

*Super*Cables

IARPA Proposers' Day
November 7, 2017



Office of the Director of National Intelligence

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BE THE FUTURE



Why we are here

- Familiarize participants with IARPA's interest in the SuperCables program
- Familiarize participants with IARPA's mission and how to do business with IARPA
- Provide answers to participants' questions
- Provide you a chance to alter the course of events
- Foster discussion of synergistic capabilities among potential program participants, i.e., facilitate teaming
- Take a chance - someone might have a missing piece of your puzzle



Additional Information

- Proposers' Day slides will be posted on iarpa.gov
- Please save questions for the end, write on notecards
- Posters are available for browsing during break/lunch
- Government will not be present during the poster/teaming session
- Discussions with PM allowed until BAA release
- Once BAA is published, questions can only be submitted and answered in writing via the BAA guidance
- Name/email list of Proposers' Day participants provided to the group **with permission**



SuperCables Notional Pre-Launch Schedule

ACTIVITY	Date
Proposers Day	November 7
BAA Draft Feedback Due	November 17
BAA Release	January 8
Proposals Due	February 19
Award	July 30



Point of Contact

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(include IARPA-BAA-18-02 in the Subject Line)

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Questions? Please fill out cards.

**This briefing is UNCLASSIFIED
All slides are Prepub-Approved**

IARPA Overview



Office of the Director of National Intelligence

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IARPA Mission and Method

IARPA's mission is to envision and lead high-risk, high-payoff research that delivers innovative technology for future overwhelming intelligence advantage

- **Bring the best minds to bear on our problems**
 - Full and open competition to the greatest possible extent, funding scientists and engineers in academia and industry, through contracts, grants, OTs, and prize challenges
 - World-class, rotational Program Managers
- **Define and execute research programs that:**
 - Have goals that are clear, measureable, ambitious and credible
 - Employ independent and rigorous Test & Evaluation
 - Involve IC partners from start to finish
 - Run from three to five years
 - Publish peer-reviewed results and data, to the greatest possible extent

IARPA's Customers



IARPA Highlights

“One of the government’s most creative agencies.”

– David Brooks, NYT

- Best known for quantum computing, superconducting computing, forecasting tournaments; but our portfolio is diverse -- math, CS, physics, chemistry, biology, neuroscience, linguistics, political science, cognitive psychology. “Everything from AI to Zika.”
- Research highlights include:
 - White House BRAIN Initiative, National Strategic Computing Initiative
 - Nobel Prize for Physics
 - Science “Breakthrough of the Year”
 - MacArthur “Genius”
 - 2,000+ journal articles
- >70% of completed research transitioned to USG partners





Current IARPA Research

Collection

- Amon-Hen (space SA)
- FELIX (syn bio)
- FunGCAT (syn bio)
- Ithildin (chem detection)
- HFGeo (HF geolocation)
- MAEGLIN (CBRN)
- MOSAIC (pattern of life)
- Odin (biometrics)
- Proteos (human ID)
- SILMARILS (chem)
- SLICE (RF tracking)
- UnderWatch (undersea)
- Seedlings and Studies

Analysis

- Aladdin (video search)
- Babel (speech recognition)
- CORE3D (3D modeling)
- DIVA (surveillance video)
- Finder (geolocate images)
- Janus (facial recog)
- KRNS (neuroimaging)
- MATERIAL (translation)
- SHARP (training)
- Seedlings and Studies

Computing

- C3 (cryogenic computing)
- HECTOR (encryption)
- LogiQ (quantum)
- MICrONS (neuromorphic)
- QEO (quantum)
- RAVEN (chip analysis)
- SuperTools (cryogenic)
- TIC (chip security)
- VirtUE (cloud security)
- Seedlings and Studies

Anticipatory Intel

- CAUSE (cyber I&W)
- CREATE (crowdsourcing)
- FUSE (S&T intel)
- Hybrid Forecasting (I&W)
- Mercury (SIGINT I&W)
- SCITE (insider threats)
- Seedlings and Studies

Prize Challenges

- Nail-to-Nail Fingerprinting
- Unconstrained Face Recognition
- Functional Map of the World
- MORGOTH'S CROWN

How to engage with IARPA

- **Website:** www.IARPA.gov
 - Reach out to us, especially the IARPA PMs. Contact information on the website.
 - Schedule a visit if you are in the DC area or invite us to visit you.
- **Opportunities to Engage:**
 - **Research Programs**
 - Multi-year research funding opportunities on specific topics
 - Proposers' Days provide opportunities to learn what is coming, and to influence programs
 - **IARPA-Wide BAA “Seedlings”**
 - Typically a 9-12 month study; you can submit your research proposal at any time
 - Strongly encouraged: informal discussion with a PM before proposal submission
 - **Prize Challenges**
 - No proposals required
 - Submit solutions to our problems; if your solutions are the best, you receive a cash prize and bragging rights
 - **Requests for Information (RFIs) and Workshops**
 - Provide input while IARPA is planning new programs



SuperCables

Technical Introduction and BAA



Office of the Director of National Intelligence

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What are you trying to do?

SuperCables (this program):

- Develop low energy-per-bit technologies for high speed data transmission between single flux quantum systems at 4 kelvins and room temperature processing systems.
- Develop test bed technologies for candidate transmission systems.

Next program:

- Integrate these technologies into complete data transmission systems.



How is it done at present?

- Systems that require cryogenic information transfer
 - Naval RF receiver prototypes (an existing system with digital I/O)
 - Quantum computing
 - NASA radio astronomy,
 - NIST noise thermometry
 - Cryogenic Computing
- Electrical wires carry the signal
 - Coaxial cable
 - Twisted pairs
 - Cu/BeCu ribbon cable



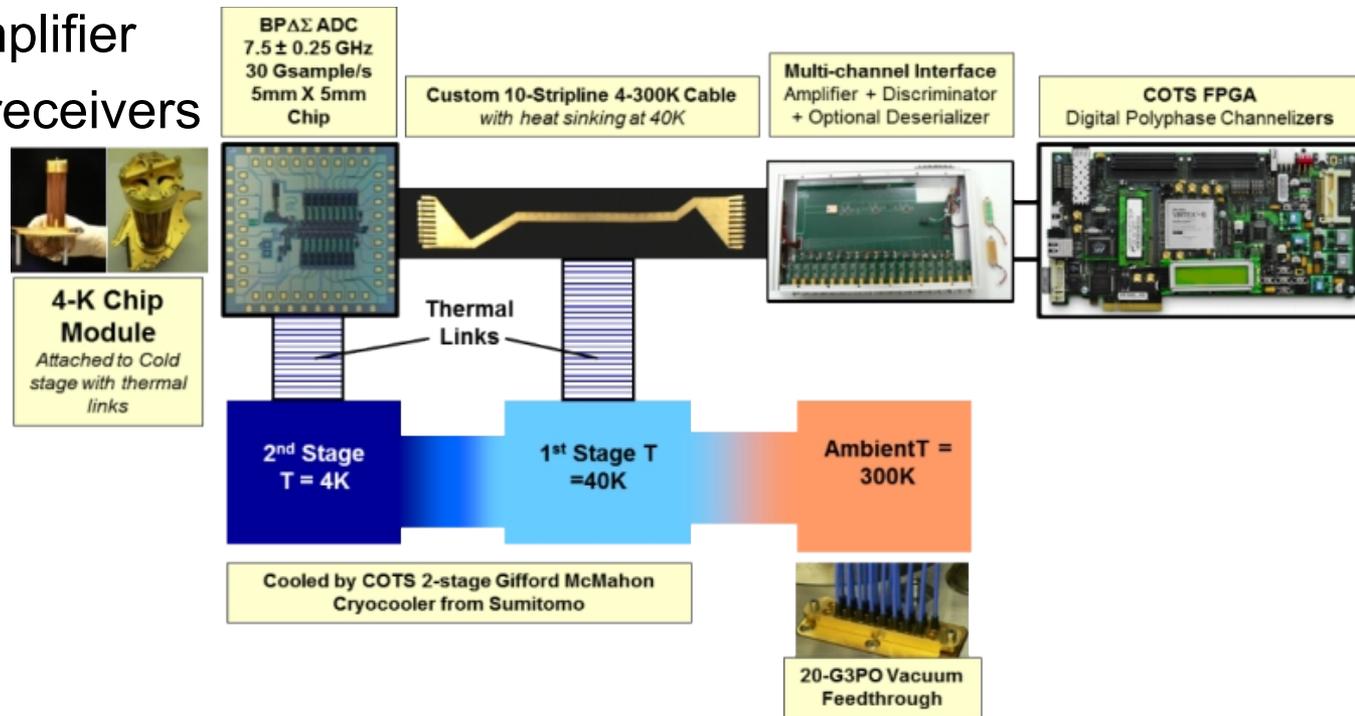
What are the limitations of present approaches?

- Poor scalability to high data transfer rates
 - Data rate per wire is small
 - 14 Gb/s per wire; ONR-Hypres
 - Thermal conductance of many-wire solution is too large
 - Example: One millimeter diameter, one meter long, Cu wire between 4 K and RT carries about 200 mW heat to 4 K. Compare with about 0.2 mW for glass fiber.
 - Problems increase with number of wires
- Unacceptable energy cost per bit
 - Above example leads to ~20 pJ/bit, just for heat leak, 4+ orders of magnitude above objective.



Today's egress datalinks in receiver prototypes

- Electrical Datalink Chain
 - Drivers on superconductor IC
 - Transmission line from 4 to 300 K
 - Interface Amplifier
 - FPGA data receivers





What is new about your approach?

- Integrated optical-electrical system for high rate data transfer between 4 kelvins and room temperature
- New or improved features
 - Optical fiber to cryogenic space
 - Cryogenic electrical-to-optical modulators (EOM)
 - Pulse sequence generator (SFQ to EOM)
 - Superconducting ribbon cable
 - Optimized cryogenic amplifiers
 - High efficiency, cryogenic, optical-to-electrical modulators (OEM)
 - Data link error detection and correction
 - Advanced modulation schemes



Why do you think that you can succeed?

- Industry is progressing towards integrated chip-level electro-optics
- Ideas for cryogenic electro-optic modulators surfaced by RFI
- New developments in data encoding enable optical fibers to carry data at ever increasing rates and at lower energy



If you succeed, what difference will it make?

High rate data transfer is an enabler for cryogenic applications of all of the following:

- Quantum computing
- Classical computing
- Digital radio
- Streaming data processing



SuperCables Program Organization

- This program: Technology development (24 months):
Set of themed projects to develop and evaluate technology for data transmission
 - Cryogenic electrical-to-optical modulators (EOM)
 - Programmable SFQ generator system (stimulus module)
 - Test and evaluation system
- Next program: Maturation and integration (36 months):
Integrators mature technologies and integrate system
 - Cryogenic optical-to-electrical modulator (OEM)
 - Test and evaluation team measures system performance
 - System model will predict scaling behavior and opportunities



SuperCables Proposed Work

- Test probe and system specification and design (T&E)
 - Energy measurement capable
 - Bit error rate measurement capable
 - Allow for various electrical-to-optical modulators (EOM)
- Pulse sequence generator (T&E)
 - Based on single flux quanta
 - Chip fabricated by Lincoln Laboratory
 - Able to generate pseudorandom pulse sequence
 - Able to supply pulses for any EOM in program
- Cryogenic electro-optic modulators (performers)
- Other?



*Super*Cables Out of Scope

- Any technology that works exclusively for data ingress
- Proposals for a complete integrated system
- Work to develop new superconducting cable



SuperCables Test and Evaluation

Possible test and evaluation partners:

NSA Laboratory for Physical Sciences

Navy-SPAWAR

Sandia National Laboratories

NIST-Boulder

NRL



SuperCables Milestones

		Month	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
Meet	Kickoff		G																									
	Site visit																											
	Technical interchange meeting								G						G						G						G	
Test	Stimulus module specification																											
	Performer cryogenic test																											
	Performer tests in GFE system																											
	T&E cryogenic tests																											
Report	Monthly report																											
	Final report																											

Performer site visit

Government hosted meeting

How hard is this problem?

- Very Hard!
 - Developing a cryogenic modulator that has sufficient bandwidth and energy efficiency
 - Developing a pulse generator that is sufficiently energy efficient
 - Developing sufficiently low loss interfaces between disparate transmission subsystems and components
- Where does our energy goal come from?
 - Energy per bit at 4 K= $(2E6\text{ W})(0.05)/(1E18/s*500) = 200\text{ aJ}$
- Lower energy per bit will enable higher data rate streaming applications.

Metric	Units	Goals		
		Threshold	Objective	Stretch
Energy per bit at 4 K	aJ/bit	2,000	200	10
Channels per chip area	cm ⁻²	10	20	100
Data rate per channel	Gbit/s	10	50	100
Latency	ns	200	50	10

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			Goals	
Metric	Unit	Goal	Objective	Stretch
Max Power	Watts	200	200	10
Capacity	bits/s	100	100	100
Data Rate	bits/s	200	200	100
Latency	ns	200	200	10

Exascale goal is 2 MW total power

Five percent of total power for data egress

One exabit per second

Refrigerator efficiency

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SuperCables Metrics and Goals

- Photonic ingress & egress components (Performers)
 - Bit energy at 4 K: 10 aJ/bit (this is about 50 flux quanta or about 100 photons)
 - Data rate: 10 Gb/s per channel
- Pulse sequence generator (Test and Evaluation team)
 - Input: 10 single flux quanta; Output: pulses up to 100 mV, 100 ps wide
 - 4 pulses proven by month 18
- Cryogenic test bed designed and built by month 12 (T&E)
- System (next program, notional)
 - Data rate: 640 Gb/s, ingress or egress
 - Bit error rate: 10^{-6} raw; 10^{-12} with more energy, more error correction, or slower rate
 - Modularity: New component can replace old with minimal redo of link, clear interface control documentation



SuperCables Key Test and Evaluation Tasks

- Cryogenic device test bed development
 - Develop interface standards with performers to optimize interchangeability
 - Design and build test beds
- Develop energy dissipation measurement protocol
- Cryogenic support to performers
- Performer device (EOM, ...) performance verification
- Stimulus module performance verification



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SuperCables Program Roles and Responsibilities

- Performer R&D
 - Device development
 - Work with T&E team to develop test bed specifications
 - Measure device performance
- Government Support
 - Government Furnished Information (GFI): None
 - Government Furnished Equipment (GFE):
 - Cryogenic test bed
 - Testing and Evaluation:
 - Test devices
 - Test pulse generator



Risks

- Developing a cryogenic modulator that has sufficient bandwidth and energy efficiency
- Developing a pulse generator that is sufficiently energy efficient
- Developing sufficiently low loss interfaces between disparate transmission subsystems and components

Point of Contact

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Questions? Please fill out cards.

Doing Business with IARPA

Mr. Tarek Abboushi, Chief Acquisitions Officer
Intelligence Advanced Research Projects Activity



Office of the Director of National Intelligence

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Doing Business with IARPA - Recurring Questions

- Questions and Answers (<http://www.iarpa.gov/index.php/faqs>)
- Eligibility Info
- Intellectual Property
- Pre-Publication Review
- Preparing the Proposal (Broad Agency Announcement (BAA) Section 4)
 - Electronic Proposal Delivery (<https://iarpa-ideas.gov>)
- Organizational Conflicts of Interest
(<http://www.iarpa.gov/index.php/working-with-iarpa/iarpas-approach-to-oci>)
- Streamlining the Award Process
 - Accounting system
 - Key Personnel
- IARPA Funds Applied Research
- RECOMMENDATION: Please read the entire BAA



Responding to Q&As

- Please read entire BAA before submitting questions
- Pay attention to Section 4 (Proposal & Submission Information)
- Read Frequently Asked Questions on the IARPA @ <http://www.iarpa.gov/index.php/faqs>
- Send your questions as soon as possible
 - Super Cables BAA: **dni-iarpa-baa-18-02@iarpa.gov** (not final email)
 - Write questions as clearly as possible
 - Do NOT include proprietary information



Eligible Applicants

- Collaborative efforts/teaming strongly encouraged
 - Content, communications, networking, and team formation are the responsibility of Proposers
- Foreign organizations and/or individuals may participate
 - Must comply with Non-Disclosure Agreements, Security Regulations, Export Control Laws, etc., as appropriate, as identified in the BAA



Ineligible Organizations

Other Government Agencies, Federally Funded Research and Development Centers (FFRDCs), University Affiliated Research Centers (UARCs), and any organizations that have a special relationship with the Government, including access to privileged and/or proprietary information, or access to Government equipment or real property, are not eligible to submit proposals under this BAA or participate as team members under proposals submitted by eligible entities.



Intellectual Property (IP)

- Unless otherwise requested, Government rights for data first produced under IARPA contracts will be UNLIMITED
- At a minimum, IARPA requires Government Purpose Rights (GPR) for data developed with mixed funding
- Exception to GPR
 - State in the proposal any restrictions on deliverables relating to existing materials (data, software, tools, etc.)



Pre-Publication Review

- Funded Applied Research efforts, IARPA encourages:
 - Publication for Peer Review of **UNCLASSIFIED** research
- Prior to public release of any work submitted for publication, the Performer will:
 - Provide copies to the IARPA PM and Contracting Officer Representative (COR/COTR)
 - Ensure shared understanding of applied research implications between IARPA and Performers
 - IARPA PM decides on approval for release or receiving courtesy copy



Preparing the Proposal

- Note restrictions in BAA Section 4 on proposal submissions
 - Interested Offerors must register electronically IAW instructions on: <https://iarpa-ideas.gov>
 - Interested Offerors are strongly encouraged to register in IDEAS at least 1 week prior to proposal “Due Date”
 - Offerors must ensure the version submitted to IDEAS is the “Final Version”
 - Classified proposals – Contact IARPA Chief of Security
- BAA format is established to answer most questions
- Check FBO for amendments & IARPA website for Q&As
- BAA Section 5 – Read Evaluation Criteria carefully
 - e.g. “The technical approach is credible and includes a clear assessment of primary risks and a means to address them”



Preparing the Proposal (BAA Sect 4)

- Read IARPA's Organizational Conflict of Interest (OCI) policy:
<http://www.iarpa.gov/index.php/working-with-iarpa/iarpas-approach-to-oci>
- See also eligibility restrictions on use of Federally Funded Research and Development Centers, University Affiliated Research Centers, and other similar organizations that have a special relationship with the Government
 - Focus on possible OCIs of your institution as well as the personnel and subcontractors on your team
 - See Section 4: It specifies the non-Government (e.g., SETA, FFRDC, UARC, etc.) support we will be using. If you have a potential or *perceived* conflict, request a waiver as soon as possible



Organizational Conflict of Interest (OCI)

- If a prospective offeror, or any of its proposed subcontractor teammates, believes that a potential conflict of interest exists or may exist (whether organizational or otherwise), the offeror should promptly raise the issue with IARPA and submit a waiver request by e-mail to the mailbox address for this BAA at **dni-iarpa-baa-18-02@iarpa.gov** (not final email).
- A potential conflict of interest includes but is not limited to any instance where an offeror, or any of its proposed subcontractor teammates, is providing either scientific, engineering and technical assistance (SETA) or technical consultation to IARPA. In all cases, the offeror shall identify the contract under which the SETA or consultant support is being provided.
- Without a waiver from the IARPA Director, neither an offeror, nor its proposed subcontractor teammates, can simultaneously provide SETA support or technical consultation to IARPA and compete or perform as a Performer under this solicitation.



Streamlining the Award Process

- Cost Proposal – we only need what we ask for in BAA
- Approved accounting system needed for Cost Reimbursable contracts
 - Must be able to accumulate costs on job-order basis
 - DCAA (or cognizant auditor) must approve system
 - See <http://www.dcaa.mil>, “Audit Process Overview - Information for Contractors” under the “Guidance” tab
- Statements of Work (format) may need to be revised
- Key Personnel
 - Expectations of time, note the Evaluation Criteria requiring relevant experience and expertise
- Following selection, Contracting Officer may request your review of subcontractor proposals



IARPA Funding

- IARPA funds Applied Research for the Intelligence Community (IC)
 - IARPA cannot waive the requirements of Export Administrative Regulation (EAR) or International Traffic in Arms Regulation (ITAR)
 - Not subject to DoD funding restrictions for R&D related to overhead rates
- IARPA is not DoD



Disclaimer

- This is Applied Research for the Intelligence Community
- Content of the Final BAA will be specific to this program
 - The Final BAA is being developed
 - Following issuance, look for Amendments and Q&As
 - There will likely be changes
- The information conveyed in this brief and discussion is for planning purposes and is subject to change prior to the release of the Final BAA.



Point of Contact

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