DEFENSE ADVANCED RESEARCH PROJECTS AGENCY (DARPA)
12.1 Small Business Innovation Research (SBIR)
Proposal Submission Instructions

Introduction:

DARPA's mission is to prevent technological surprise for the United States and to create technological surprise for its adversaries. The DARPA SBIR and STTR Programs are designed to provide small, high-tech businesses and academic institutions the opportunity to propose radical, innovative, high-risk approaches to address existing and emerging national security threats; thereby supporting DARPA's overall strategy to bridge the gap between fundamental discoveries and the provision of new military capabilities.

The responsibility for implementing DARPA's Small Business Innovation Research (SBIR) Program rests with the Small Business Programs Office.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
Attention: DIRO/SBPO
3701 North Fairfax Drive
Arlington, VA 22203-1714
(703) 526-4170
Home Page http://www.darpa.mil/Opportunities/SBIR_STTR/SBIR_STTR.aspx

Offerors responding to the DARPA topics listed in Section 8.0 of the DoD 12.1 SBIR Solicitation must follow all the instructions provided in the DoD Program Solicitation. Specific DARPA requirements in addition to or that deviate from the DoD Program Solicitation are provided below and reference the appropriate section of the DoD Solicitation.

SPECIFIC DARPA REQUIREMENTS:

Please note – these requirements and guidelines are supplemental to the DoD 12.1 SBIR Program Solicitation. For additional information, please refer to the corresponding section number in the DoD solicitation (http://www.dodsbir.net/solicitation/sbir121/preface121.htm).

2.3 Foreign National

DARPA topics are unclassified; however, the subject matter may be considered to be a "critical technology" and therefore subject to ITAR restrictions. ALL offerors proposing to use foreign nationals MUST follow Section 3.5, b, (8) of the DoD Program Solicitation and disclose this information regardless of whether the topic is subject to ITAR restrictions. See **Export Control** requirements below in Section 5.

3.5 Phase I Proposal Format

PHASE I OPTION

DARPA has implemented the use of a Phase I Option that may be exercised to fund interim Phase I activities while a Phase II contract is being negotiated. Only Phase I companies selected for Phase II will be eligible to exercise the Phase I Option. The Phase I Option covers activities over a period of up to four months and should describe appropriate initial Phase II activities that may lead to the successful demonstration of a product or technology. The Phase I Option counts toward the 25-page limit for the Phase I proposal.

A Phase I Cost Proposal ($150,000 maximum) must be submitted in detail online. Proposers that participate in this solicitation must complete the Phase I Cost Proposal, not to exceed the maximum dollar amount of $100,000, and a Phase I Option Cost Proposal, not to exceed the maximum dollar amount of $50,000. Phase I and Phase I Option costs must be shown separately but may be presented side-by-side on a single Cost Proposal. The Cost Proposal DOES NOT count toward the 25-page limit for the Phase I proposal. Phase I awards and options are subject to the availability of funds.

**Please note: In accordance with section 3-209 of DOD 5500.7-R, Joint Ethics Regulation, letters from government personnel will NOT be considered during the evaluation process.

3.7 Phase II Proposals

DARPA Program Managers may invite Phase I performers to submit a Phase II proposal based upon the success of the Phase I contract to meet the technical goals of the topic, as well as the overall merit based upon the criteria in section 4.3 of the DoD Program Solicitation. Phase II proposals will be evaluated in accordance with the evaluation criteria provided in section 4.3. Information regarding Phase II Proposal format will be included in the Phase II Invitation letter.

In addition, each Phase II proposal must contain a five-page commercialization strategy as part of the technical proposal, addressing the following questions:

1. Product Description/System Application – Identify the Commercial product(s) and/or DoD system(s) or system(s) under development or potential new systems that this technology will be/or has the potential to be integrated into.

**2. Advocacy Letters – Feedback received from potential Commercial and/or DoD customers and other end-users regarding their interest in the technology to support their capability gaps.

**3. Letters of Intent/Commitment – Relationships established, feedback received, support and commitment for the technology with one or more of the following: Commercial customer, DoD PM/PEO, a Defense Prime, or vendor/supplier to the Primes and/or other vendors/suppliers identified as having a potential role in the integration of the technology into fielded systems/products or those under development.

4. Business Models/Procurement Mechanisms/Vehicles – Business models, procurement mechanisms, vehicles and, as relevant, commercial channels, and/or licensing/teaming agreements you plan to employ to sell into your targeted markets.

- What is the business model you plan to adopt to generate revenue from your innovation?
- Describe the procurement mechanisms, vehicles and channels you plan to employ to reach the targeted markets/customers.
- If you plan to pursue a licensing model, what is your plan to identify potential licensees?

5. Market/Customer Sets/Value Proposition – Describe the market and customer sets you propose to target, their size, and their key reasons they would consider procuring the technology.

- What is the current size of the broad market you plan to enter and the “niche” market opportunity you are addressing?
- What are the growth trends for the market and the key trends in the industry that you are planning to target?
- What features of your technology will allow you to provide a compelling value proposition?

- Have you validated the significance of these features and if not, how do you plan to validate?

6. Competition Assessment – Describe the competition in these markets/customer sets and your anticipated advantage (e.g., function, performance, price, quality, etc.)

7. Funding Requirements – List your targeted funding sources (e.g., federal, state and local, private (internal, loan, angel, venture capital, etc.) and your proposed plan and schedule to secure this funding. Provide anticipated funding requirements both during and after Phase II required to:

- mature the technology
- as required, mature the manufacturing processes
- test and evaluate the technology
- receive required certifications
- secure patents, or other protections of intellectual property
- manufacture the technology to bring the technology to market for use in operational environments
- market/sell technology to targeted customers

8. Sales Projections – Provide a schedule that outlines your anticipated sales projections and indicate when you anticipate breaking even.

9. Expertise/Qualifications of Team/Company Readiness - Describe the expertise and qualifications of your management, marketing/business development and technical team that will support the transition of the technology from the prototype to the commercial market and into operational environments. Has this team previously taken similar products/services to market? If the present team does not have this needed expertise, how do you intend to obtain it? What is the financial history and health of your company (e.g., availability of cash, profitability, revenue growth, etc)?

The commercialization strategy must also include a schedule showing the quantitative commercialization results from the Phase II project that your company expects to report in its Company Commercialization Report Updates one year after the start of Phase II, at the completion of Phase II, and after the completion of Phase II (i.e., amount of additional investment, sales revenue, etc. - see section 5.4).

**Please note: In accordance with section 3-209 of DOD 5500.7-R, Joint Ethics Regulation, letters from government personnel will NOT be considered during the evaluation process.

PHASE II OPTION

DARPA has implemented the use of a Phase II Option that may be exercised at the DARPA Program Manager's discretion to continue funding Phase II activities that will further mature the technology for insertion into a larger DARPA Program or DoD Acquisition Program. The Phase II Option covers activities over a period of up to 24 months and should describe Phase II activities that may lead to the successful demonstration of a product or technology. The Phase II Option counts toward the 40-page limit for the Phase II proposal.

A Phase II Cost Proposal ($1,000,000 maximum) must be submitted in detail online. Proposers that submit a Phase II proposal must complete the Phase II Cost Proposal, not to exceed the maximum dollar amount of $1,000,000, and a Phase II Option Cost Proposal, not to exceed the maximum dollar amount of $750,000. Phase II and Phase II Option costs must be shown separately but may be presented side-by-side on a single Cost Proposal. The Cost Proposal DOES NOT count toward the 40-page limit for the Phase II proposal. Phase II awards and options are subject to the availability of funds.

If selected, the government may elect not to include the option in the negotiated contract.

4.0 Method of Selection and Evaluation Criteria
The offeror's attention is directed to the fact that non-Government advisors to the Government may review and provide support in proposal evaluations during source selection. Non-government advisors may have access to the offeror's proposals, may be utilized to review proposals, and may provide comments and recommendations to the Government's decision makers. These advisors will not establish final assessments of risk and will not rate or rank offeror's proposals. They are also expressly prohibited from competing for DARPA SBIR or STTR awards in the SBIR/STTR topics they review and/or provide comments on to the Government. All advisors are required to comply with procurement integrity laws and are required to sign Non-Disclosure and Rules of Conduct/Conflict of Interest statements. Non-Government technical consultants/experts will not have access to proposals that are labeled by their proposers as "Government Only."

Please note that qualified advocacy letters will count towards the proposal page limit and will be evaluated towards criterion C. Advocacy letters are not required for Phase I or Phase II. Consistent with Section 3-209 of DoD 5500.7-R, Joint Ethics Regulation, which as a general rule prohibits endorsement and preferential treatment of a non-federal entity, product, service or enterprise by DoD or DoD employees in their official capacities, letters from government personnel will NOT be considered during the evaluation process.

A qualified advocacy letter is from a relevant commercial procuring organization(s) working with a DoD or other Federal entity, articulating their pull for the technology (i.e., what need the technology supports and why it is important to fund it), and possible commitment to provide additional funding and/or insert the technology in their acquisition/sustainment program. If submitted, the letter should be included as the last page of your technical upload. Advocacy letters which are faxed or e-mailed separately will NOT be considered.

4.2 Evaluation Criteria
In Phase I, DARPA will select proposals for funding based on the evaluation criteria contained in Section 4.2 of the DoD Program Solicitation, including potential benefit to DARPA, in assessing and selecting for award those proposals offering the best value to the Government.

In Phase II, DARPA will select proposals for funding based on the evaluation criteria contained in Section 4.3 of the Program Solicitation, including potential benefit to DARPA and ability to transition the technology into an identified system, in assessing and selecting for award those proposals offering the best value to the Government.

As funding is limited, DARPA reserves the right to select and fund only those proposals considered to be of superior quality and highly relevant to the DARPA mission. As a result, DARPA may fund more than one proposal in a specific topic area if the quality of the proposals is deemed superior and are highly relevant to the DARPA mission, or it may not fund any proposals in a topic area. Each proposal submitted to DARPA must have a topic number and must be responsive to only one topic.

4.4 Assessing Commercial Potential of Proposals
DARPA is particularly interested in the potential transition of SBIR project results to the U.S. military, and expects explicit discussion of a transition vision in the commercialization strategy part of the proposal. That vision should include identification of the problem, need, or requirement in the Department of Defense that the SBIR project results would address; a description of how wide-spread and significant the problem, need, or requirement is; identification of the potential end-users (Army, Navy,

Air Force, SOCOM, etc.) who would likely use the technology; and the operational environments and potential application area(s).

Technology commercialization and transition from Research and Development activities to fielded systems within the DoD is challenging. Phase I is the time to plan for and begin transition specific activities. The small business must convey an understanding of the transition path or paths to be established during the Phase I and II projects. That plan should include the Technology Readiness Level (TRL) at the start and end of the Phase II. The plan should also include a description of targeted operational environments and priority application areas for initial Phase III transition; potential Phase III transition funding sources; anticipated business model and identified commercial and federal partners the SBIR company has identified to support transition activities. Also include key proposed milestones anticipated during Phase I, II or beyond Phase II that include, but are not limited to: prototype development, laboratory and systems testing, integration, testing in operational environment, and demonstrations.

4.5 SBIR Fast Track

Small businesses that participate in the Fast Track program do not require an invitation to submit a proposal, but must submit an application. The complete Fast Track application must be received by DARPA no later than the last day of the fifth month of the Phase I effort. Once your application is submitted, the DARPA Program Manager will make a determination on whether or not a technical proposal will be accepted for the Phase II effort. If the DARPA Program Manager approves the Fast Track application, the small business will have 30 days to submit the technical proposal.

Any Fast Track applications not meeting these dates may be declined. All Fast Track applications and required information must have a complete electronic submission. The DoD proposal submission site will lead you through the process for submitting your technical proposal and all of the sections electronically.

Firms who wish to submit a Fast Track Application to DARPA must utilize the DARPA Fast Track application template. Failure to follow these instructions may result in automatic rejection of your application. Phase I interim funding is not guaranteed. If awarded, it is expected that interim funding will generally not exceed $50,000. Selection and award of a Fast Track proposal is not mandated and DARPA retains the discretion not to select or fund any Fast Track applicants. NOTE: Phase I firms whose proposals are not accepted for a Fast Track Phase II award are not eligible to receive a Phase II invitation from the agency.

- DARPA encourages Phase I performers to discuss its intention to pursue Fast Track with the DARPA Program Manager prior to submitting a Fast Track application or proposal.
- Fast Track awards are subject to the availability of funds.
- After coordination with the DARPA Program Manager, the performer and the investor should submit a Fast Track application through the DoD Submission Web site no later than the last day of the fifth month of the Phase I effort.
- The Fast Track Interim amount is not to exceed $50,000.
- Additional information regarding the DARPA Fast Track process and application template may be found at: http://www.darpa.mil/Opportunities/SBIR_STTR/SBIR.aspx

4.6 Phase II Enhancement Policy

To encourage transition of SBIR projects into DoD systems, DARPA's Phase II Enhancement Program provides a Phase II performer up to $200,000 of additional Phase II SBIR funding if the performer can match the additional SBIR funds with funds from a DoD acquisition program, a non-SBIR/non-STTR

government program or private sector investments. The Phase II Enhancement Program allows for an existing Phase II SBIR to be extended for up to one year per Phase II Enhancement application, to perform additional research and development and further mature the technology. Phase II Transition matching funds will be provided on a one-for-one basis up to a maximum amount of $200,000 of SBIR or funds in accordance with DARPA Phase II Enhancement policy.

Phase II Enhancement funding can only be applied to an active DoD Phase II SBIR contract. The funds provided by the DoD acquisition program or a non-SBIR/non-STTR government program may be obligated on the Phase II contract as a modification prior to or concurrent with the modification adding DARPA SBIR funds, OR may be obligated under a separate contract. Private sector funds must be from an "outside investor" which may include such entities as another company, or an investor. It does not include the owners or family members, or affiliates of the small business (13 CFR 121.103).

5.1.b. Type of Funding Agreement (Phase I)

- DARPA Phase I awards will be Firm Fixed Price contracts.
- Companies that choose to collaborate with a University must highlight the research that is being performed by the University and verify that the work is FUNDAMENTAL RESEARCH.
- Companies are strongly encouraged to pursue implementing a government acceptable cost accounting system during the Phase I project to avoid delay in receiving a Phase II award. Visit www.dcaa.mil and download the “Information for Contractors” guide for more information.

5.1.c. Average Dollar Value of Awards (Phase I)

DARPA Phase I proposals **shall not exceed $150,000,** and are generally 6 months in duration.

5.2.b. Type of Funding Agreement (Phase II)

- DARPA Phase II awards are typically Cost-Plus-Fixed-Fee contracts; however, DARPA may choose to award a Firm Fixed Price Phase II contract or an Other Transaction (OT) on a case-by-case basis. Visit: http://www.darpa.mil/Opportunities/SBIR_STTR/Small_Business_OTs.aspx for more information on Other Transactions.
- Companies are advised to continue pursuit of implementation of a government acceptable cost accounting system in order to facilitate their eligibility for future government contracts.
- Companies that choose to collaborate with a university must highlight the research that is being performed by the university and verify that the work is FUNDAMENTAL RESEARCH.

5.2.c. Average Dollar Value of Awards (Phase II)

DARPA Phase II proposals should be structured as a 24 month effort in two equal increments of approximately $500,000 each. The entire Phase II base effort should generally not exceed $1,000,000.

5.3 Phase I Report

All DARPA Phase I and Phase II awardees are required to submit a final report, which is due within 60 days following completion of the technical period of performance and must be provided to the individuals identified in Exhibit A of the contract. Please contact your contracting officer immediately if your final report may be delayed.

5.11.r. Export Control
The following will apply to all projects with military or dual-use applications that develop beyond fundamental research (basic and applied research ordinarily published and shared broadly within the scientific community):

(1) The Contractor shall comply with all U. S. export control laws and regulations, including the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 through 130, and the Export Administration Regulations (EAR), 15 CFR Parts 730 through 799, in the performance of this contract. In the absence of available license exemptions/exceptions, the Contractor shall be responsible for obtaining the appropriate licenses or other approvals, if required, for exports of (including deemed exports) hardware, technical data, and software, or for the provision of technical assistance.

(2) The Contractor shall be responsible for obtaining export licenses, if required, before utilizing foreign persons in the performance of this contract, including instances where the work is to be performed on-site at any Government installation (whether in or outside the United States), where the foreign person will have access to export-controlled technologies, including technical data or software.

(3) The Contractor shall be responsible for all regulatory record keeping requirements associated with the use of licenses and license exemptions/exceptions.

(4) The Contractor shall be responsible for ensuring that the provisions of this clause apply to its subcontractors.

Please visit http://www.pmddtc.state.gov/regulations_laws/itar.html for more detailed information regarding ITAR requirements.

5.11.s. Publication Approval (Public Release)
NSDD 189 established the national policy for controlling the flow of scientific, technical, and engineering information produced in federally funded fundamental research at colleges, universities, and laboratories. The directive defines fundamental research as follows: "Fundamental research' means basic and applied research in science and engineering, the results of which ordinarily are published and shared broadly within the scientific community, as distinguished from proprietary research and from industrial development, design, production, and product utilization, the results of which ordinarily are restricted for proprietary or national security reasons."

It is DARPA's goal to eliminate pre-publication review and other restrictions on fundamental research except in those exceptional cases when it is in the best interest of national security. Please visit http://www.darpa.mil/NewsEvents/Public_Release_Center/Public_Release_Center.aspx for additional information and applicable publication approval procedures. Visit http://dtsn.darpa.mil/fundamentalresearch/ to verify whether or not your award has a pre-publication review requirement.

5.15.h. Human and/or Animal Use
This solicitation may contain topics that have been identified by the program manager as research involving Human and/or Animal Use. In accordance with DoD policy, human and/or animal subjects in research conducted or supported by DARPA shall be protected. Although these protocols will most likely not be needed to carry out the Phase I, significant lead time is required to prepare the documentation and obtain approval in order to avoid delay of the Phase II award. Please visit http://www.darpa.mil/Opportunities/SBIR_STTR/SBIR.aspx to review the Human and Animal Use PowerPoint presentation(s) to understand what is required to comply with human and/or animal protocols.

- **Human Use:** All research involving human subjects, to include use of human biological specimens and human data, selected for funding must comply with the federal regulations for human subject protection. Further, research involving human subjects that is conducted or supported by the DoD must comply with 32 CFR 219, *Protection of Human Subjects* http://www.access.gpo.gov/nara/cfr/waisidx_07/32cfr219_07.html) and DoD Directive 3216.02, *Protection of Human Subjects and Adherence to Ethical Standards in DoD-Supported Research* (http://www.dtic.mil/whs/directives/corres/pdf/321602p.pdf).

  Institutions awarded funding for research involving human subjects must provide documentation of a current Assurance of Compliance with Federal regulations for human subject protection, for example a Department of Health and Human Services, Office of Human Research Protection Federal Wide Assurance (http://www.hhs.gov/ohrp). All institutions engaged in human subject research, to include subcontractors, must also have a valid Assurance. In addition, personnel involved in human subjects research must provide documentation of completing appropriate training for the protection of human subjects.

  For all proposed research that will involve human subjects in the first year or phase of the project, the institution must provide evidence of or a plan for review by an Institutional Review Board (IRB) upon final proposal submission to DARPA. The IRB conducting the review must be the IRB identified on the institution's Assurance. The protocol, separate from the proposal, must include a detailed description of the research plan, study population, risks and benefits of study participation, recruitment and consent process, data collection, and data analysis. Consult the designated IRB for guidance on writing the protocol. The informed consent document must comply with federal regulations (32 CFR 219.116). A valid Assurance along with evidence of appropriate training for all investigators should accompany the protocol for review by the IRB.

  In addition to a local IRB approval, a headquarters-level human subjects regulatory review and approval is required for all research conducted or supported by the DoD. The Army, Navy, or Air Force office responsible for managing the award can provide guidance and information about their component's headquarters-level review process. Note that confirmation of a current Assurance and appropriate human subjects protection training is required before headquarters-level approval can be issued.

  The amount of time required to complete the IRB review/approval process may vary depending on the complexity of the research and/or the level of risk to study participants. Ample time should be allotted to complete the approval process. The IRB approval process can last between one to three months, followed by a DoD review that could last between three to six months. No DoD/DARPA funding can be used towards human subjects research until ALL approvals are granted.

- **Animal Use:** Any Recipient performing research, experimentation, or testing involving the use of animals shall comply with the rules on animal acquisition, transport, care, handling, and use in: (i) 9 CFR parts 1-4, Department of Agriculture rules that implement the Laboratory Animal Welfare Act of 1966, as amended, (7 U.S.C. 2131-2159); (ii) the guidelines described in National Institutes of Health Publication No. 86-23, "Guide for the Care and Use of Laboratory Animals"; (iii) DoD Directive 3216.01, "Use of Laboratory Animals in DoD Program."

For submissions containing animal use, proposals should briefly describe plans for Institutional Animal Care and Use Committee (IACUC) review and approval. Animal studies in the program will be expected to comply with the PHS Policy on Humane Care and Use of Laboratory Animals, available at http://grants.nih.gov/grants/olaw/olaw.htm.

All Recipients must receive approval by a DoD certified veterinarian, in addition to an IACUC approval. No animal studies may be conducted using DoD/DARPA funding until the USAMRMC Animal Care and Use Review Office (ACURO) or other appropriate DoD veterinary office(s) grant approval. As a part of this secondary review process, the Recipient will be required to complete and submit an ACURO Animal Use Appendix, which may be found at: https://mrmc-www.army.mil/index.cfm?pageid=Research_Protections.acuro&rn=1.

6.3 Notification of Proposal Receipt

After the solicitation closing date, DARPA will send an e-mail to the person listed as the "Corporate Official" on the Proposal Coversheet with instructions for retrieving the letter acknowledging receipt of proposal from the DARPA SBIR/STTR Information Portal.

6.4 Information on Proposal Status

Once the source selection is complete, DARPA will send an email to the person listed as the "Corporate Official" on the Proposal Coversheet with instructions for retrieving letters of selection or non-selection from the DARPA SBIR/STTR Information Portal.

6.5 Debriefing of Unsuccessful Offerors

DARPA will provide debriefings to offerors in accordance with FAR Subpart 15.5. The notification letter referenced above in paragraph 6.4 will provide instructions for requesting a proposal debriefing. Small Businesses will receive a notification for each proposal submitted. Please read each notification carefully and note the proposal number and topic number referenced. All communication from the DARPA SBIR/STTR Program management will originate from the sbir@darpa.mil e-mail address. Please white-list this address in your company's spam filters to ensure timely receipt of communications from our office.

DARPA SBIR 12.1 Topic Index

SB121-001 TITLE: Optical Frequency Comb-Based 10 GHz Microwave Oscillators

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: DARPA QuASAR, ORCHID, PINS, IMPACT, HUMS

OBJECTIVE: To develop ultralow phase noise portable 10 GHz microwave oscillators based on optical frequency combs.

DESCRIPTION: Modern sensing and communication systems rely critically on low- noise microwave oscillators to provide short-term temporal stability. Department of Defense (DoD) related applications including robust, synchronous optical networks, millimeter-wave radar, synthetic aperture and multi-static imaging, and precision time keeping require pure 10 GHz reference tones with low phase noise. Quartz crystal oscillators are pervasive in current systems due to their portability and reliability, but suffer from poor phase noise characteristics, making them unsuitable for many applications of interest [1]. Current commercial rack-mount state-of-the-art ultra-low noise oscillators are based on sapphire oscillators [2].

Lower phase noise oscillators close to a 10 GHz carrier frequency have recently been developed in a laboratory environment. These oscillators, based on optical frequency combs, have 10,000 times less phase noise close-to-carrier compared to any available commercial oscillator [3]. Such oscillators will prove invaluable in future military systems by, for example, enabling high bandwidth robust communication systems and improved resolution bistatic radar [4]. The advantage of laboratory-based frequency combs is derived from the division of stable optical to microwave frequencies produced by the frequency comb. However, several improvements are required to create a robust, portable system, including improving the phase noise at large carrier offsets (> 10 kHz), and the miniaturization of the system to a rack mount device. To this end, several components must be improved and miniaturized with the final goal of low phase noise from 1 Hz to 1 MHz, and integration into a deployable oscillator system.

Possible work includes, but is not limited to: comb miniaturization, development of acceleration-insensitive frequency-selective components, development of high linearity and high power photodiodes, development of 10 GHz repetition rate miniature frequency combs, and optimization and innovation to maintain performance in a rack mountable device. As an example of such work, consider photo-detector technology. At large frequency offsets (> 10 kHz) phase stability is limited by photocurrent shot noise due to detector saturation [3]. To reach the state-of-the-art level of 180 dBc/Hz at 1 MHz offset, one would need to develop high linearity and high power photodiodes. Alternatively, one could make an array of independently-illuminated diodes which are monolithically integrated with an on-chip coherent power combiner to overcome the shot noise limit [5].

PHASE I: Identify key components and technologies and define their contribution to the improvement and/or miniaturization of frequency comb based 10 GHz microwave oscillators. These components may include but are not limited to: fieldable isolated optical cavities, compact frequency combs, and photodiode solutions.

The chosen work must be compatible with a 10 GHz frequency comb oscillator with less than 100 dBc/Hz phase noise at a 1 Hz offset and 180 dBc/Hz at 1 MHz offset. Exhibit the feasibility of the approach through a laboratory demonstration. Phase I deliverables will include a design review including expected device performance and a report presenting the plans for Phase II.

PHASE II: Fabricate and test a prototype device demonstrating the device performance outlined in Phase I. The Technology Readiness Level (TRL) to be reached is 5: Component and/or breadboard validation in relevant environment.

PHASE III: Commercial Applications include: Low phase noise microwave oscillators may lead to improvements in commercial applications such as improved telecommunications and radar imaging systems. DoD/Military Applications include: Low phase noise microwave oscillators will lead to military applications including robust,

synchronous optical networks, millimeter wave radar, synthetic aperture and multistatic imaging, and precision time keeping.

REFERENCES:
[1] P. Khanna, “Microwave Oscillators: The State of the Technology,” Microwave Journal, vol. 49, no. 4, p. 22, Apr. 2006.

[2] “Poseidon Scientific Instruments: SLCO Sapphire Loaded Cavity Oscillator (BCS).” [Online]. Available: http://psi.com.au/products/index/slcosapphireloadedcavityoscillatorbcs. [Accessed: 06Jun2011].

[3] T. M. Fortier et al., “Generation of Ultrastable Microwaves via Optical Frequency Division,” 1101.3616, Jan. 2011.

[4] N. J. Willis, Bistatic Radar. SciTech Publishing, 2005.

[5] “High linearity photodiode array with monolithically integrated Wilkinson power combiner,” pp. 111-113, Oct. 2010.

KEYWORDS: Microwave oscillator, frequency comb, phase noise, photodiodes, optical cavities, lasers

SB121-002 TITLE: Assessment of Asymmetric Social Indicators

TECHNOLOGY AREAS: Information Systems, Sensors, Human Systems

OBJECTIVE: Develop and implement algorithms for capturing, measuring, and assessing social interactions in military contexts (training, medical and mental health settings, security) based on asymmetric data.

DESCRIPTION: Effective social interactions are vital in military, law enforcement, and other life critical environments. Practitioners under extreme stress are routinely asked to enter unfamiliar situations in cultures alien to their own and conduct activities, adjudicate arguments, and facilitate life altering decisions. Enabling these complex social interactions affords improved performance (e.g., fewer misunderstandings, increased efficiency, better decisions). However, in order to train or provide feedback to individuals about their social interactions, one must first have an understandable way to capture and represent those interactions.

Manual, ethnographic techniques provide significant insights, but are not scalable. Automated techniques involving wearable sensors and video processing show significant promise. However, these methods assume that all parties involved in an interaction are instrumented in a way that allows for subsequent data analysis. In many realistic situations, it is only possible to instrument one party in an interaction. For instance, military emergency department staff involved in an on-the-job assessment could be instrumented while their patients could not. This limits the environments in which these technologies can be actively used to training and experimental venues, which lose real-world contextual cues critical in social interactions.

This topic seeks innovative algorithmic approaches to "filling in the gaps" in social interactions when data collection systematically misses one party in bi-lateral and multi¬-lateral social encounters. Solutions should show the utility of particular approaches on quasi-realistic data sets, and should articulate the assumptions being made respecting data collection approaches, sensor types, and domain requirements.

A field or laboratory validation study is critical to assess the utility of any proposed approach. Solutions must be capable of hypothesizing social interactions with 70% accuracy compared to "ground truth" in a “known” realistic dataset provided by the performer. Alternative metrics of performance will be considered. Algorithms must be capable of being run on commercially available PCs and, eventually, state of the art mobile platforms. Interpretability by relevant subject matter experts of the hypothesized social interactions must be demonstrated.

PHASE I: Describe and implement algorithms designed to represent bi-lateral or multi-lateral social interactions based on datasets chosen by the company with incomplete or asymmetric collection. Demonstrate utility of the algorithms in a quasi-realistic dataset that does not involve human use to generate.

PHASE II: Refine and implement algorithms; integrate algorithms within a system created by the performer designed for description, measurement, and assessment of social interaction or team performance; demonstrate on a realistic dataset.

PHASE III: Develop operational system for use in assessing military and law enforcement interactions in operational settings. Should be able to examine effectiveness of military or law enforcement training oriented toward social performance with asymmetric data collection.

REFERENCES:
1) Collins, Randall. 2005. Interaction Ritual Chains. Princeton, NJ: Princeton University Press.

2) Alex (Sandy) Pentland With Tracy Heibeck, "Honest Signals How They Shape Our World", (Cambridge, MA: The MIT Press 2008).

3) Fuchs, Stephan. 2001. Against Essentialism: A Theory of Culture and Society. Cambridge, MA: Harvard University Press.

4) Inferring Colocation and Conversation Networks from Privacy-Sensitive Audio with Implications for Computational Social Science. ACM Transactions on Intelligent Systems and Technology. 2(1):7.1–7.41. January 2011.

5) Martin, John Levi. 2010. Social Structures. Princeton, Nj: Princeton University Press.

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KEYWORDS: Social Signals,Network Science, Honest Signals, Social Interactions

SB121-003 TITLE: Rapidly Adaptable Nanotherapeutics

TECHNOLOGY AREAS: Chemical/Bio Defense, Biomedical

OBJECTIVE: Develop a platform capable of rapidly synthesizing therapeutic nanoparticles targeted against evolving and engineered pathogens.

DESCRIPTION: Multiple classes of antibiotics exist, but the vast majority target only a handful of major bacterial functions, including bacterial protein production (such as translational blockade by anti-ribosomal agents), bacterial cell wall integrity, and genome integrity (DNA gyrase). The majority of these agents have been neutralized by bacterial selection and development of transmissible resistance, while the rest are prone to the same issues and may ultimately meet a similar fate. Ironically, the widespread use of antibiotics in agriculture and medicine has led to the emergence of "super strains" that are resistant to medical intervention.

Acquired resistance compromises our ability to fight emergent bacterial threats in injured warfighters and our military treatment facilities. For burn patients in particular, multidrug-resistant Acinetobacter calcoaceticus-baumannii complex (ABC) is a common cause of nosocomial infection, causing severe morbidity as well as longer hospital stays. Typically, antimicrobial resistant infections require a hospital stay three times as long and are in excess of four times as expensive. Therefore, new and innovative methods to control bacterial infection in the military health system are of critical importance.

Although broad spectrum antibiotics using a small molecule-based approach has been the historic solution, the time and money required to develop and obtain regulatory approval of new small molecule antibiotics has stifled production. For example, from 1983-1987 sixteen new antibacterial agents received FDA approval, while from 2003-2007 only four new agents were approved. Furthermore, many current and future small molecule agents would have limited applicability to engineered biological threats. Recent advances in nanomaterials, genome sequencing, nucleotide synthesis, and bioinformatics could converge in nanotherapeutics with tailored sequence, specificity, and function that can overcome earlier challenges. Collectively, these core technologies could permit the development of an innovative pharmaceutical platform composed of nanoparticles with tethered small interfering RNA (siRNA) oligonucelotides whose sequence and objective can be reprogrammed "on-the-fly" to inhibit multiple targets within multiple classes of pathogens.

This topic is focused on the development of a revolutionary rapidly adaptable nanotherapeutic platform effective against evolving and engineered pathogens. The biocompatible materials used to fabricate the nanoparticle should optimize cellular targeting, intracellular concentration, target sequence affinity, resistance to nuclease, and knockdown of target genes. The platform should leverage state-of-the-art genomic sequencing and oligonucleotide synthesis technologies to permit rapid programmability against evolving biologic threats.

Proposers should highlight the role of bioinformatics in the platform development and therapeutic design with an emphasis on using this information to: characterize pathogens that cannot be cultured; compare samples against a growing library of known pathogens; improve effectiveness of the recommended siRNA oligonucleotides; limit host transcriptome overlap and side effects; and potentially make recommendations on compassionate use in cases of life threatening pandemic infection.

Regulatory approval is key to successful use of the developed nanotherapeutics. Proposers should develop a regulatory approval plan for a representative nanotherapeutic as well as subsequent reiated nanotherapeutics produced by the good manufacturing practice (GMP) platform.

PHASE I: Define the component technologies necessary to develop a nanotherapeutic platform for the control of infection caused by evolving multi-drug resistant infection, including but not limited to nanomaterials; high fidelity DNA and RNA sequencing; siRNA oligonucleotide synthesis; evolving bioinformatics algorithms; and high throughput, reproducible biomaterials fabrication. Highlight new nanoparticle materials and functionalization that demonstrate high target entry, affinity and specificity with minimal side effects. Investigate relevant pathogen and molecular targets of interest for the military and civilian sectors that may be used for future proof of concept demonstrations. Develop and define the FDA regulatory approval plan for the initial nanotherapeutic, subsequent related nanotherapeutics, and eventual GMP platform. Phase I deliverables will include A detailed breadboard design of a Rapidly Adaptable Nanotherapeutic (RANT) platform.

PHASE II: Fabricate and iteratively refine the breadboard nanotherapeutic system. Fabricate a representative nanotherapeutic against a military relevant multidrug resistant organism. Iteratively refine the nanotherapeutic to suppress pathogen growth and/or toxicity. Validate the nanotherapeutic in a relevant small animal model. Phase II deliverables will include: 1. A representative nanotherapeutic that suppresses the growth and/or toxicity of a military relevant multidrug resistant organism. 2. A breadboard system capable of synthesizing nanotherapeutics against multidrug resistant pathogens. 3. Report detailing validation of the initial nanotherapeutic, GMP system design, and plan for regulatory approval.

PHASE III: Rapid identification and synthesis of nanotherapeutics targeted against evolving and engineered pathogens will improve care and mitigate biological threats. Development of an integrated platform system could be rapidly transitioned to pharmaceutical or medical device companies to enable an adaptable method for manufacturing therapeutic agents to target emerging threats on the battlefield or in both military and civilian

hospitals. A prototype device may be capable of identifying and manufacturing therapeutic agents against multidrug resistant pathogens in military and civilian medical treatment facilities. A clear plan towards FDA approval for the therapeutic agent (or agents) and diagnostic/delivery platform will be in place, and additional testing to meet FDA requirements will be completed. Additional funding may be provided by DoD sources, but the awardee must also look towards other government or civilian funding sources to continue the process of translation and commercialization.

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KEYWORDS: Nanoparticles, nanotherapeutics, genome sequencing, oligonucleotide synthesis, small interfering RNA (siRNA), multi-drug resistant organisms (MDRO), engineered pathogens, medical countermeasures, bioinformatics, pharmaceutical regulatory ap

SB121-004 TITLE: Biometrics-at-a-distance

TECHNOLOGY AREAS: Information Systems, Biomedical, Electronics, Battlespace

OBJECTIVE: Demonstrate the ability to collect, localize, and evaluate physiological signals (e.g., heart rate) at distances greater than 10 meters, non-line-of-sight, and through solid objects (walls, rock, concrete, etc.).

DESCRIPTION: There is a need to remotely detect, collect, and evaluate physiological signals of interest. Applications and concepts-of-operations (CONOPs) that would benefit from this capability include, but are not limited to: building-clearing, warfighter health monitoring or battle damage assessment and triage, situational awareness and assessment. Existing micro-impulse radar (MIR) and ultra-wideband (UWB) technologies have the capability of detecting heartbeat and respiration at distances up to 8 meters (1) but are limited in at greater distances and in challenging environments, such as penetration through thick or multiple walls, concrete, and RF-noisy environments. There is interest in counting and localizing the sources of multiple physiological signatures in a cluttered environment. For example, in a building that has experienced a catastrophic event (fire, earthquake, etc.), the detection of survivors and assessment of their medical condition, in addition to their location to within 1 meter

accuracy, would improve the likelihood of recovery of personnel and their survivability. Additionally in a crowded environment it is highly challenging to uniquely identify persons based on collection of physiological signatures, such as electrocardiograms (ECGs). It is possible that high-frequency ECGs or other signals could improve the confidence level in unique identification. Approaches using "on body" sensors that transmit signals to remote locations will NOT be considered.

PHASE I: Demonstrate through simulation and basic proof-of-concept experiment the feasibility of a technology that can record human vital signs at distances greater than 10 meters, using non-line-of-sight and non-invasive or non-contact methods. Should be able to uniquely identify 10 subjects with >95% confidence inside a building or similar structure. Deliverable will be a paper study with detailed physics and link- margin analysis, and if possible a proof-of-concept experiment. The Technology Readiness Level (TRL) at the end of Phase1 should strive to be 2-3.

PHASE II: Using surrogate signals, demonstrate the capability to detect, localize, and discriminate ten sources of surrogate physiological signals. Assess the limits of the capabilities using physics-based modeling and proof-of-concept experiments to prove your predictions. Compare the captured signal quality to the quality of signals acquired by contact methods. The Technology Readiness Level (TRL) at the end of Phase2 should strive to be 4-5.

PHASE III: Commercial applications for this technology include use by disaster response search and rescue teams, fire and rescue, police and hostage rescue. Military applications include: building-clearing, warfighter health monitoring or battle damage assessment and triage, situational awareness and assessment.

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KEYWORDS: Biometrics, physiological signals, remote triage

SB121-005 TITLE: High Strength Materials at Elevated Temperatures for High Pressure Turbines

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: DARPA Vulcan PROGRAM

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: To develop high temperature materials and manufacturing processes to enable increased temperatures in combustors and high pressure turbine sections of jet engines.

DESCRIPTION: Basic principles of jet propulsion dictate fuel consumption to be a function of the fuel energy content, engine propulsion, and thermal efficiency. The gas turbine industry has been focused on improving thermal efficiencies for some time by driving engine overall pressure ratios to higher and higher levels. The realization of higher overall pressure ratios in current state-of the-art engines has been paced by advancements in hot section materials and cooling capabilities. The temperature capabilities of hot section hardware (turbine blades and vanes) have increased mainly through four approaches: alloy development, manufacturing processes, cooling path design, and thermal barrier coatings. By continuing the development of high temperature materials, capable of retaining their material properties at elevated temperature and stress (rotating parts) environments, we can further improve engine efficiencies through higher overall pressure ratios and reductions in blade film cooling requirements.

The purpose of this SBIR is to develop new manufacturing processes and materials that reduce cost, complexity, and manufacturing time for hot section components of gas turbine engines, while increasing stagnation temperature

limits and strength in the high pressure turbine. Current state-of-the-art technology limits turbine inlet temperatures to low 3000F with cooling air. This SBIR seeks to develop materials and manufacturing process that can attain 3500F turbine inlet temperatures without cooling air at high rotational speed.

PHASE I: Design a concept for manufacturing uncooled turbine blades and determine feasible materials to meet the requirements. Produce a conceptual design of a first stage high pressure turbine rotor and stator and manufacture hardware that can be tested in a relevant environment. The Phase I deliverables will include material specifications, manufacturing processes, test hardware, interim reports and final SBIR report.

PHASE II: Develop, demonstrate and validate a first stage high pressure turbine rotor and blades and test in a gas turbine engine.

PHASE III: Phase III would include integrating this new technology into current gas turbine engines. All four branches of the military as well as several commercial markets utilize gas turbines for propulsion as well as power generation. This new technology would be transitioned to one of the major engine designers/manufacturers in the US for integration into new products with significantly higher efficiency. A prime example of a specific military application would be the Pratt and Whitney F-135 that powers the F-35, but it is envisioned that this technology would feed into commercial market engines as well, such as the General Electric GE90 that powers the Boeing 777.

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KEYWORDS: Gas Turbines, Turbojet, Turboshaft, Turbofan, Hot Section, Blisk, Blades, High Pressure Turbine, First Stage Nozzle