DEPARTMENT OF THE NAVY (DON)
20.3 Small Business Innovation Research (SBIR)
Proposal Submission Instructions

IMPORTANT

- **The following instructions apply to SBIR topics only:**
  - **N203-148 through N203-152**
- **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.**
- **Proposers that are more than 50% owned by multiple venture capital operating companies (VCOC), hedge funds (HF), private equity firms (PEF) or any combination of these are eligible to submit proposals in response to DON topics advertised in this BAA. Information on Majority Ownership in Part and certification requirements at time of submission for these proposers are detailed in the section titled ADDITIONAL NOTES.**
- A Phase I proposal template specific to DON topics will be available to assist small businesses to generate a Phase I Technical Volume (Volume 2). The template will be located on https://www.navysbir.com/links_forms.htm.
- 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 optional Supporting Documents Volume (Volume 5) is available for the SBIR 20.3 BAA cycle. The optional 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 Director of the DON SBIR/STTR Programs is Mr. Robert Smith. For program and administrative questions, contact the SYSCOM Program Manager listed in Table 1; **do not** contact them for technical questions. For technical questions about a topic, contact the Topic Authors listed within each topic during the period **25 August 2020 through 22 September 2020.** Beginning **23 September 2020,** the DoD SBIR/STTR Topic Q&A platform (https://www.dodsbirsttr.mil/submissions) listed in Section 4.13.d of the Department of Defense (DoD) SBIR/STTR Program Broad Agency Announcement (BAA) must be used for any technical inquiry. For general inquiries or problems with electronic submission, contact the DoD SBIR/STTR Help Desk at 1-703-214-1333 (Monday through Friday, 9:00 a.m. to 5:00 p.m. ET) or via email at dodsbirsupport@reisystems.com.

TABLE 1: DON SYSTEMS COMMAND (SYSCOM) SBIR PROGRAM MANAGERS

Topic Numbers	Point of Contact	SYSCOM	Email
N202-148	Mr. Jeffrey Kent	Marine Corps Systems Command (MCSC)	jeffrey.a.kent@usmc.mil
N202-149 to N202-152	Mr. Shadi Azoum	Naval Information Warfare Systems Command (NAVWAR)	shadi.azoum@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 programs 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 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 follow the Phase I Proposal Template that is specific to DON topics as a guide for structuring proposals. The template will be located on https://navysbir.com/links_forms.htm. Inclusion of cost estimates for travel to the sponsoring SYSCOM's facility for one day of meetings is recommended for all proposals.

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 MUST BE MET or the proposal will be deemed noncompliant and may be REJECTED.

- **Proposal Cover Sheet (Volume 1).** As specified in DoD SBIR/STTR Program 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.

*For headers, footers, listed references, and imbedded tables, figures, images, or graphics that include text, a font size smaller than 10-point is allowable; however, proposers are cautioned that the text may be unreadable by evaluators.

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).

Phase I Options are typically exercised upon selection for Phase II. Option tasks should be those tasks that would enable rapid transition from the Phase I feasibility effort into the Phase II prototype effort.

- **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)**. Volume 4 is not available for the 20.3 BAA. Please refer to the DoD SBIR/STTR Program BAA section 5.4(e) for further information.

- **Supporting Documents (Volume 5)**. The optional Volume 5 is provided for small businesses to submit additional documentation to support the Technical Proposal (Volume 2) and the Cost Volume (Volume 3). Volume 5 is available for use when submitting Phase I and Phase II proposals. A template for Volume 5 is available on https://navysbir.com/links_forms.htm. DON will not be using any of the information in Volume 5 during the evaluation.

  Note: Even if you are not providing documentation within Volume 5, DSIP will require you to respond to a "yes" or "no" question regarding the volume. Failure to respond may stop you from submitting and certifying your proposal.

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

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 has implemented the optional Fraud, Waste and Abuse Training Certification (Volume 6). DON does not require evidence of Fraud, Waste and Abuse Training at the time of proposal submission. Therefore, DON will not require proposers to use Volume 6.

DON SBIR 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. Enter this information in the "Explanatory Material" field in the online DoD Volume 3. 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. 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).

- **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 added in the "Explanatory Material" field of the online DoD Volume 3. If the supporting information exceeds the character limits of the Explanatory Material field of Volume 3, this information must be included in Volume 5 as "Additional Cost Information" as noted above. Failure to add the required information in the online DoD Volume 3 and, if necessary, Volume 5 will result in the denial of TABA. TABA may be proposed in the Base and/or Option periods, but the total value may 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 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 all 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.

Approval of direct funding for TABA will be evaluated by the DON SBIR/STTR Program Office. A detailed request for TABA must include:

- 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 SBIR applicant
- Propose a TABA provider that is the SBIR applicant
- Propose a TABA provider that is an affiliate of the SBIR applicant
- Propose a TABA provider that is an investor of the SBIR 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 must be included in the Cost Volume (Volume 3) as follows:

- Phase I: The value of the TABA request must be included on the TABA line in the online DoD Volume 3 and, if necessary, Volume 5 as described above. The detailed request for TABA (as specified above) must be included in the "Explanatory Material" field of the online DoD Volume 3 and be specifically identified as "Discretionary Technical and Business Assistance".
- Phase II: The value of the TABA request must be included on the TABA line in the DON Phase II Cost Volume (provided by the DON SYSCOM). The detailed request for TABA (as specified above) must be included as a note in the Phase II Cost Volume and be specifically identified as "Discretionary Technical and Business Assistance".

TABA may be proposed in the Base and/or Option periods. Proposed values for TABA must NOT 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

NOTE: Section 9(b)(5) of the SBIR and STTR Policy Directive requires that a firm receiving technical or business assistance from a vendor during a fiscal year submit a report with a description of the technical or business assistance received and the benefits and results of the technical or business assistance provided. More information on the reporting requirements of awardees that receive TABA funding through the DON can be found on https://www.navysbir.com/links_forms.htm. Awardees that receive

TABA funding through the DON will upload the report to https://www.navysbirprogram.com/navydeliverables/.

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 7.0 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. As noted in the sections of the aforementioned Announcement on proposal submission requirements, proposals exceeding the total costs established for the Base and/or any Options as specified by the sponsoring DON SYSCOM will be rejected without evaluation or consideration for award. Due to limited funding, the DON reserves the right to limit the number of 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 1. If the protest is to be filed with the GAO, please refer to 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 4.12.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 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 SBIR may transition in Phase II to STTR and vice versa. Please refer to instructions provided in section 7.2 of the DoD SBIR/STTR Program BAA.

ADDITIONAL NOTES

Majority Ownership in Part. Proposers which are more than 50% owned by multiple venture capital operating companies (VCOC), hedge funds (HF), private equity firms (PEF), or any combination of these as set forth in 13 C.F.R. § 121.702, are eligible to submit proposals in response to DON topics advertised within this BAA.

The following must be satisfied for proposals to be accepted and evaluated:

a. Prior to submitting a proposal concerns must register with the SBA Company Registry Database.
b. The proposer within its submission must submit the Majority-Owned VCOC, HF, and PEF Certification. The SBIR VC Certification must be included in the Supporting Documents Volume (Volume 5). A copy of the SBIR VC Certification can be found on https://navysbir.com/links_forms.htm.
c. Should a proposer become a member of this ownership class after submitting its application and prior to any receipt of a funding agreement, the proposer must immediately notify the Contracting Officer, register in the appropriate SBA database, and submit the required certification which can be found on https://navysbir.com/links_forms.htm.

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 carryout 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.

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 Technical 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 SBIR 20.3 Phase I Topic Index

N203-148 TITLE: Crawling Amphibious Breacher (CRAB)

RT&L FOCUS AREA(S): Autonomy
TECHNOLOGY AREA(S): Ground Sea

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a submersible autonomous amphibious breaching vehicle capable of proofing assault lanes from the surf zone (<10 feet depth) through the beach zone, reducing explosive and non-explosive obstacles, and clearing craft landing zones.

DESCRIPTION: The CRAB (Crawling Amphibious Breacher) would be a small, inexpensive, (>$100K per system) submersible autonomous vehicle that will operate in concert with other CRABs. They would be capable of being deployed off-shore, from a depth of approximately 40 feet. CRABs would drop from surface craft to the seafloor and maneuver toward the beach, clearing a lane in a formation. As they move toward the shore, they will neutralize buried and proud (i.e., bottom) sea mines along the way. Mines would be neutralized by targeting the fuze types: pressure fuzed mines by rolling over them; magnetic mines by the heavy metal construction of the CRAB, and tilt-rod fuzed mines by driving into the tilt-rod itself. Once the CRABs exit the surf zone, they will continue up the assault lane, neutralizing land mines by targeting the fuze types, as listed above. CRABs would be small enough that their wreckage can be driven over by an Amphibious Combat Vehicle (ACV) or other large assault vehicles. Once the CRABs reach their limit of advance, they would move out of the assault lane and remain there until the breach is complete. As the CRABs move through the lane, they would drop markers (GPS or other) that landing forces can see on a screen to indicate the cleared lane. These markers would be picked up by receivers in the amphibious force vehicle's common operating picture systems and generate a visible path on the driver display. The CRAB will not be designed to neutralize moored or floating sea mines and will operate without prior Intelligence, surveillance and reconnaissance (ISR) targeting information. The Marine Corps would like the CRAB to be capable of reducing submerged man-made obstacles using a clamshell type of arm, like that of an excavator, but realizes this may make each CRAB too expensive. This SBIR topic is looking for an innovative way to also reduce man-made obstacles using the most inexpensive means.

Key Performance Parameters (required) of the CRAB:

- Error rate of <3 ft.
- Autonomous underwater operation
- Operating in depths of <40 ft of saltwater
- Capable of deployment from surface or subsurface watercraft near shoreline <400m from shore
- Must be able to self-right or operate in any orientation (if flipped over, can still maneuver or turnover)
- Must be capable of operating in sand, mud, and shell soil sea floor
- Must detonate pressure fuzed buried and bottom sea mines (~500lbs PSI)
- Must detonate pressure fuze buried and surface laid land mines (~500lbs PSI)

- Overall size must not exceed (LxW) 12’7” x 5’0”
- Overall weight must not exceed 14,000 lbs

Key System Attributes (desired) of the CRAB:

- Capable of remote or waypoint operation
- Capable of using targeting data (potentially IS2OPS) to target identified buried mines
- Capable of swarming or moving in formation
- Capable of communication within swarm while underwater
- Capable of communication to surface craft
- Mark cleared lane with dropped sensor in water and land (example; dropped RFI pucks along outer edge of breached lane)
- Battery operated with enough operation time to conduct an eight hour mission
- Capable of reducing submerged man-made obstacles (pushing hedgehogs, tetrahedrons, cutting concertina wire)
- Capable of detonating tilt-rod fuzed mines
- Capable of detonating magnetic influence mines

PHASE I: Develop concepts for a CRAB vehicle that meets the requirements described above. Demonstrate the feasibility of the concepts in meeting Marine Corps needs and establish that the concepts can be developed into a useful product for the Marine Corps. Establish feasibility by material testing and analytical modeling, as appropriate. Provide a Phase II development plan with performance goals and key technical milestones, and that addresses technical risk reduction.

PHASE II: Develop a scaled prototype for evaluation. Determine the prototype’s capability in meeting the performance goals defined in the Phase II development plan and the Marine Corps requirements for the single amphibious integrated precision augmented-reality navigation system. Demonstrate system performance through prototype evaluation and modeling or analytical methods over the required range of parameters, including numerous deployment cycles. Use evaluation results to refine the prototype into an initial design that meets Marine Corps requirements. Prepare a Phase III development plan to transition the technology to Marine Corps use.

PHASE III DUAL USE APPLICATIONS: Support the Marine Corps in transitioning the technology through test and validation to certify and qualify the system for Marine Corps use. Develop a CRAB vehicle for evaluation to determine its effectiveness in an operationally relevant environment. Support the Marine Corps for test and validation to certify and qualify the system for Marine Corps use.

REFERENCES:

1. Daily, William, et al. “Initial Development of An Amphibious ROV for Use in Big Surf.” Maritime Technology Society Journal; Volume 28, Number 1, Spring 1994. https://www.researchgate.net/publication/293000294_Initial_development_of_an_amphibious_ROV_for_use_in_big_surf/link/5b37fc56aca2720785fd8c1b/download
2. South, Todd “Marines want to use artificial intelligence to help find and neutralize sea mines.” Marine Corps Times, 14 September 2018, https://www.marinecorpstimes.com/news/your-marine-corps/2018/09/14/marines-want-to-use-artificial-intelligence-to-help-find-and-neutralize-sea-mines/

KEYWORDS: Autonomous; Unmanned Underwater Vehicle; UUV; Mine Countermeasures; Swarming; Breaching; Amphibious

N203-149 TITLE: Advanced Radio Frequency (RF) Photonic Integrated Circuit (PIC)

RT&L FOCUS AREA(S): Microelectronics
TECHNOLOGY AREA(S): Electronics

OBJECTIVE: Develop Photonic Integrated Circuits (PICs) that have high dynamic range (> 90 dB) and large instantaneous operational bandwidth (> 10 GHz), with digital signal processing at native Radio Frequency (RF) or Intermediate Frequency (IF). PICs are expected to operate from L to Ka bands (specifically, 950 MHz to 40 GHz); wider upper frequency range is also desired.

DESCRIPTION: The Wideband Anti-jam Modem System (WAMS) modem is the Navy's next generation software-defined wideband modem for both transponded and processed satellites and will be integrated with the Navy Multiband Terminal (NMT) on ships and submarines, Commercial Broadband Satellite Program (CBSP) on ships, and the Modernization of Enterprise Terminal (MET) on shore for communications. WAMS will enhance shipboard and submarine wideband functionality to provide resilient communications. The WAMS modem will provide protected communications through two waveforms: Protected Tactical Waveform (PTW) and Direct Sequence Spread Spectrum (DSSS). These waveforms require both wide bandwidth and high dynamic range, which requires relatively large Size, Weight, and Power (SWaP) with current conventional electronic circuits.

PICs offer numerous advantages such as greater operational bandwidth and reduced SWaP requirements. PICs may offer the ability to directly sample wide swaths of RF bandwidth and process them directly at the antenna. Optical transport of signals over relatively low cost and highly durable optical cables offer the potential to significantly reduce operational and maintenance costs. Further, optical transport is more immune to Electro-Magnetic Interference (EMI) and, complementarily, less likely to produce EMI. Unlike electronic integrated circuits where silicon (Si) is the dominant material, PICs have been fabricated from a variety of materials (e.g., gallium arsenide, lithium niobate). Each material provides different advantages. This SBIR topic will explore the variety of fabrication materials for PICs and develop an advanced signal processing system to yield high dynamic range and wide bandwidth capabilities for the WAMS modem.

This SBIR topic falls under the NDS Alignment of "Modernize Key Capabilities" and the DDR&E (RT&L) Tech Priority "Microelectronics."

PHASE I: Explore a variety of fabrication materials for PICs and investigate their performance in regard to bandwidth and dynamic range. As some materials used in PICs are considered rare earth materials, investigate the ease of acquiring and manufacturing for the materials explored.

Develop a concept for the architecture of an optical signal processing system that can directly capture and process wide band RF or IF at the antenna or up/down conversion subsystem, respectively. The optical signal processing system should perform all the necessary frequency translations in the optical domain and render the bands of interest in digital electronic form. Consider in the research that the ideal formatting for the electrical signals will be in VITA 49.2 or ANSI 5041 standard; however, contractor format is acceptable for Phase I. Ensure that the minimum analog – digital bit depth shall be 16 bits each for I and Q signals.

Describe the most promising technical solutions based on the investigations and technical trade-offs performed earlier in this phase.

For the identified technical solutions, develop the SBIR Phase II Project Plan to include a detailed schedule (in Gantt format), spend plan, performance objectives, and transition plan for the identified Program of Record (PoR).

PHASE II: Develop a set of performance specifications for the Advanced RF PIC and conduct a System Requirements Review (SRR).

Establish a working relationship with a candidate WAMS modem contractor to perform initial integration activities and identification/development of any necessary Pre-Planned Product Improvement (P3I) requirements on the candidate WAMS modem. Engage with the Program Office to assist in the identification, introduction, and collaboration with the candidate WAMS modem contractor.

Develop the prototype Advanced RF PIC for demonstration and validation in the candidate WAMS modem or equivalent development environment. Conduct Preliminary Design Review (PDR) for the Advanced RF PIC prototype and commence development of an Engineering Development Model (EDM) system. Conduct Critical Design Review (CDR) prior to building the EDM.

Develop the lifecycle support strategies and concepts for the Advanced RF PIC.

Develop SBIR Phase III Project Plan to include a detailed schedule (in Gantt format) and spend plan, performance requirements, and revised transition plan for the identified PoR.

PHASE III DUAL USE APPLICATIONS: Refine and fully develop the Phase II EMD to produce a Production Representative Article (PRA) of the Advanced RF PIC and integrate into the final target WAMS modem.

Perform Formal Qualification Tests (FQT) (e.g., field testing, operational assessments) of the PRA Advanced RF PIC with the WAMS modem and associated terminal.

Provide life-cycle support strategies and concepts for Advanced RF PIC with the WAMS modem contractor by developing a Life-Cycle Sustainment Plan (LCSP).

Investigate the dual use of the developed technologies for commercial applications such as in telecommunications. With 5G, new waveforms must be capable of supporting a greater density of users (e.g., up to a million devices per square kilometer) and higher data throughput (speeds in the Gbps), and provide more efficient utilization of available spectrum. Advanced RF PICs can potentially provide the high dynamic range and spectral processing power to meet these needs. Another potential commercial application is optical or photonic computing where high performance computer systems are required to process and transport petabyte scale data within and among distributed computing environments.

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KEYWORDS: Navy Multiband Terminal; NMT; Commercial Broadband Satellite Program; CBSP; Wideband Anti-jam Modem System; WAMS; WAM; Satellite Communications, SATCOM; Military

Satellite Communications; MILSATCOM; Photonic Integrated Circuit; PIC; RF; Radio Frequency; Operating Systems Design and Implementation; OSDI; VITA 49.2; Communications Satellite

N203-150 TITLE: Frequency Hopping Optimization (FHO) for Tactical Data Links

RT&L FOCUS AREA(S): Network Command, Control and Communications, 5G
TECHNOLOGY AREA(S): Battlespace; Electronics; Materials

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and utilize modern receiver digital compensations algorithms to increase tactical network capacity for tactical data links.

DESCRIPTION: Over the past two decades, algorithms have been developed that allow for multi-user detection, cancellation, and signal separation enabling overlapping channel condition such that network capacity could be effectively doubled. Overlapping channel techniques can provide significant improvements in spectrum utilization and application performance; however, such techniques or algorithms have not been used for tactical data link applications [Refs 1-4].

The goal of this SBIR topic is to increase tactical data links network capacity and throughput (i.e., node to node) by employing partially overlapping channels using leveraging techniques or algorithms that can significantly suppresses adjacent channel interference. A key aspect of this effort to achieve a higher network capacity in tactical data links is analyzing, simulating, and documenting the feasibility of implementing efficiencies on a given channel. In performing design trades, the overlapping channel solution should be implementable within the current Software Interface Specification (SiS) and not degrade current network capacity or performance (e.g., anti-jam, sensitivity, throughput). The Navy seeks innovative overlapping channel algorithms solutions for tactical data links application that can be implemented in a Field Programmable Gated Array (FPGA). Desired solutions should be software and/or firmware solutions. Trades affecting hardware receiver resources utilization (e.g., FPGA resources) and any other system software impacts are required.

Implementing this type of capability would provide greater spectral efficiency and bandwidth for tactical data links. The attributes cited above would provide substantial network improvements in reducing overall spectral access requirements while simultaneously increasing warfighter communication and data network capacity.

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 NAVWAR 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: Demonstrate the feasibility of new or existing partial overlapping channel techniques and/or algorithms for tactical data links application within the intended radio subsystem. Evaluate the feasibility of potential solutions through the analysis inclusive of simulations of Physical Layer (PHY)-level changes. Evaluate key metrics including channel capacity (i.e., this number depends on modulation and throughput but typically it will be about 20-30% improvement), channel overlap (20-30%), node-to-node throughput (20% improvement) and network capacity (1.2x # of nodes). Include simulations to establish feasibility basis for the proposed techniques. Assume parameters outlined in the Description. Detail the feasibility, development and integration challenges of the proposed technology solutions as well as any other technical risks. The Phase I effort will include prototype plans for a Multifunctional Information Distribution Systems (MIDS) Joint Tactical Radio System (JTRS) TRL 6 - integration and demonstration of solution on a relevant operational laboratory environment - to be developed under Phase II. Note: Partnership with MIDS prime vendors is encouraged during Phase I efforts.

PHASE II: Prototype and demonstrate a MIDS JTRS TRL6 partial overlapping channel solution(s), encompassing both the design of the algorithms and anticipated effects. Conduct evaluations by testing the algorithms against baseline network performance, receiver sensitivity and A/J metrics on a MIDS JTRS TRL 6 relevant operational laboratory environment to test and validate performance and/or any adverse impact. Prepare and document a report that discusses the results, analysis of the performance, challenges and/or shortfalls, and risks and recommendations for transition. Prepare a Phase III development plan to transition the technology for Navy and potential commercial use.

Note: The expected TRL for this project is TRL 6 (i.e., prototype demonstrated in a relevant laboratory environment). Partnership with MIDS prime vendors is encouraged to support tasks for this Phase II effort and enable potential transition. MIDS JTRS is a National Security Agency-certified type 1 encryption system; hence, information assurance (IA) compliance will apply during Phase II and subsequent transition efforts. Work produced in Phase II and subsequent efforts will be classified (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the algorithms and solutions to Navy use. Refine the algorithms, software code, validation, documentation, and IA compliance. Perform test and validation to certify and qualify software and firmware components for Navy use. Implement the capability in the form of fast, efficient algorithms that, once proven, can be coded in software-defined radios.

Partial overlapping channel algorithms have tremendous application in the area of dense enterprise wireless local area networks and commercial cellular communication. Partial overlapping channel technology has wide commercial applications to address LTE, 5G, and WIFI technology deployment due proximity with other interferences, spectrum challenges, etc.

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KEYWORDS: Partial Overlapping Channels; Spectrum Utilization; Tactical Data Links; MIDS; Multifunctional Information Distribution Systems; Network Capacity

N203-151 TITLE: Machine Learning Detection of Source Code Vulnerability

RT&L FOCUS AREA(S): Artificial Intelligence/ Machine Learning, General Warfighting Requirements
TECHNOLOGY AREA(S): Information Systems

OBJECTIVE: Develop and demonstrate a software capability that utilizes machine-learning techniques to scan source code for its dependencies; trains cataloging algorithms on code dependencies and detection of known vulnerabilities, and scales to support polyglot architectures.

DESCRIPTION: Nearly every software library in the world is dependent on some other library, and the identification of security vulnerabilities on the entire corpus of these dependencies is an extremely challenging endeavor. As part of a Development, Security, and Operations (DevSecOps) process, this identification is typically accomplished using the following methods: (a) Using static code analyzers. This can be useful but is technically challenging to implement in large and complex legacy environments. They typically require setting up a build environment for each version to build call and control flow graphs, and are language-specific and thus do not work well when there are multiple versions of software using different dependency versions. (b) Using dynamic code review. This is extremely costly to implement, as it requires a complete setup of an isolated environment, including all applications and databases a project interacts with. (c) Using decompilation to perform static code analysis. This is again dependent on software version and is specific to the way machine-code is generated.

The above methods by themselves generate statistically significant numbers of false positives and false negatives: False positives come from the erroneous detection of vulnerabilities and require a human in the loop to discern signal from noise. False negatives come from the prevalence of undetected altered dependent software (e.g., copy/paste/change from external libraries).

Promising developments from commercial vendors provide text mining services for project source trees and compare them against vulnerability databases, such as Synopsis/Blackduck Hub, IBM AppScan, and Facebook's Infer. However, these tools are costly to use and require the packaging of one's code to be uploaded to a third-party service.

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 NAVWAR 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 a concept for a design for a software utility that:

- Performs text mining on source trees so that it (a) accurately identifies all declared and undeclared dependencies, and (b) does not require a setup of the build environment.
- Trains algorithms to catalog multiple vulnerability databases, both public and internal to the Defense and Intelligence communities, to detect known vulnerabilities, and delineate recommended fixes for the software developer.
- Trains algorithms to catalog the libraries that many projects depend upon (e.g., OpenSSL), mapping their correct version, identifying known vulnerabilities in that version, and reconciling

against the current project so that scanning the entire corpus of external dependencies is an efficient and scalable process (note: these parameters must also be able to be tuned for each project).
- Detects if code was extracted from external libraries and manipulated to make it look as if it was organically produced (presumably using the above cataloging features).
- Scales to support polyglot architectures.
- Performs the above services for every version in a code repository so that vulnerabilities across multiple versions can be comprehensively tracked.

The feasibility study must show that the software utility can easily integrate into existing Continuous Integration/Continuous Development (CI/CD) DevSecOps tools. Metrics for accuracy, scalability, and speed must also be provided. Develop integration plans for Phase II.

NOTE: Detailed knowledge of Navy data sources may not be necessary during Phase I if the performer can show the above. It is recommended to use publicly available open-source software repositories. For example, the Linux kernel, or the Chromium project, and leverage, for example, the National Vulnerability Database or Common Vulnerabilities and Exposures databases.

PHASE II: Develop, demonstrate, validate, and mature the Phase I-developed concepts into prototype software. Work with the Government to establish metrics and acceptance testing for the bullets listed in Phase I.

- Demonstrate that the cataloging of dependent software packages can scale to internal and external dependent software packages.
- Demonstrate that the number of source vulnerability databases can be expanded to include internal and external sources.
- Demonstrate that the service can scan for vulnerabilities in more than two languages, to include Java, C++, and Python.
- Demonstrate that the service can ingest custom vulnerability information using a known specification (e.g., SCAP, CWE).
- Provide interfaces to ingest, process, and validate a user's custom source code and custom security bug information.
- Establish/document a lifecycle maintenance plan for the Navy.

It is probable that the work under this effort will be classified under Phase II (see Description for details).

PHASE III DUAL USE APPLICATIONS: Integrate the service into an existing Navy CI/CD DevSecOps process:

- Provide methods to rapidly ingest security and software package information.
- Implement data procurement and on-boarding processes.
- Develop product/service to a maturity level that allows it to enter the third party market as dependent software package management and security vulnerability identification tools in both the commercial and government sector.

Any commercial organization, private or public (e.g., Transportation, Medical Device Development, and/or the FDA), that does software verification and validation should be able to leverage the service.

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KEYWORDS: DevSecOps; Continuous Integration; Continuous Deployment; Software; Vulnerabilities; Legacy Code; Software Scanning; Vulnerability Databases; Development, Security and Operations

N203-152 TITLE: Platform Is The Antenna

RT&L FOCUS AREA(S): Network Command, Control and Communications
TECHNOLOGY AREA(S): Electronics

OBJECTIVE: Develop a conformal printed or applique antenna system to be placed directly on the platform to yield Electro Magnetic (EM) transmit, receive, and absorptive capabilities. If possible, ensure that the antenna system maximally utilize the platform as the conductive medium with appropriate current probes and shunting mechanisms. Design an antenna system that covers the military High Frequency (HF) operational frequencies.

DESCRIPTION: With the recent advances in digital communications, the ability to perform highly complex signal processing has almost become a commodity. However, a ship's limited topside offers little space to host the complementary antennas. In addition to limited topside space, the confluence of apertures severely challenges the ship designer's ability to yield low overall Radar Cross Section (RCS) ship designs.

This SBIR topic focuses on solving both communications and RCS problems by combining novel reduced Size, Weight, and Power (SWaP) conformal antenna systems that can perform at or near (within 3 dB) the same level of performance as antennas currently fielded in the High Frequency (HF) (2 MHz to 30 MHz) as a threshold and Very High Frequency (VHF) (30 MHz to 88 MHz) to Ultra High Frequency (UHF) (225 MHz to 3 GHz) as objective bands. Note: It is acceptable to divide the UHF operational frequencies in to two bands: 225 MHz to 512 MHz and 500 MHz to 3 GHz. Further, this antenna system must provide beam forming capabilities in support of new "massive Multiple In and Multiple Out (MIMO)" multi-carrier waveforms in the HF domain. Platform Is The Antenna (PITA) can be the primary (objective) or supplemental (threshold) HF massive MIMO antenna system.

This SBIR topic falls under the NDS Alignment of "Modernize Key Capabilities" and the DDR&E (RT&L) Tech Priority "Networked Command, Control, and Communications (C3)."

PHASE I: Conduct a study to determine the technical feasibility of a conformal and/or applique antenna system that covers the operational frequencies of 2 MHz to 3 GHz. Determine the Effective Radiated Power (ERP) and antenna gain to noise temperature (G/T) necessary to perform at or near the same level of performance (within 3 dB) as antennas currently in the HF to UHF bands.

Describe the technical solution based on the investigations and technical trade-offs.

For the identified solution, develop the SBIR Phase II Project Plan to include a detailed schedule (in Gantt format), spend plan, performance objectives, and transition plan for the identified Program of Records (PoRs).

PHASE II: Develop a set of performance specifications for the PITA system and conduct a System Requirements Review (SRR).

Establish a working relationship with Naval Information Warfare Center (NIWC) Pacific engineers to perform initial integration activities and identification/development of any necessary engineering changes to the current HF, VHF, and UHF systems. Engage with the Program Office in its introduction and collaboration with NIWC Pacific engineers.

Develop the prototype antenna for demonstration and validation in a laboratory environment. The antenna will meet the relevant Environmental Qualification Testing (EQT) and Electromagnetic Environment

Effects (E3) testing for shipboard installation (e.g., MIL-STD-810H, MIL-STD-1399, MIL-HDBK-2036, NAVSEA Instruction 9700.2, etc.). Conduct a Preliminary Design Review (PDR) for the antenna and commence development of an Engineering Development Model (EDM) system. Conduct a Critical Design Review (CDR) prior to building the EDM.

Develop the life-cycle support strategies and concepts for the antenna.

Develop a SBIR Phase III Project Plan to include a detailed schedule (in Gantt format) and spend plan, performance requirements, and revised transition plan for the identified PoRs.

PHASE III DUAL USE APPLICATIONS: Refine and fully develop the EDM to build upon and produce a Production Representative Article (PRA) of the antenna and integrate with the targeted systems. Perform Formal Qualification Tests (FQT) (e.g., field testing, operational assessments, ship-to-ship testing) of the antenna with a ship or an equivalent representation.

Provide life-cycle support strategies and concepts for PITA by developing a Life-Cycle Sustainment Plan (LCSP).

Investigate the dual use of the developed technologies for commercial applications such as in the automotive industry. A conformal antenna, printed or applied, on a vehicle (e.g., bumper) could be used for vehicular communications, allowing for vehicles to become communicating nodes that can provide information (e.g., safety warnings, traffic information) between vehicles, which can be effective in avoiding accidents and traffic congestion. Other applications of this technology include on trains as an antenna and/or communications relay; cellular base station antennas conformed to various existing surfaces; commercial aircraft antenna system whereby the aircraft is the antenna; and commercial ship antennas where the developed conformal antennas could be directly utilized in the same manner as suggested in this topic.

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KEYWORDS: DMR; Digital Modular Radio; Battle Force Tactical Network; BFTN; BFTN Resilient Command and Control System Enhancements; BRSE; Tactical Communications; TACCOM; Antenna; 3D Printing; Additive Manufacturing; Subtractive Manufacturing; Current Probes; current Clamps; HF; High Frequency; VHF; Very High Frequency; UHF; Ultra High Frequency