RQ 21-66

1. **Research Title:** Integrated Resilient and Predictive Control of Propulsion/Power Systems for Improved Reliability and Performance
2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level**
Aerospace Engineering, Mechanical Engineering, and Electrical Engineering: Guidance, Navigation and Control, Turbine-Engines Health Monitoring (MS or PhD level)
4. **Objectives** The role of a resilient, predictive controller is to enhance prevention and recovery of the (robust) control system from unanticipated adverse conditions and faults as well as from emergency situations by predicting potential behaviors in advance and altering its operational envelope in real time. Objectives of Resilient control design are:
   - Robust and accurate prediction of system behaviors from real-time and past operational data collected from sensors, prior knowledge and system specifications.
   - Reliable and fast recovery from adverse conditions and emergency situations
   - Restoration of the control configuration upon returning to normalcy or upon graceful degradation within design specifications
   - Performing fast what-if scenario analysis online and achieving trade-offs between stability and performance under disturbances and (both structured and unstructured) uncertainties within specified bounds
   - Mitigation of the detrimental effects of disturbances and uncertainties
5. **Description:** Resilient control systems in critical infrastructures require increased cyber-security and situation-awareness. One of the necessary conditions for achieving the desired high level of resiliency is timely reporting and understanding of the status and behavioral trends of the control system. New control architectures are needed that will enhance the reliability of the system, by incorporating a new Intelligent Distributed Control Network with data fusion and increased state-awareness and developing a rigorous prediction-based optimization system for resilient control systems. The key design approach is to use the new architecture both in terms of heterogeneous, decentralized hardware and hierarchical, modular control system software design using smart sensors or actuators connected through high-speed data buses and communication channels. Traditional systems incorporate the sub-systems required to deliver the common operational picture. Reduction of those integrated sub-systems is unacceptable; therefore, introducing a decentralized architecture is going to carry with it the requirement of a seamless interaction despite being separated. Decentralization is a design process that allows a constellation capability to seek more nodes than what would be normally available when residing in the same payload. This is a measure of design success that enhances the evaluation of a system's capability and its ability to survive risk (i.e., its resilience).

6. **Research Classification/Restrictions:** Unclassified

7. **Eligible Research Institutions:** DAGSI Universities

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