Department of the Navy SBIR/STTR Transition Program

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Topic # N202-104
Time and Phase Synchronization of Radio Frequency (RF) Sources across Multiple Unmanned Aerial System/Vehicle (UAS/UAV) Platforms
4S - Silversword Software and Services, LLC

WHO

SYSCOM: NAVAIR

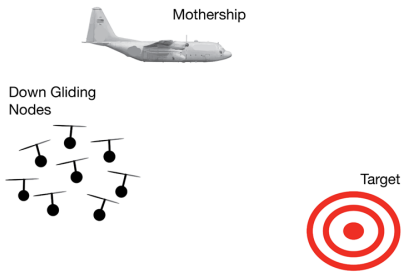
Sponsoring Program: PMA-265

Transition Target: F/A-18

TPOC: (301) 342-9113

Other Transition Opportunities: UAV Swarms

Notes: The graphic included in this quad chart depicts an ensemble of down gliding, Radio Frequency (RF) nodes formed into a mobile phase array antenna. The nodes are released from a mother ship and use 4S free space optical communications technology to measure node positions, create a common timing reference clock, and form a 3D map of the overall ensemble. The 3D map enables calculation of node RF transmission timing that produces a phase aligned wave directed toward a selected target.
Acronyms include:
TALOC – Through the Air Link Optical Component
RADAR - Radio Assisted Detection and Ranging
LIDAR – Light Detection and Ranging
UAV - Unmanned Airborne Vehicle
UAS - Unmanned Airborne Systems
EW - Electronic Warfare



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WHAT

Operational Need and Improvement: The contract objective is to create a time and phase synchronization method that can be used to form a swarm of UAS into a collaborative and distributed phased array system in the air which reduces line-of-sight obstructions and extends the range of communications and EW applications. Each node includes an embedded RF transceiver that is synchronized in both time and phase (i.e. coherent carrier frequency) across the swarm. Current techniques rely on GPS or cooperation from the target/receiving end to synchronize multiple UASs. A solution is needed that; 1) synchronizes multiple platforms without GPS or cooperative targets, 2) operates in a Group 3 UAS relevant temperature and vibration, environment, 3) meets the Group 3 UAS space, weight, power, and cooling (SWAP-c) requirements. The technology developed under the Phase I and Phase II efforts addresses the objective and provides an undeterrable secure, mobile, RADAR transmission solution.

Specifications Required: The target use case, phase array RADAR, has the following requirements:
- RF beam pointing stability shall be maintained while transmitting from uncorrelated moving nodes
- Beam power on target shall be enhanced in proportion to the number of RF nodes squared
- Downgliding nodes dwell time at operational altitude is a figure of merit

Technology Developed: An optically enabled phase array antenna formed from distributed moving RF nodes will be designed and demonstrated during Phase II. This technology enables the accurate 3D mapping of mobile RF nodes for formation of an RF beam that can be directed to a selected target. The technology utilizes patented TALOC communications capabilities to increase positional accuracies.

Warfighter Value: The TALOC enabled RADAR transmitter is:
- Realized from mobile downgliding RF nodes
- Attritable - loss of a few nodes does not degrade performance
- Covert – mother ship is not locatable
- High resolution – ensemble volume diameter defines diffraction limited beam pointing

WHEN

Contract Number: N68335-22-C-0067 **Ending on:** Nov 22, 2023

Milestone	Risk Level	Measure of Success	Ending TRL	Date
3D Map formation of antenna nodes	Low	3D Map node configuration	3	TBD
Providing a common clock timing reference among all distributed RF nodes	Medium	Required reference clock synchronization achieved	3	TBD
Successful integration on mobile platform	Medium	Synchronization is maintained on moving platforms	4	TBD
Evaluate beam directional stability	Medium	Beam stability is maintained with moving platforms	5	TBD
Phase II demonstration	Medium	Score the degree of success in keeping RF beam on target with moving platforms	6	TBD

HOW

Projected Business Model: Our business plan is to license the developed technology to a partner who can take the technology to full production for a program of record. We intend to identify this partner during Phase II. Once identified, we expect to enter into a close working relationship with our partner through all stages of the development.

Company Objectives: 4S - Silversword is seeking Phase 2.5 funding to complete the development and testing required to successfully field the mobile time and phase technology developed during Phase I and Phase II. Discussions with potential partners such as Lockheed Martin and Boeing have already been initiated. We intend to bring matching funds from potential partners and programs of record to improve the funding base of the Phase 2.5 SBIR investment.

Potential Commercial Applications: Telecommunications commercial opportunities
Low Earth Orbit (LEO) internet service is notable among emerging telecommunications initiatives. If, instead of a single RF antenna, each satellite links to a cluster of tethered RF nodes, broad band data streams may be bidirectionally directed in parallel to highly localized surface receivers. An early version of phase array narrowcast communications could be deployed in the form of aerostats or drones hovering over urban areas for 5g/6g connectivity.

Terrain mapping commercial opportunities
The potential value added to Side Looking Airborne Radar (SLAR) by phase array lies in the fact that SLAR cross range resolution is inversely proportional to antenna length in the direction of flight. If a phase array antenna is extended hundreds of meters by phase alignment of a linearly deployed swarm, SLAR cross range resolution becomes competitive with LIDAR while across track range is inherently well beyond the capability of LIDAR.

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