

1. **Research Title:** Autonomous Control of Software-Defined Digital Arrays
2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level:** Electrical/Computer Engineering, Computer Science, and Applied Math (MS or Ph.D. level)
4. **Objectives:** Modern digital array radar systems operate in highly dynamic and congested spectral environments, requiring real-time, closed-loop adaptation to maintain mission performance. This research aims to develop and evaluate advanced optimization and sequential decision-making frameworks to autonomously manage the high-dimensional parameter space of software-defined digital arrays. Key objectives include:
 - a. Formulating radar resource allocation as a multi-variable closed-loop control problem, where the state space includes external factors affecting the radar and the action space includes the many software-programmable degrees of freedom (DoFs) controllable by the radar.
 - b. Investigating scalable, real-time algorithms—including reinforcement learning, mathematical optimization, and evolutionary/genetic algorithms—to optimize these parameters against multiple targets and dynamic interference sources.
 - c. Exploring warm-start methodologies (such as decision-tree-based function approximators like ProLoNets) and transfer learning techniques to minimize convergence time and improve transient performance during environmental transitions.
 - d. Evaluating the computational trade-offs of these techniques in simulation, with a focus on algorithms suitable for direct implementation on software-defined radios.
5. **Description:** This research will focus on the design and evaluation of autonomous, real-time control algorithms for adaptive digital array radar. The researcher will investigate methodologies to dynamically optimize a comprehensive suite of radar system parameters in response to a changing external state. The researcher will develop and compare various mathematical optimization and feedback control techniques, analyzing their stability, transient behavior, and computational complexity. The goal is to establish parametric trade-offs and identify viable algorithmic pathways capable of executing real-time closed-loop control on physical software-defined digital array platforms.
6. **Research Classification/Restrictions:** This research is unclassified.
7. **Eligible Research Institutions:** All organizations
8. **PA Approval Number:** AFRL-2026-3938