

# Abstract

## SAIC Capabilities Supporting DARPA PHOENIX Program

The DARPA PHOENIX mission requires the capability to perform autonomous satellite rendezvous and proximity operations. Autonomous Guidance and Control of satellites is critical for effective execution of these operations. Spacecraft executing these operations may frequently operate for significant periods of time without instruction from the ground and will often be required to respond to unexpected environmental stimuli. SAIC solutions will include the use of adaptive and game-theoretic control to mitigate structured and unstructured uncertainties to bound control solutions in a robust manner, and the employment of advanced high-fidelity modeling & simulation to verify these control solutions and further develop closed-loop approaches to guidance utilizing novel image processing and sensor fusion techniques.

SAIC will leverage its expertise in the following areas

- Nonlinear Adaptive Control to develop control solutions that optimize rendezvous times, fuel usage and mission specific metrics (such as visual coverage for inspection).
- Adaptive Control – To improve performance in the presence of structured uncertainty, such as unmodeled dynamics, the robust, optimal adaptive control subject matter expertise of SAIC will be employed to augment optimal control approaches with adaptation.
- Mission Planning – SAIC has significant experience in the development of mission planning algorithms, which are required for taking navigation information and turning it into effective guidance and control that is truly autonomous. This expertise will be used to incorporate these advanced control methods in an autonomous RPO framework.
- Long-term experience in modeling and simulation of autonomous satellite proximity operations, including run-time, real-time, hardware-in-the-loop and camera-in-the-loop simulation activities to test and verify autonomous control solutions. The central simulation capability for the NASA AR&D program was the Simulation Package for Autonomous Rendezvous Test and Analysis (SPARTAN), developed as a high-fidelity on-orbit simulation for NASA in Matlab/Simulink. SPARTAN was the first NASA product to simulate multiple six-degree-of-freedom spacecraft in a variety of orbits in order to test next-generation autonomy concepts for AR&D mission management and GN&C algorithms for the Constellation program.
- Sensor Development – SAIC San Diego has developed successful and relevant sensors for the XSS-10, XSS-11, NFIRE, APATS, P805, and ANGELS Development programs.



SAIC subject matter expertise in advanced control concepts includes multiple PhD degreed published authors with credentials in the areas of Robust Optimal Nonlinear Control, Optimal Adaptive Control, Inverse Optimal Nonlinear Control, Sliding Mode Control and Optimal Control for Satellite Guidance, Navigation, and Control (GN&C). SAIC expertise has been most notably demonstrated through a technical leadership role in the NASA, Marshall Space Flight Center, Autonomous Rendezvous and Docking (AR&D) program. Predominance of this effort would be performed by SAIC offices in Huntsville, AL, and Seal Beach and San Diego, CA.