N202-104 TITLE: Time and Phase Synchronization of Radio Frequency (RF) Sources across Multiple Unmanned Aerial System/Vehicle (UAS/UAV) Platforms

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

TECHNOLOGY AREA(S): Air Platform, Battlespace

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 demonstrate a capability to perform high-precision time and phase synchronization (phase coherency) of multiple distributed radio frequency (RF) sources located on Unmanned Aerial Systems (UASs) platforms such as Group 3 drones separated in a dynamic and Global Positioning System (GPS) denied environment.

DESCRIPTION: Small UASs have found many applications within both the defense and commercial sectors. With the increasing use of small UASs, it is desired to equip them with RF sensors/payloads to permit them to work together to form a coherent beam on a target. In order to do this, precise time synchronization among the UASs is essential. Current techniques rely on either the use of GPS or an embedded signal from the target in order to time synchronize multiple UASs. In order to be more operationally suitable, development of a solution to the time synchronization problem for multiple spatially dispersed UASs, which works in the absence of both GPS and cooperative targets is needed. Additionally, the developed solution must be able to operate in a relevant environment that can have wide ranges in temperature, vibration [Ref 7], and meet the space, weight (<100 lbs), power, and cooling (SWaP-C) requirements of a small UAS such as Group 3 [Ref 6] and typical payloads such as a datalink, an electronic warfare (EW) system, etc.

The goal is to obtain accuracy in timing (10 to 100 picoseconds) and phase coherency to within 1/10 to 1/12 of a relevant RF operating wavelength (UHF or higher band) between nodes (or between slave nodes and the master node).

The details on the methods and mechanism of obtaining coherency across all nodes in the network are requested, additionally, any special waveforms or control signals that are employed and any special oscillators required are also requested. The ability to easily integrate into existing datalinks and radio designs (specify one or more applications for a UHF, C Band, S Band, other data link using single carrier modulation, spread spectrum, or Orthogonal Frequency Division Multiplex (OFDM) or a Common Data Link (CDL) is requested. Provide details of how to integrate this into existing designs or new designs.

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 and Security Agency (DCSA). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel 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: Design and develop the concept and approach for time synchronization of RF sources across a distributed system. Demonstrate the feasibility of the designed approach through modeling and simulation for a swarm consisting of 10 UAS randomly distributed spatially throughout a one-mile area, and quantify the beam pointing error as a function of frequency. Include the processing blocks that provide the critical functions and include a baseline set of quantitative implementation requirements that will form the basis for further development in Phase II. Phase I will consider UAS’s from Group’s 1 or 2. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Refine the approach developed in Phase I. Develop prototype hardware and demonstrate the approach on 3 to 6 platforms. Include a static demonstration and then if deemed successful, end with a dynamic demonstration (i.e., quadcopters). Phase II will consider flight demonstrations from UAS Group 3 drones such as the Tigershark XP. Prepare a Phase III development plan to transition the technology for Navy and potential commercial use.

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

PHASE III DUAL USE APPLICATIONS: Refine the technology developed for easier integration into tactical data links. Install on several types of Navy UASs and deploy on larger UAS swarms.

Successful technology development could benefit the Telecom and Mapping industries.

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KEYWORDS: Swarm, Timing, Phase, Coherent, UAV, Unmanned Aerial Vehicles, Beamforming, Unmanned Aerial System, UAS

TPOC-1: Marc Blaydoe

Phone: (301)757-6483

TPOC-2: Charles Rea

Phone: (301)342-9113

Alt Phone: (410)610-2765

Question:

1. To provide beamforming from the distributed multiple RF sources the time/phase synchronization of the sources is not enough. The 3D positions of the sources are needed. Is the determination of the source’s positions beyond the scope of the project?
2. If the answer on the first question is NO and we need to have positioning of the all drones, do we need to determine target position to send the coordinated message?
3. Are the distributed RF sources will operate in both transmit and receive modes, or on transmit only?
4. What update rate for synchronization of the RF sources is expected? The update rate depends on the stability of the relative positions of the drones.
5. What max signal bandwidth should be provided?