1. **Research Title:** Digital Engineering and Model Based Systems Engineering (MBSE) for Aircraft Power and Thermal Subsystems

2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level**
Aerospace/Mechanical/Electrical/Chemical Engineering and Computer Science (MS or Ph.D.)

4. **Objectives:** Development of digital representations and virtual prototyping of aircraft power and thermal subsystems, and evaluation of their performance to enable accurate technology trade studies, with the use of multi-fidelity numerical analysis, supplementary data processing and advance simulation tools.

5. **Description:** Cross-domain, physics-based modeling and simulation tools have been identified by the Air Force as game changers that can significantly reduce development and deployment cycle time for acquisition. Our research focusses on development of advanced computational methods, tools and models for performance-analysis of aircraft power and thermal (P&T) management systems. Commercial and in-house software enable high-fidelity simulations of steady state and transient physics, and incorporation of control laws to satisfy desired system behavior. These simulations possess the capability to resolve the disparate spatial and temporal scales prevalent in these subsystems, and do so at moderate computational expense. Subsequently, determinations of the feasibility and technological impact of P&T solutions for future aircraft may be completed at relatively high computational expense but is mitigated by high performance computing. Several research areas of interest to advance digital engineering capabilities include:
   a. Development of unified P&T assessment tools with dynamic and transient modeling capability;
   b. Model based systems engineering;
   c. Multi-domain system of system analysis;
   d. Numerical schemes for steady and highly transient refrigeration system dynamics in single and multiphase flows;
   e. Reduced order modeling or novel multi-fidelity methods to increase computational efficiency while maintaining a desired level of accuracy;
   f. Graph theoretic applications to identify power systems and thermodynamic cycles;
   g. Model predictive control;
   h. Generator and power system performance;
   i. Co-simulation to assess impact of P&T subsystems coupling to aircraft propulsion system during subsonic and supersonic flight.

   Access to several commercial and in-house developed codes, computing resources at the DoD Super Computing Resource Center and collaboration opportunities with experimental projects are available.

6. **Research Classification/Restrictions:** This research is unclassified. U.S. citizenship is required for this position.

7. **Eligible Research Institutions:** All DAGSI.
8. **PA Approval #** 88ABW-2020-2817