DAGSI Research Topic

1. **Research Title:** Detecting Idiosyncratic Signatures of Radio Frequency Transmitters
2. **Individual Sponsor:**

Dr. David A. Kapp, AFRL/RY
david.kapp@us.af.mil
Dr. Ethan Lin, AFRL/RY
ethan.lin.1@us.af.mil
Building 620
2241 Avionics Circle
WPAFB, OH 45433-7333

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

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

4. **Objectives:** The ability to associate transmitted electromagnetic waveforms with the specific emitter hardware that created those waveforms has important applications in a congested and contested environment. One approach to detect, characterize, and identify an emitter is to analyze the transmitted waveforms for key parameters, such as frequency, pulse width, pulse repetition frequency, and angle of arrival, and cluster those waveforms to attempt to identify a common source. One challenge, however, is that many emitter sources are software-controlled and defined and can rapidly change these output parameters, making source identification difficult. In addition, multipath effects from terrain can obfuscate the location of the emitting source. The goal of the proposed research project to develop methodologies that can distinguish one transmitting radio frequency source from another, including those transmitters that have parts with the same model number and manufacturer. To that end, this project will have the following research objectives: (1) study the differences between different radio transmitters with the same waveform parameters to determine if underlying idiosyncratic signatures can be detected, (2) select unique and stable radio frequency signatures to monitor, (3) identify, where possible, the hardware component within the transmitter that is the source of the unique signature, (4) model hardware variations within the emitter to determine if the modeled output waveform variations correlate with real data, (5) use these statistical differences in hardware part manufacturing to identify the emitter source for each waveform or pulse, and (6) perform an analysis to determine the limitations of the technology with respect to signal-to-noise ratio (SNR) and density of the emitter environment.

5. **Description:**

This project is focused on the identification, modeling, and characterization of idiosyncratic signatures in radio frequency transmitting devices due to hardware manufacturing variations or defects. The purpose is to use these variations or defects to identify the emitter source for each received waveform or pulse. The advantage of the proposed approach is one can perform detection that is independent of software-defined transmitter waveform parameters. The approach would also be able to identify the emitter independently of the transmitted location or the time of arrive of the transmitted pulses. In addition, the approach mitigates the problem of multipath scattering of the transmitted waveform from terrain, which can obfuscate the true location of the transmitter, and as a result cause the waveform characterization software to improperly group or separate the received waveforms or pulses.

6. **Research Classification/Restrictions:** Basic Fundamental research, Controlled Unclassified Information restrictions anticipated.

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.

PA APPROVAL #: AFRL-2024-4686