DAGSI Research Topic 2

1. **Research Title:** Research and Development of Electronic Attack Effectiveness Measurements via Behavior Tracking

2. **Individual Sponsors:**

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3. **Academic Area/Field and Education Level**

   Electrical Engineering, Computer Engineering, Computer Science,
   Software and Systems Engineering (MS or PhD level)

4. **Objectives:** Electro Magnetic Spectrum Operation (EMSO) is the major deciding factor for dominance of the future battle space, especially within a highly congested area. The better situational awareness within EMSO is, the more successful and seamless the mission operations will be. Majority of research focus on the pre-Electronic Attack (EA) action sensing, but after EA actions have been taken, it is also critical to evaluate their effectiveness so the system can assess the overall situation and conduct optimal follow-on actions. Since there are few research and development efforts that evaluate EA effectiveness based on behavior modeling, and most of traditional measurements are related to functions performed by Electronic Support (ES) subsystems, it is rare and difficult to estimate the EA effectiveness due to the lack of related information and difficulty extracting this information. The benefit of tracking an emitter's behavior is the ability to use the analogy of the cause-and-effect, namely, each EA action leads to an emitter reaction. The overarching goal of the proposed research project is to develop a behavior tracking model for EA action effectiveness estimates, which can be used in open and closed-loop simulations, as well as in real-world mission operations. To that end, this project will have the following research objectives: (1) conduct a technology survey on current battle damage assessment of EA, including AI/ML algorithm-aided sensing, behavior tracking, pattern monitoring, etc., (2) design and develop a behavior-tracking algorithm and perform an analysis with emitter models from AFRL's ARCEM toolset (see below), and (3) verify and test the proposed algorithm with emitter models and compare it with existing ES functions that are used for EA effectiveness evaluation.

5. **Description:** Electromagnetic warfare function is within EMSO environment, and it includes characterizing emitter system output to understand the electromagnetic operating

environment. This function is made difficult by agile software-defined radar systems that can react and adapt to changing circumstances. The ability to track an emitters' behavior/pattern correctly and sufficiently can improve our understanding of emitter intent. Furthermore, using a cause-and-effect concept, emitters will behave differently with respect to the user commands, environmental effects, and countermeasures, so monitoring these behaviors provides insights into how emitters react to the situation around them. Therefore, the goal of this research topic is to take a closer look at these behavior/patterns and develop metrics to evaluate the effectiveness of EA countermeasure so EW platforms can optimize subsequent actions.

6. **Research Classification/Restrictions:** Applied research. CUI restrictions anticipated. AFRL's Advanced Research Concept for Electronic Measurement (ARCEM) toolset will be shared with the DAGSI performers.

7. **Eligible Research Institutions:** Air Force Institute of Technology, University of Cincinnati, University of Dayton, Wright-State University, or other state universities with a suitable research background.

8. **PR Approved:** AFRL-2024-4683