IMPORTANT

- **The following instructions apply to STTR topics only:**
  - **N21B-T019 through N21B-T024**

- **The information provided in the DON Proposal Submission Instruction document takes precedence over the DoD Instructions posted for this Broad Agency Announcement (BAA).**

- **DON Phase I Technical Volume (Volume 2) page limit is not to exceed 10 pages.**

- A Phase I Technical Proposal (Volume 2) proposal template, specific to DON topics, is available at https://www.navysbir.com/links_forms.htm; use this template to meet Volume 2 requirements.

- The DON provides notice that Basic Ordering Agreements (BOAs) may be used for Phase I awards, and BOAs or Other Transaction Agreements (OTAs) may be used for Phase II awards.

- The Supporting Documents Volume (Volume 5) is available for the STTR 21.B BAA cycle. The Supporting Documents Volume is provided for small businesses to submit additional documentation to support the Technical Volume (Volume 2) and the Cost Volume (Volume 3). Volume 5 is available for use when submitting Phase I and Phase II proposals. DON will not be using any of the information in Volume 5 during the evaluation.

INTRODUCTION

The Program Manager of the DON STTR Program is Mr. Steve Sullivan. For questions regarding this BAA, use the following information in Table 1 to determine who to contact for what types of questions.

TABLE 1: POINTS OF CONTACT FOR QUESTIONS REGARDING THIS BAA

Type of Question	When	Contact Information
Program and administrative	Always	Program Managers list in Table 2 (below)
Topic-specific technical questions	BAA Pre-release	Technical Point of Contact (TPOC) listed in each topic. Refer to section 4.13 of the DoD BAA for details.
	BAA Open	DoD SBIR/STTR Topic Q&A platform (https://www.dodsbirsttr.mil/submissions) Refer to section 4.13 of the DoD BAA for details.
Electronic submission to the DoD SBIR/STTR Innovation Portal (DSIP)	Always	DoD Help Desk via email at dodsbirsupport@reisystems.com
Navy-specific BAA instructions and forms	Always	Navy-sbir-sttr.fct@navy.mil

TABLE 21: DON SYSTEMS COMMAND (SYSCOM) STTR PROGRAM MANAGER

Topic Numbers	Point of Contact	SYSCOM	Email
N21B-T019 to N21B-T024	Ms. Donna Attick	Naval Air Systems Command (NAVAIR)	navair.sbir@navy.mil

The DON SBIR/STTR Programs are mission-oriented programs that integrate the needs and requirements of the DON's Fleet through research and development (R&D) topics that have dual-use potential, but primarily address the needs of the DON. More information on the program can be found on the DON SBIR/STTR website at www.navysbir.com. Additional information pertaining to the DON's mission can be obtained from the DON website at www.navy.mil.

PHASE I GUIDELINES

Follow the instructions in the DoD SBIR/STTR Program BAA at the DoD SBIR/STTR Innovation Portal (DSIP), https://www.dodsbirsttr.mil/submissions, for requirements and proposal submission guidelines. Please keep in mind that Phase I must address the feasibility of a solution to the topic. It is highly recommended that proposers use the Phase I proposal template, specific to DON topics, at https://navysbir.com/links_forms.htm to meet Phase I Technical Volume (Volume 2) requirements. Inclusion of cost estimates for travel to the sponsoring SYSCOM's facility for one day of meetings is recommended for all proposals.

Proposers are required to submit proposals via DSIP; proposals submitted by any other means will be disregarded. Proposers submitting through this site for the first time will be asked to register. It is recommended that firms register as soon as possible upon identification of a proposal opportunity to avoid delays in the proposal submission process. Proposals that are not successfully certified in the Defense SBIR/STTR Innovation Portal (DSIP) prior to BAA Close will NOT be considered submitted. Please refer to section 5.1 of the DoD SBIR/STTR Program BAA for further information.

PHASE I PROPOSAL SUBMISSION REQUIREMENTS

The following SHALL BE MET or the proposal will be REJECTED for noncompliance.

- **Proposal Cover Sheet (Volume 1).** As specified in DoD SBIR/STTR BAA section 5.4(a).

- **Technical Proposal (Volume 2).** Technical Proposal (Volume 2) must meet the following requirements:
  - Content is responsive to evaluation criteria as specified in DoD SBIR/STTR Program BAA section 6.0
  - Not to exceed **10** pages, regardless of page content
  - Single column format, single-spaced typed lines
  - Standard 8 ½" x 11" paper
  - Page margins one-inch on all sides. A header and footer may be included in the one-inch margin.
  - No font size smaller than 10-point*
  - Include, within the **10-page limit of Volume 2**, an Option that furthers the effort in preparation for Phase II and will bridge the funding gap between the end of Phase I and the start of Phase II. Tasks for both the Phase I Base and the Phase I Option must be clearly identified. Phase I Options are exercise upon selection for Phase II.

*For headers, footers, and imbedded tables, figures, images, or graphics that include text, a font size smaller than 10-point is allowable; however, proposers are cautioned that if the text is too small to be legible it will not be evaluated.

Volume 2 is the technical proposal. Additional documents may be submitted to support Volume 2 in accordance with the instructions for Supporting Documents Volume (Volume 5) as detailed below.

Disclosure of Information (DFARS 252.204-7000)
In order to eliminate the requirements for prior approval of public disclosure of information (in accordance with DFARS 252.204-7000) under this or any subsequent award, the proposer shall identify and describe all fundamental research to be performed under its proposal, including subcontracted work, with sufficient specificity to demonstrate that the work qualifies as fundamental research. 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. Simply identifying fundamental research in the proposal does NOT constitute acceptance of the exclusion. All exclusions will be reviewed and noted in the award. NOTE: Fundamental research included in the technical proposal that the proposer is requesting be eliminated from the requirements for prior approval of public disclosure of information, must be uploaded in a separate document (under "Other") in the Supporting Documents Volume (Volume 5).

- **Cost Volume (Volume 3).** The Phase I Base amount must not exceed $140,000 and the Phase I Option amount must not exceed $100,000. Costs for the Base and Option must be separated and clearly identified on the Proposal Cover Sheet (Volume 1) and in Volume 3.

- **Period of Performance.** The Phase I Base Period of Performance must be exactly six (6) months and the Phase I Option Period of Performance must be exactly six (6) months.

- **Company Commercialization Report (Volume 4)**. DoD requires Volume 4 for submission to the 21.B Phase I BAA. Please refer to instructions provided in section 5.4.e of the DoD SBIR/STTR Program BAA.

- **Supporting Documents (Volume 5)**. Volume 5 is available for use when submitting Phase I and Phase II proposals.

  The DoD must comply with Section 889(a)(1)(B) of the FY2019 National Defense Authorization Act (NDAA) and is working to reduce or eliminate contracts, or extending or renewing a contract with an entity that uses any equipment, system, or service that uses covered telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system. **As such, all proposals must include as a part of their submission a written certification in response to the NDAA clauses (Federal Acquisition Regulation clauses 52.204-24, 52-204-25 and 52-204-26).** The written certification can be found in Attachment 1 of the DoD SBIR/STTR Program BAA. This certification must be signed by the authorized company representative and is to be uploaded as a separate PDF file in Volume 5. Failure to submit the required certification as a part of the proposal submission process will be cause for rejection of the proposal submission without evaluation. Please refer to instructions provided in section 5.4.g of the DoD SBIR/STTR Program BAA.

In accordance with DFARS provision 252.209-7002, a proposer is required to disclose any interest a foreign government has in the proposer when that interest constitutes control by foreign government. Proposers must review the Foreign Ownership or Control Disclosure information to determine applicability. If applicable, an authorized firm representative must complete the Disclosure of Offeror's Ownership or Control by a Foreign Government (found in Attachment 2 of the DoD SBIR/STTR Program BAA) and upload as a separate PDF file in Volume 5. Please refer to instructions provided in section 5.4.h of the DoD SBIR/STTR Program BAA.

Volume 5 is available for small businesses to submit additional documentation to support the Technical Proposal (Volume 2) and the Cost Volume (Volume 3). A template is available on https://navysbir.com/links_forms.htm. DON will not be using any of the information in Volume 5 during the evaluation.

- o Additional Cost Information
- o SBIR/STTR Funding Agreement Certification
- o Data Rights
- o Allocation of Rights between Prime and Subcontractor
- o Disclosure of Information (DFARS 252.204-7000)
- o Prior, Current, or Pending Support of Similar Proposals or Awards
- o Foreign Citizens
- o Majority-Owned VCOC, HF, and PEF Certification, if applicable (SBIR Only)

NOTE: The inclusion of documents or information other than that listed above (e.g., resumes, test data, technical reports, publications) may result in the proposal being deemed "Non-compliant" and REJECTED.

A font size smaller than 10-point is allowable for documents in Volume 5; however, proposers are cautioned that the text may be unreadable.

- **Fraud, Waste and Abuse Training Certification (Volume 6)**. DoD requires Volume 6 for submission to the 21.B Phase I BAA. Please refer to instructions provided in section 5.4.i of the DoD SBIR/STTR Program BAA.

DON STTR PHASE I PROPOSAL SUBMISSION CHECKLIST
- **Subcontractor, Material, and Travel Cost Detail.** In the Cost Volume (Volume 3), proposers must provide sufficient detail for subcontractor, material, and travel costs. Subcontractor costs must be detailed to the same level as the prime contractor. Material costs must include a listing of items and cost per item. Travel costs must include the purpose of the trip, number of trips, location, length of trip, and number of personnel. The "Additional Cost Information" of Volume 5 may be used if additional space is needed to detail these costs. When a proposal is selected for award, be prepared to submit further documentation to the SYSCOM Contracting Officer to substantiate costs (e.g., an explanation of cost estimates for equipment, materials, and consultants or subcontractors).

For Phase I a minimum of 40% of the work is performed by the proposing firm, and a minimum of 30% of the work is performed by the single research institution. The percentage of work is measured by both direct and indirect costs.

To calculate the minimum percentage of effort for the proposing firm the sum of all direct and indirect costs attributable to the proposing firm represent the numerator and the total proposals costs (i.e. costs before profit or fee) is the denominator. The single research institution percentage

is calculated by taking the sum of all costs attributable to the single research institution as the numerator and the total proposal costs (i.e. costs before profit or fee) as the denominator.

- **Performance Benchmarks.** Proposers must meet the two benchmark requirements for progress toward Commercialization as determined by the Small Business Administration (SBA) on June 1 each year. Please note that the DON applies performance benchmarks at time of proposal submission, not at time of contract award.

- **Discretionary Technical and Business Assistance (TABA).** If TABA is proposed, the information required to support TABA (as specified in the TABA section below) must be included in Volume 5 as "Additional Cost Information". Failure to include the required information in Volume 5 will result in the denial of TABA. The total value of TABA must not exceed $6,500 in Phase I.

DISCRETIONARY TECHNICAL AND BUSINESS ASSISTANCE (TABA)

The SBIR and STTR Policy Directive section 9(b) allows the DON to provide TABA (formerly referred to as DTA) to its awardees. The purpose of TABA is to assist awardees in making better technical decisions on SBIR/STTR projects; solving technical problems that arise during SBIR/STTR projects; minimizing the technical risks associated with SBIR/STTR projects; and commercializing the SBIR/STTR product or process, including intellectual property protections. Firms may request, in their Phase I Cost Volume (Volume 3) and Phase II Cost Volume, to contract these services themselves through one or more TABA providers in an amount not to exceed the values specified below. The Phase I TABA amount is up to $6,500 and is in addition to the award amount. The Phase II TABA amount is up to $25,000 per award. The TABA amount, of up to $25,000, is to be included as part of the award amount and is limited by the established award values for Phase II by the SYSCOM (i.e. within the $1,700,000 or lower limit specified by the SYSCOM). As with Phase I, the amount proposed for TABA cannot include any profit/fee application by the SBIR/STTR awardee and must be inclusive of the applicable indirect costs. A Phase II project may receive up to an additional $25,000 for TABA as part of one additional (sequential) Phase II award under the project for a total TABA award of up to $50,000 per project. A TABA Report, detailing the results and benefits of the service received, will be required annually by October 30.

Approval of direct funding for TABA will be evaluated by the DON SBIR/STTR Program Office. If the TABA request does not include the following items the TABA request will be denied.
- TABA provider(s) (firm name)
- TABA provider(s) point of contact, email address, and phone number
- An explanation of why the TABA provider(s) is uniquely qualified to provide the service
- Tasks the TABA provider(s) will perform
- Total TABA provider(s) cost, number of hours, and labor rates (average/blended rate is acceptable)

TABA must NOT:
- Be subject to any profit or fee by the STTR applicant
- Propose a TABA provider that is the STTR applicant
- Propose a TABA provider that is an affiliate of the STTR applicant
- Propose a TABA provider that is an investor of the STTR applicant
- Propose a TABA provider that is a subcontractor or consultant of the requesting firm otherwise required as part of the paid portion of the research effort (e.g., research partner, consultant, tester, or administrative service provider).

TABA requests must be included as follows:
- Phase I:

- Online DoD Cost Volume (Volume 3) - the value of the TABA request.
- Supporting Documents Volume (Volume 5) – a detailed request for TABA (as specified above) specifically identified as "Discretionary Technical and Business Assistance".
- Phase II:
  - DON Phase II Cost Volume (provided by the DON SYSCOM) - the value of the TABA request.
  - Volume 5 – a detailed request for TABA (as specified above) specifically identified as "Discretionary Technical and Business Assistance".

Proposed values for TABA must <u>NOT</u> exceed:
- Phase I: A total of $6,500
- Phase II: A total of $25,000 per award, not to exceed $50,000 per Phase II project

If a proposer requests and is awarded TABA in a Phase II contract, the proposer will be eliminated from participating in the DON SBIR/STTR Transition Program (STP), the DON Forum for SBIR/STTR Transition (FST), and any other assistance the DON provides directly to awardees.

All Phase II awardees not receiving funds for TABA in their awards must attend a one-day DON STP meeting during the first or second year of the Phase II contract. This meeting is typically held in the spring/summer in the Washington, D.C. area. STP information can be obtained at: https://navystp.com. Phase II awardees will be contacted separately regarding this program. It is recommended that Phase II cost estimates include travel to Washington, D.C. for this event.

EVALUATION AND SELECTION

The DON will evaluate and select Phase I and Phase II proposals using the evaluation criteria in Sections 6.0 and 8.0 of the DoD SBIR/STTR Program BAA respectively, with technical merit being most important, followed by qualifications of key personnel and commercialization potential of equal importance. Due to limited funding, the DON reserves the right to limit awards under any topic.

Approximately one week after the Phase I BAA closing, e-mail notifications that proposals have been received and processed for evaluation will be sent. Consequently, the e-mail address on the proposal Cover Sheet must be correct.

Requests for a debrief must be made within 15 calendar days of select/non-select notification via email as specified in the select/non-select notification. Please note debriefs are typically provided in writing via email to the Corporate Official identified in the firm proposal within 60 days of receipt of the request. Requests for oral debriefs may not be accommodated. If contact information for the Corporate Official has changed since proposal submission, a notice of the change on company letterhead signed by the Corporate Official must accompany the debrief request.

Protests of Phase I and II selections and awards must be directed to the cognizant Contracting Officer for the DON Topic Number, or filed with the Government Accountability Office (GAO). Contact information for Contracting Officers may be obtained from the DON SYSCOM Program Managers listed in Table 2. If the protest is to be filed with the GAO, please refer to the instructions provided in section 4.11 of the DoD SBIR/STTR Program BAA.

Protests to this BAA and proposal submission must be directed to the DoD SBIR/STTR Program BAA Contracting Officer, or filed with the GAO. Contact information for the DoD SBIR/STTR Program BAA Contracting Officer can be found in section 4.11 of the DoD SBIR/STTR Program BAA.

CONTRACT DELIVERABLES

Contract deliverables for Phase I are typically a kick-off brief, progress reports, and a final report. Required contract deliverables must be uploaded to https://www.navysbirprogram.com/navydeliverables/.

AWARD AND FUNDING LIMITATIONS

Awards. The DON typically awards a Firm Fixed Price (FFP) contract or a small purchase agreement for Phase I. In addition to the negotiated contract award types listed in Section 4.14.b of the DoD SBIR/STTR Program BAA for Phase II awards, the DON may (under appropriate circumstances) propose the use of an Other Transaction Agreement (OTA) as specified in 10 U.S.C. 2371/10 U.S.C. 2371b and related implementing policies and regulations. The DON may choose to use a Basic Ordering Agreement (BOA) for Phase I and Phase II awards.

Funding Limitations. In accordance with the SBIR and STTR Policy Directive section 4(b)(5), there is a limit of one sequential Phase II award per firm per topic. Additionally, to adjust for inflation DON has raised Phase I and Phase II award amounts. The maximum Phase I proposal/award amount including all options (less TABA) is $240,000. The Phase I Base amount must not exceed $140,000 and the Phase I Option amount must not exceed $100,000. The maximum Phase II proposal/award amount including all options (including TABA) is $1,700,000 (unless non-SBIR/STTR funding is being added). Individual SYSCOMs may award amounts, including Base and all Options, of less than $1,700,000 based on available funding. The structure of the Phase II proposal/award, including maximum amounts as well as breakdown between Base and Option amounts will be provided to all Phase I awardees either in their Phase I award or in a minimum of 30 days prior to the due date for submission of their Initial Phase II proposal.

PAYMENTS

The DON makes three payments from the start of the Phase I Base period, and from the start of the Phase I Option period, if exercised. Payment amounts represent a set percentage of the Base or Option value as follows:

Days From Start of Base Award or Option	Payment Amount
15 Days	50% of Total Base or Option
90 Days	35% of Total Base or Option
180 Days	15% of Total Base or Option

TRANSFER BETWEEN SBIR AND STTR PROGRAMS

Section 4(b)(1)(i) of the SBIR and STTR Policy Directive provides that, at the agency's discretion, projects awarded a Phase I under a BAA for STTR may transition in Phase II to SBIR and vice versa. Please refer to instructions provided in section 7.2 of the DoD SBIR/STTR Program BAA.

ADDITIONAL NOTES

System for Award Management (SAM). It is strongly encouraged that proposers register in SAM, https://beta.sam.gov, by the Close date of this BAA, or verify their registrations are still active and will not expire within 60 days of BAA Close. Additionally, proposers should confirm that they are registered to receive contracts (not just grants) and the address in SAM matches the address on the proposal.

Human Subjects, Animal Testing, and Recombinant DNA. Due to the short timeframe associated with Phase I of the SBIR/STTR process, the DON does not recommend the submission of Phase I proposals that require the use of Human Subjects, Animal Testing, or Recombinant DNA. For example, the ability to obtain Institutional Review Board (IRB) approval for proposals that involve human subjects can take 6-12 months, and that lengthy process can be at odds with the Phase I goal for time-to-award. Before the DON

makes any award that involves an IRB or similar approval requirement, the proposer must demonstrate compliance with relevant regulatory approval requirements that pertain to proposals involving human, animal, or recombinant DNA protocols. It will not impact the DON's evaluation, but requiring IRB approval may delay the start time of the Phase I award and if approvals are not obtained within two months of notification of selection, the decision to award may be terminated. If the use of human, animal, and recombinant DNA is included under a Phase I or Phase II proposal, please carefully review the requirements at http://www.onr.navy.mil/About-ONR/compliance-protections/Research-Protections/Human-Subject-Research.aspx. This webpage provides guidance and lists approvals that may be required before contract/work can begin.

Government Furnished Equipment (GFE). Due to the typical lengthy time for approval to obtain GFE, it is recommended that GFE is not proposed as part of the Phase I proposal. If GFE is proposed and it is determined during the proposal evaluation process to be unavailable, proposed GFE may be considered a weakness in the proposal.

International Traffic in Arms Regulation (ITAR). For topics indicating ITAR restrictions or the potential for classified work, limitations are generally placed on disclosure of information involving topics of a classified nature or those involving export control restrictions, which may curtail or preclude the involvement of universities and certain non-profit institutions beyond the basic research level. Small businesses must structure their proposals to clearly identify the work that will be performed that is of a basic research nature and how it can be segregated from work that falls under the classification and export control restrictions. As a result, information must also be provided on how efforts can be performed in later phases if the university/research institution is the source of critical knowledge, effort, or infrastructure (facilities and equipment).

Support Contract Personnel for Administrative Functions. Proposers are advised that support contract personnel will be used to carry out administrative functions and may have access to proposals, contract award documents, contract deliverables, and reports. All support contract personnel are bound by appropriate non-disclosure agreements.

Partnering Research Institutions. The Naval Academy, the Naval Postgraduate School, and other military academies are Government organizations but qualify as partnering research institutions. However, DON laboratories DO NOT qualify as research partners. DON laboratories may be proposed only IN ADDITION TO the partnering research institution.

PHASE II GUIDELINES

All Phase I awardees can submit an **Initial** Phase II proposal for evaluation and selection. The Phase I Final Report, Initial Phase II Proposal, and Transition Outbrief (as applicable) will be used to evaluate the proposer's potential to progress to a workable prototype in Phase II and transition technology to Phase III. Details on the due date, content, and submission requirements of the Initial Phase II Proposal will be provided by the awarding SYSCOM either in the Phase I contract or by subsequent notification.

NOTE: All SBIR/STTR Phase II awards made on topics from solicitations prior to FY13 will be conducted in accordance with the procedures specified in those solicitations (for all DON topics, this means by invitation only).

The DON typically awards a Cost Plus Fixed Fee contract for Phase II; but, may consider other types of agreement vehicles. Phase II awards can be structured in a way that allows for increased funding levels based on the project's transition potential. To accelerate the transition of SBIR/STTR-funded technologies to Phase III, especially those that lead to Programs of Record and fielded systems, the Commercialization

Readiness Program was authorized and created as part of section 5122 of the National Defense Authorization Act of Fiscal Year 2012. The statute set-aside is 1% of the available SBIR/STTR funding to be used for administrative support to accelerate transition of SBIR/STTR-developed technologies and provide non-financial resources for the firms (e.g., the DON STP).

PHASE III GUIDELINES

A Phase III SBIR/STTR award is any work that derives from, extends, or completes effort(s) performed under prior SBIR/STTR funding agreements, but is funded by sources other than the SBIR/STTR programs. This covers any contract, grant, or agreement issued as a follow-on Phase III award or any contract, grant, or agreement award issued as a result of a competitive process where the awardee was an SBIR/STTR firm that developed the technology as a result of a Phase I or Phase II award. The DON will give Phase III status to any award that falls within the above-mentioned description, which includes assigning SBIR/STTR Data Rights to any noncommercial technical data and/or noncommercial computer software delivered in Phase III that was developed under SBIR/STTR Phase I/II effort(s). Government prime contractors and/or their subcontractors must follow the same guidelines as above and ensure that companies operating on behalf of the DON protect the rights of the SBIR/STTR firm.

NAVY 21.B STTR PHASE I TOPIC INDEX

N21B-T019   TITLE: Tunable Wideband Differential Interferometer for Radio Frequency Photonic
              Links

RT&L FOCUS AREA(S): Autonomy;General Warfighting Requirements (GWR);Networked C3

TECHNOLOGY AREA(S): Air Platforms

OBJECTIVE: Develop a tunable differential interferometer for wideband phase-to-amplitude conversion to enable wide-dynamic-range radio frequency (RF) photonic links.

DESCRIPTION: Many defense applications require the remoting of antennas at a significant distance from the receiver. At high frequencies, coaxial cables losses are consequential for many applications and require the use of distributed low-noise amplifiers to prevent impacts to receiver performance. In certain applications, the antenna aperture is highly size, weight, and power (SWaP)-constrained, and the implementation of any electronics at the antenna aperture is problematic. Recent advances in RF photonic components show promise in realizing high-frequency antenna remoting with low-noise figure and high-dynamic range. However, most broadband link architectures utilize amplitude modulators at the encoding point that require active bias compensation to ensure linear operation, which can be problematic in SWaP-constrained environments. Many attempts to develop a bias-free modulator have met with limited success [Refs 1, 2], particularly in the harsh environments dictated by most military applications. An alternative amplitude modulation link architecture utilizes phase-to-amplitude conversion devices, such as a differential Mach-Zehnder interferometer (DMZI) to convert a phase-modulated link signal to an amplitude-modulated link signal directly prior to photo detection, thereby removing the need for any bias electronics at the RF encoding point [Refs 3, 4]. Unfortunately, this conversion process results in links limited in bandwidth on the order of one octave due to the details of the conversion process, even though the phase modulators can encode much wider bands. This STTR topic seeks the development of tunable phase-to-amplitude conversion elements, which can take advantage of wideband, bias-free modulation at the remote RF encoding point.

The goals of this effort are to develop a fiber-pigtailed phase-to-amplitude conversion device with a tunable operating frequency range that is compatible with both single and balanced photodiodes. The device must have sufficiently high-optical power handling (> 300 mW) and low loss (< 3 dB excess optical loss) to ensure the creation of low-noise figure, high-dynamic range RF-over-fiber links. The device should operate over a -40°C to +85°C operational temperature range, and be tunable to cover phase-to-amplitude conversion from 1 GHz on the low end to 45 GHz on the high end, with an instantaneous operational bandwidth of at least one octave [Ref 6]. The device should have dimensions no greater than 1 cm height, 10 cm long, and 3 cm wide. Individual devices should be designed to operate in 1 µm wavelength and 1550 nm wavelength RF over fiber links. Tuning speeds over this range on the order of < 10 ms are desired. It is expected that bias control of the device will be necessary to ensure linear operation, but this bias control is performed at the receiver where SWaP constraints are less burdensome. The proposed techniques must provide for closed-loop bias control. Dual-output devices that would be compatible with differential balanced photodiodes are also desirable. Highly accelerated life testing will provide initial device reliability performance [Refs 5, 6].

PHASE I: Develop and analyze a new design. Demonstrate key performance parameters of the proposed phase-to-amplitude conversion approach and simulate component performance. Develop a fabrication process, packaging approach, and test plan. Demonstrate the feasibility that the wideband differential interferometer can achieve the desired RF performance specifications with a proof of principle bench top experiment or preferably in an initial prototype. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Optimize the Phase I design and create a functioning tunable phase-to-amplitude conversion prototype device. Demonstrate prototype operation in an RF photonic link. Show compliance of the prototype with the objective power levels, optical losses, tuning range, tuning speed, and temperature performance reached. Demonstrate a packaged, fiber-pigtailed prototype for direct insertion into single-ended and balanced-photonic links.

PHASE III DUAL USE APPLICATIONS: The proposed phase-to-amplitude conversion devices also function for digital-link applications and can be used as quadrature phase-shift keying (QPSK) demodulators for optical communications links. Such a tunable device would enable tunable bit-rate digital demodulators for reconfigurable communications links and would provide a direct dual-use application for telecommunications.

REFERENCES:
1. Fu, Y., Zhang, X., Hraimel, B., Liu, T. and Shen, D. "Mach-Zehnder: a review of bias control techniques for Mach-Zehnder modulators in photonic analog links." IEEE Microwave Magazine, 14(7), 2013, pp. 102-107. https://doi.org/10.1109/MMM.2013.2280332
2. Salvestrini, J. P., Guilbert, L., Fontana, M., Abarkan, M. and Gille, S. "Analysis and control of the DC drift in LiNbO3Based Mach–Zehnder modulators." Journal of Lightwave Technology, 29(10), May15, 2011, pp1522-1534. https://doi.org/10.1109/JLT.2011.2136322
3. Urick, V. J., Bucholtz, F., Devgan, P. S., McKinney, J. D. and Williams, K. J. "Phase modulation with interferometric detection as an alternative to intensity modulation with direct detection for analog-photonic links." IEEE transactions on microwave theory and techniques, 55(9), October 2007, pp. 1978-1985. https://doi.org/10.1109/TMTT.2007.904087
4. Urick, V. J., Williams, K. J. and McKinney, J. D. "Fundamentals of microwave photonics." John Wiley & Sons, 2015. https://doi.org/10.1002/9781119029816
5. AS-3 Fiber Optics and Applied Photonics Committee. "ARP6318 Verification of Discrete and Packaged Photonic Device Technology Readiness." SAE International, August 20, 2018. https://doi.org/10.4271/ARP6318
6. "MIL-STD-810H, Department of Defense test method standard: Environmental engineering considerations and laboratory tests." Department of Defense, US Army Test and Evaluation Command, January 31, 2019. http://everyspec.com/MIL-STD/MIL-STD-0800-0899/MIL-STD-810H_55998/

KEYWORDS: RF-over-fiber; balanced link; phase modulation; differential interferometer; fiber optic; quadrature phase-shift keying; phase-to-amplitude

N21B-T020   TITLE: Compact, Hatchable Transformer Rectifier

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR)

TECHNOLOGY AREA(S): Electronics

OBJECTIVE: Improve transformer rectifier (T/R) maintainability via modular, portable design and/or introduction of technologies to significantly decrease footprint, volume, and weight.

DESCRIPTION: An existing transformer/rectifier (T/R) is approximately 450 ft³ (12.75 m³) in volume and weighs nearly 40,000 lbs (18,144 kg). The transformer accounts for approximately 25% of the volume and 45% of the weight of the T/R. If the transformer fails, the entire T/R must be removed, which is a complex, expensive, and time-consuming process with a lengthy mean time to repair (MTTR).

The Navy requires a transformer/rectifier that receives 13.8 kVAC RMS, three-phase, 60 Hz power, and outputs ±850 VDC nominal. The T/R must be capable of providing output power in the single-digit megawatt (MW) range continuously for tens of minutes. It must also output less than 0.5 MW for greater than one hour. It receives single-digit MW input power.

The T/R should be hatchable, that is, T/R components or line replaceable units (LRUs) must be smaller than 26" x 66" x 33" (66 x 167 x 83 cm) in order to fit through hatches. Therefore, solutions should focus on decreasing T/R size and weight and improving supportability by making components removable/replaceable/repairable within the space constraints. A hatchable T/R will improve maintainability and decrease MTTR.

LRUs, or other removable subassemblies or parts, should be of reasonable weight so that they can be lifted and carried over moderate distances through passageways, doors, and hatches. For reference, existing LRUs are 31.5" H x 9.5" W x 22" D (80 cm H x 24 cm W x 56 cm D) and weigh approximately 150 lbs (68 kg). Technologies that minimize LRU weight are encouraged and preferred as heavier loads increase injury risk and require additional personnel. MIL-STD-1472G, TABLE XXXIX [Ref 5] and similar tables may be used as a guide for one-person, two-person, and more than two-person lifting/carrying limits. Other military standards should be referenced for shock (MIL-DTL-901E [Grade A]) [Ref 2], vibration (MIL-STD-167-1A [Type 1]) [Ref 3], electromagnetic interference (MIL-STD-461G) [Ref 4], and environmental factors (MIL-STD-810H) [Ref 1] since the system must be rugged to be viable. The ability to regulate T/R temperature (i.e., thermal management) should also be considered. The T/R should remove self-generated heat to maintain acceptable component temperatures. The maximum thermal load from the transformer should be 77.5 kW at 212 °F (100 °C), and the maximum thermal load from the rectifier should be 2.0 kW. At the ambient temperature of 77 °F (25 °C), the operating temperature of control panels and controls should not exceed 120 °F (49 °C). Surface hot spots on accessible equipment exteriors should not exceed 140 °F (60 °C). The temperature of all other exposed surfaces should not be greater than 158 °F (70 °C).

Designs that achieve both transformation and rectification in a more reliable, maintainable (modular/portable/hatchable), and compact package are ideal as they will increase operational availability (Ao). However, solutions cannot sacrifice performance as nominal output voltages/currents must meet certain tolerances as defined by requirements in an existing specification. For example, transformer output (rectifier input) shall have a nominal output voltage of hundreds of volts RMS, +/-2%. Further information on this and other requirements will be identified to the Phase I performers.

Advances in silicon carbide (SiC) and high-frequency transformer technology, or other related innovations associated with miniaturization of power electronics, may be leveraged to achieve the goals as outlined.

PHASE I: Develop a concept for a compact and maintainable transformer/rectifier, which may consist of modular, portable, electronic building blocks, also known as LRUs. Demonstrate feasibility using modeling and power simulation tools, or other applicable design methodologies. Subscale designs are allowable at this preliminary design stage assuming the concepts are scalable. Supporting documentation that shows how a subscale system might be scaled-up to meet full power requirements will help determine if the solution will be effective, suitable, and sustainable for this application. For example, a subscale T/R that meets input/output voltage requirements but not full-scale power requirements may still be practical if it can be shown that multiple subscale T/Rs can be connected together to achieve full-scale power. The same can be said of modules that do not meet full voltage/current requirements but can be connected in series/parallel. Evaluate thermal/cooling requirements to prepare for construction of a physical prototype. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Design and build a prototype based on Phase I work. Demonstrate the technology and utilize Hardware-in-the-Loop (HIL) simulations, including Controller Hardware-in-the-Loop (CHIL) and Power Hardware-in-the-Loop (PHIL), to test and characterize performance. Validate and verify operation of the system against electrical, mechanical, and thermal requirements. If the prototype is subscale and intended for partial power, plans for how to achieve scalability and test at full rated power should be well documented.

Assuming iterative design is utilized and a larger and more capable system is developed gradually throughout this phase, consideration must be given to packaging, thermal/cooling requirements, communications, controls, and user interfaces as the effort progresses.

PHASE III DUAL USE APPLICATIONS: Design and construct a full-scale T/R based on work completed during earlier phases. Perform final testing at full-scale power via T/R test procedures and fault scenarios as defined by existing specifications and test plans. Validate and verify T/R performance. Transition after successful testing.

Transformers increase or decrease AC (alternating current) voltage, and rectifiers convert AC to DC (direct current).

Transformers and rectifiers are increasingly vital as the energy sector moves towards renewables, such as wind and solar, and the transportation industry moves towards electric vehicles (EVs). This is because T/Rs are useful for energy transmission, storage, and charging applications.

For example, to transmit energy over long distances, transformers are used to increase voltage since high-voltage energy transmission decreases energy losses over long cable runs. In addition, more so than fossil fuels, renewables utilize energy storage so that power remains available even if the sun is not shining or the wind is not blowing. Many energy storage technologies, such as batteries, accept DC voltage; however, energy is often generated as AC, so it needs to be converted by a rectifier prior to storage.

Conversion from AC to DC is also required to charge everything from cellphones to electric vehicle batteries. Therefore, for those who own an electric vehicle (EV), the AC power available in their houses must be converted to DC to charge their EVs. This functionality is often incorporated into power supplies themselves. For example, the "brick" on a phone or laptop charger converts AC power from a wall outlet to DC to charge/power the device.

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KEYWORDS: Transformer; rectifier; T/R; power; portable-electronic-building-blocks; silicon-carbide; high-frequency-transformer

N21B-T021　　　　TITLE: Artificial Intelligence and Machine Learning-Based Autonomous Mission Planning for Intelligence, Surveillance, and Reconnaissance (ISR) Missions

RT&L FOCUS AREA(S): Artificial Intelligence (AI)/Machine Learning (ML);Autonomy

TECHNOLOGY AREA(S): Air Platforms;Battlespace Environments;Information Systems

OBJECTIVE: Develop a capability to autonomously generate mission plans for onboard Unmanned Aerial Systems (UAS) in support of Intelligence, Surveillance, and Reconnaissance (ISR) missions by applying artificial intelligence (AI) and machine learning (ML) techniques.

DESCRIPTION: With today's advances in software and hardware, autonomous operation is a capability, even if still somewhat disruptive, that is fully realizable as highlighted in references 1–6. In fact, autonomous operation is becoming a critical capability in order to stay ahead of our adversaries. But there are other reasons for autonomous systems [Ref 2], such as "when the world can't be sufficiently specified a priori" and "when adaptation must occur at machine speed". It also makes a good case for AI, which enables significant autonomy and includes learning, reasoning, introspection, decision making, and much more. Exploiting unmanned systems autonomous mission planning is the next stage in enhancing the capabilities of these systems in the operational environments.

This project's success relies on utilizing sophisticated software solutions including machine intelligence/learning and modern computer hardware or graphics processing units (CPUs/GPUs – a scaled version of a workload-optimized massively parallelized computer). It should be evident that the size of unmanned aerial vehicles (UAVs) (Groups 1-5) and the types of missions will impact the overall mission planning requirements and complexity.

The goal is to be entirely autonomous; however, in particular with Group 4-5 systems, embedding trust/risk capabilities and detailed contingency plans in autonomous operation—if unacceptable behavior is detected—is as critical as meeting mission success. Even within autonomous operations, there will still be means to alert the Common Control System operator via the envisioned tool that monitors trust embedded on the platform. With these risk mitigations capabilities, the goal of this project will focus on ISR collection – a more simplistic mission when compared to a strike execution mission, which would in the future add considerable levels of mission complexities.

All UAVs will have the necessary sensors and flight control systems to embed the software to generate autonomous missions from takeoff (flight plan and mission plan) to landing, while completing missions including collection and dissemination of ISR data, i.e., when connectivity is available. It is anticipated that activity-based intelligence and/or other relevant information will start the components-based planning process to determine a suitable platform; route planning, types of sensors in support of ISR collection and sensor collection requirements to generate an entire flight plan with associated requirements; and when to disseminate data. Note that many route planning and resource management algorithms exist, thus any solution should include the ability to adaptively change a particular part of the overall planning process. It should also include consideration for automated contingency plans and dynamic replanning capabilities due to various unexpected factors, such as weather, change in mission requirements, etc. These fully autonomous, mission planning service capabilities must be able to be integrated into the Next-Gen Navy Mission Planning System (NGNMPS) and be shared with the Common Control Systems operator with any available communication system with the ability to be modified if necessary, and more importantly, to actually realize the autonomous behavior be embedded on board the platform. Due to the autonomous plan to be initially shared NGNMPS and CCS operator, it will be necessary to define how the plan is presented to the operators.

Finally, in order to meet mission requirements, the solution needs to specify CPU/GPU requirements to achieve as close to real-time performance as possible; and to paraphrase the Heilmeier Catechism exams for success [Ref 11], it will be essential to understand "how to eventually test, verify and evaluate the overall accuracy and performance of the autonomous mission planning process" that need to be addressed as part of this development effort.

PHASE I: Generate a concept of autonomous mission planning from launch to execution of mission specific requirements (ISR as specified in a tasking order and other data such as activity based intelligence data) to data dissemination, and finally, to return to base. This mission plan may also be an airborne modification (dynamic replanning) to the current mission, applying artificial intelligence techniques. Mission plans will take into consideration threat and friendly disposition, weather, terrain, and any onboard sensor (collection) requirements and limitations. In addition the concept needs to outline required hardware to achieve real-time or near real-time processing capabilities. The Phase I effort will include prototype plans to be developed under Phase II. The overall solution should outline data sources and information that will be required to successfully generate mission plans. It is also required to take into account STANAG processes and procedures to minimize proprietary solutions.

PHASE II: Develop a prototype software solution that can be tested in a simulated mission environment.

In Phase II, the program office will provide additional details about the platforms and sensors characteristics and other vital data critical in support of a realistic prototype development.

PHASE III DUAL USE APPLICATIONS: Finalize the prototype version. Perform final testing and verification in a simulated environment and potentially in a real environment using a surrogate vehicle. Transition to naval platform.

Companies such as Amazon, and similar delivery companies that have already started drone-based package delivery, would benefit from this development. FEDEX and UPS would benefit in terms of using large UAVs for package deliveries from large collection centers to smaller distribution centers.

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KEYWORDS: Mission Planning; Unmanned Aerial Vehicle; UAV; Intelligence, Surveillance and Reconnaissance; ISR; Artificial Intelligence; Autonomous; Machine Learning

N21B-T022   TITLE: Integrated Computational Materials Engineering (ICME) Modeling Tool for Optimum Gas Flow in Metal Additive Manufacturing Processes

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR);Hypersonics;Space

TECHNOLOGY AREA(S): Air Platforms;Materials / Processes;Weapons

OBJECTIVE: Develop an Integrated Computational Materials Engineering (ICME) modeling tool to predict the effect of gas flow on metal additive manufacturing processes for improvement in the quality of the parts.

DESCRIPTION: Additive manufacturing (AM) processes, such as powder bed fusion (PBF) and directed energy deposition (DED), have the potential to revolutionize the manufacturing and repairing of complex metal components in aerospace, medical, and automotive industries. Current processes are not yet fully matured. There is a great need for the processes to produce parts that are free from defects, such as pores, lack of fusion, metal oxidation, and fusion of splattered condensate.

To prevent the parts from oxidizing, AM processes blow inert gases - such as argon and nitrogen - to shield the fusion zone from oxygen. In PBF processes, the shielding gas flow is directed over the build layer to remove metal condensate and spatter from the fusion zone and then is pulled out of the chamber through filters to remove the splattered particle. Improper shielding and removal of spatter particles lead to defects in a PBF process. For example, it has been shown that:
   a) the condensed metal vapor particles could attenuate the laser beam up to 10%,
   b) spatter falling back on the powder bed could locally increase the layer thickness, and
   c) spatter falling onto the consolidated surface could fuse resulting in poor surface finish [Ref 1].

The direction of the flow relative to the laser scanning direction plays a significant role in the quality of the product [Ref 2]. Similarly, the DED processes are also strongly dependent on the flow rates of carrying and shielding gases. Higher flow rates could result in higher cooling rates and reduced heat-affected zone, but could also cause discontinuities and gaps in the deposition. Microhardness could vary with the changes in flow rates [Ref 3]. Current literature surveys show limitations in the modeling efforts. Adam Philo et al. (2017) have developed a computational model of gas-flow effects in the inlet design for the Renishaw AM250 to predict spatter particulate accumulation [Refs 4]. Florian Wirth et al. (2017) have shown the interaction of powder jet and laser beam in a powder-blown machine and cases for laser beam attenuation [Ref 5]. Praveen BidareI et al. (2017) use Schlieren imaging and multiphysics modeling to investigate the inert atmosphere and laser plume in PBF [Ref 6]. References 7 through 14 provide additional experimental and computational efforts. However, a comprehensive modeling tool for gas flow interacting with all major AM process parameters is not available for designing and developing better AM processes.

An ICME framework is needed to represent the process-structure-property-performance relationship in metallic AM. The tool sought in this STTR topic will be part of the framework. It should integrate critical fundamental physics, such as mass, fluid and heat transport, phase transition, surface tension, Marangoni stress, recoil pressure, and melt pool fluid dynamics, into one comprehensive framework. With manufacturing parameters and material properties as the inputs, the framework should quantify the effect of gas flow on melt pool dimension, surface morphology, temperature profile, solidification rate, powder spattering, and pore formation/propagation. The framework should provide mitigation strategies for the gas-induced powder spattering and pore formation, which degrade the property of the fabricated metallic part.

Overall, the model should enable optimizing the gas flow including improvement in nozzle designs; gas circulation to match the design of the AM machine offering optimum shielding of the fusion area and the

melt pool; and the efficient removal of the gas and debris from the chamber. The model should provide ways to set print parameters for optimum part performance for the raw material used and the scan patterns for the part.

PHASE I: Demonstrate the feasibility of a multiphysics model gas flow interaction with metal fusion in the PBF or DED additive manufacturing process. Show that the model works efficiently within the ICME framework to enable proper design and control of gas flow for producing defect-free AM products. Carry out experiments for the chosen AM process to validate the simulated results. Evaluate the model based on the AM products, such as surface finish, defects (size, density, and distribution), and/or microhardness. Demonstrate the potential for this prototype to address factors additional to the subset chosen above for a fully developed modeling system in the ICME framework in Phase II.

PHASE II: Based on the prototype modeling tool developed in Phase I, fully develop and validate the predictive modeling tool to fine-tune the gas flow and the associated process parameters to improve AM part quality, such as fewer defects, better surface finish, and desirable microhardness. Demonstrate its capability of additive manufacturing of aircraft components with complex geometry and tailored performance.

PHASE III DUAL USE APPLICATIONS: Mature the modeling tool further by extending the capability for common airframe metal alloys, such as aluminum, steel, and titanium. Demonstrate the capability to optimize the AM process for multiple metals. Validate the tool in final testing of the capability by printing parts of more than one metal alloy and carrying out component tests demonstrating strength and durability.

AM in the commercial sector is progressing with individual companies developing limited capabilities using ICME tools. The commercial sector broadly treats material qualification and part certification for AM as separate processes, one followed by the other. ICME tools integrate them to have a seamless process. Hence, this tool will open the possibilities for the commercial sector to take advantage of developing quality products for their customers.

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N21B-T023   TITLE: High Specific Energy Lithium-Ion Battery with Carbon-Based Nanostructures

RT&L FOCUS AREA(S): General Warfighting Requirements (GWR);Microelectronics;Quantum Science

TECHNOLOGY AREA(S): Electronics

OBJECTIVE: Develop and demonstrate a novel high-energy (> 600 Whr/kg) rechargeable lithium-ion battery technology to provide high-quality enduring power for Navy hand-held portable electronics and small unmanned aerial system (UAS) applications.

DESCRIPTION: Rechargeable Lithium-ion (Li-ion) batteries [Ref 1] are widely used for a wide variety of commercial and naval electronics and electrical applications. The weight of the naval power battery system can be a significant portion of the overall weight of the portable electrical device on board a ground or aerial vehicle. Furthermore, the energy capacity of existing Li-ion batteries is not adequate to support prolonged operating times of current and future naval platforms, such as unmanned aerial systems (UASs) and portable communication and surveillance systems, for extended mission endurance. Moreover, the current batteries necessitate frequent recharging and the times for full recharging are in the range of hours.

In order to increase the energy capacity, reduce the weight, and shorten the recharging time of next-generation rechargeable batteries for future naval missions, high-performance rechargeable batteries with higher specific energy and much shorter recharging cycle times are needed. Current state-of-the art Li-ion batteries use graphite as an anode. Research has shown that the use of carbon-based nanomaterials, such as graphene, carbon nanotubes, carbon nanofibers, etc., as potential anode materials for Li-ion batteries enhancements to replace graphite, shows great promise in providing high-galvanometric capacity while also maintaining reasonable cycling stability [Refs 2, 3].

The objective of this STTR topic is to develop and demonstrate a novel rechargeable Li-ion battery enhanced by using carbon-based nanostructures with a specific energy > 600 Whr/kg at 0.5C discharge rate, and specific capacity of > 600 Ahr/kg. The battery is also expected to exhibit an excellent cycle stability and maintain 85% capacity after 1000 cycles and operate over a wide temperature range of -30°C to +55°C. The high-energy cell should have the ability to operate up to a 3C continuous discharge rate at the stated operational conditions, as well as to be stored over a wide temperature range (-40°C to +70°C). Proposed innovative approaches may include improvements to cell components, novel materials or processes, or other innovative ideas.

PHASE I: Develop, design, and demonstrate the feasibility of an innovative Li-ion battery using the most promising carbon-based nanomaterials as the anode material. Perform analysis and initial testing to determine the ability of the proposed battery with the chosen anode, cathode, and electrolyte material combination in terms of the performance metrics, including specific energy, specific capacity, reliable charge/discharge capabilities, and cycle life as stated in the Description. Project the overall performance improvements of the proposed battery configuration to be fabricated in Phase II compared to a common lithium ion battery. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Fabricate and demonstrate a complete cell, based on the down-selected design in Phase I. Demonstrate and validate the performance of the novel Li-ion battery to meet stated design metrics listed in the Description. Perform laboratory testing to confirm performance. Assess the risks associated with the storage and operation of the battery and propose viable risk mitigation solutions. Deliver a prototype to NAVAIR for further field testing and evaluation.

PHASE III DUAL USE APPLICATIONS: Fully develop and transition the Lithium ion Battery based on the final design from Phase II for naval applications in various UAV platforms.

The commercial sectors such as electrical vehicles and other commercial electronic devices, would significantly benefit from this research and development in high-performance, lightweight batteries.

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KEYWORDS: Specific-Energy; Lithium-Ion; Li-ion; Battery; Carbon-Based Nanostructures; Graphene; Carbon nano-tubes

N21B-T024 TITLE: Predictive Data Analytics to Refine Aircrew Training and Operations

RT&L FOCUS AREA(S): Artificial Intelligence (AI)/Machine Learning (ML);Autonomy;General Warfighting Requirements (GWR)

TECHNOLOGY AREA(S): Air Platforms;Human Systems

OBJECTIVE: Research and develop a technology that supports ingesting large and disparate data sets from naval aviation aircraft and uses data science to provide outputs that increase enterprise level knowledge of aviator performance, safety, and effectiveness through data-driven predictive analytics to influence training and operations.

DESCRIPTION: The success of military operations significantly depends on the level of quality training, safety, and operational effectiveness demonstrated by its personnel. This is especially true for naval aviation operations. There are a large set of factors that affect the successful employment of naval aircraft during peacetime and wartime. These factors can change with time and with the situation and are articulated in vast and disparate data sets. These data sets, when captured, traditionally provide immediate evaluation and aircrew debrief. Generally, a vast amount of data that affects and describes crew performance is discarded or stored with no long-term data analytics processing conducted that could provide valuable trend and predictive insight.

The ability to identify performance trends is a key factor today in the effectiveness of any enterprise. This is especially true in aviation and military operations. The capability to capture large sets of performance/attribute data, and analyze the data to establish baseline and standard performance levels, enables the identification of performance anomalies, trends, and predictive outcomes. This capability has become a standard in commercial aviation and has the same applicability to military operations. The implementation of this capability to the highly complex naval aviation operations would provide great benefit from the comprehensive analysis aircrew performance to gain greater insight into areas including aircraft flight path management, procedural compliance, stores deployment, situational awareness, threat/error management, distraction management, environmental effects, aircraft envelope management, and many other performance areas. However, solutions must address both the opportunities and the challenges associated with data analytic solutions [Ref 1].

The Navy requires a technology that supports ingesting large and disparate data sets from naval aviation aircraft, supporting required parsing, sorting, and fusion to manage relevant data. Development efforts should focus on providing data analytic functionality that results in outputs that increase enterprise-level knowledge of aviator performance, safety, and effectiveness. Further, the technology functionality should extend traditional data science solutions to include capabilities for data-driven predictive analytics to influence training and operations [Ref 2]. The research and development effort should provide focus on the visualization capabilities to increase end user understanding of data analysis processes and outputs, in addition to an underlying data analytic architecture. The technology developed must meet the system DoD accreditation and certification requirements to support processing approvals for use through Risk Management Framework [Refs 4, 5, and 7] and any use of artificial intelligence (AI) as part of defined solutions should understand ethical use recommendations [Ref 6]. The policy cited in Department of Defense Instruction (DoDI) 8510.01, Risk Management Framework (RMF) for DoD Information Technology (IT) [Ref 3] and compliance with appropriate DoDI 8500.01, Cybersecurity [Ref 8] are necessary to support future transition needs.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by DoD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved

by the Defense Counterintelligence Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advanced phases of this contract.

PHASE I: Develop, design, and demonstrate a strategy, taking into consideration the feasibility, suitability, and acceptability, to leverage all available aircraft and related crew performance data. Identify potential roadblocks likely to be encountered and formulate approaches to overcome them. Design an architecture and implementation plan illustrating the benefits of training analytics through training use cases to demonstrate benefits of predictive analytics. The Phase I effort will include prototype plans to be developed under Phase II, with consideration for options on system architecture (e.g., Navy Marine Corps Intranet (NMCI), standalone system).

PHASE II: Develop a working prototype of the selected concept to include high-level requirements, design, initial testing, and demonstration. Demonstrate the prototype in a lab or live environment. Planning and consideration for information assurance compliance and certification for an authority to operate, including updates to support installation on Navy Marine Corps Intranet (NMCI) systems or other DoD hardware.

Work in Phase II may become classified. Please see note in the Description section.

PHASE III DUAL USE APPLICATIONS: Extend the baseline functionality to include advanced or more robust data analytic techniques, and/or integrate developed capability with existing database and analysis systems. Implement Risk Management Framework guidelines [Refs 3, 4, 5, 6, and 7] to support information assurance compliance and certification for an authority to operate, including updates to support installation on NMCI systems or other DoD hardware.

Data analytics are relevant to a range of other domains such as athletics and medical communities. For medical communications, rapidly evolving situations with minimal established information is a critical and timely use case given novel infectious diseases; in addition to traditional data analytics for trends, understanding potential predictive analytics will inform decisions at various levels of leadership based on expected trends. Further, domains with quickly advancing technology due to the rapid pace of innovation and advances will benefit from similar technology solutions as a means to provide unique insights based on data analytics and predictive analyses.

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