findings and products of the work conducted under an agreement, including costs of reports, reprints, page charges, or other journal costs (except costs for prior or early publication); necessary illustrations, cleanup, documentation, storage, and indexing of data and databases; and development, documentation, and debugging of software.

H.) Consultant Costs: Offerors normally are expected to utilize the services of their own staff to the maximum extent possible in managing and performing the project's effort. If the need for consultant services is anticipated, the nature of proposed consultant services should be justified and included in the technical proposal narrative. The cost proposal should include the names of consultant(s), primary organizational affiliation, each individual's expertise, daily compensation rate, number of days of expected service, and estimated travel and per diem costs.

I.) Computer Services: The cost of computer services, including computer-based retrieval of scientific, technical, and educational information, may be requested. A justification/explanation based on the established computer service rates at the proposing organization should be included. The budget also may request costs, which must be shown to be reasonable, for leasing automatic data processing equipment. The purchase of computers or associated hardware and software should be requested as items of equipment.

J.) Subawards (subcontracts or subgrants): A precise description of services or materials that are to be awarded by a subaward must be provided. For subawards totaling \$10,000 or more, provide the following specific information:

- 1) A clear description of the work to be performed.
- 2) If known, the identification of the proposed subawardee and an explanation of why and how the subawardee was selected or will be selected.
- 3) The identification of the type of award to be used (cost reimbursement, fixed price, etc.).
- 4) Whether or not the award will be competitive and, if noncompetitive, rationale to justify the absence of competition.
- 5) A detailed cost summary.

K.) Other Direct Costs: Itemize and provide the basis for proposed costs for other anticipated direct costs such as communications, transportation, insurance, and rental of equipment other than computer related items. Unusual or expensive items shall be fully explained and justified.

L.) Profit/ Fee: Profit/ fee is not allowed for the Recipient of or subaward to an assistance instrument, where the principal purpose of the activity to be carried out is to stimulate or support a public purpose (i.e., to provide assistance), rather than acquisition (i.e., to acquire goods and services for the direct benefit of the United States Government). A subaward is an award of financial assistance in the form of money, or property in lieu of money, made under a DoD grant or cooperative agreement by a recipient to an eligible subrecipient. The term includes financial assistance for substantive program performance by the subrecipient of a portion of the program for which the DoD grant or cooperative agreement was made. It does not include the recipient's procurement of goods and services needed to carry out the program.

M.) Subcontracting Plan: Subcontracting plans do not apply to assistance instruments.

CONTRACT FACILITIES CAPITAL COST OF MONEY: If cost of money is proposed, a completed Contract Facilities Capital Cost of Money (FCCM) (DD Form 1861) is required.