

# Department of the Navy SBIR/STTR Transition Program

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NAVAIR #2022-762

Topic # N111-025

Collision Avoidance Decision Making in the Face of Uncertainty  
Scientific Systems Company, Inc

## WHO

**SYSCOM:** NAVAIR

**Sponsoring Program:** PMA-266, NAVAIR's Program office for Multi-Mission Tactical Unmanned Aerial Systems (UAS)

**Transition Target:** MQ-8C Fire Scout

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**Other Transition Opportunities:** While much of the development of the SAFESEE capability to-date has been geared towards the Navy's MQ-8 Fire Scout platform, the system concept is broadly applicable across all UAS platforms. SSCI's open architectural approach poses the OASES system as a common solution for Naval UAS including the MQ-25A Stingray, MQ-4C Triton and RQ-21A Blackjack platforms. In addition, the SAFESEE system can a valuable additional to commercial UAS to support Beyond Visual Line-of-Sight operations – SSCI is currently working on lower SWAP versions of the SAFESEE hardware to support these small, lightweight commercial UAS.

**Notes:** SSCI's commercial product Open Autonomy/Safety Enhancement System (OASES) combines an advanced suite of software modules with low SWAP-C hardware (rugged sensors and a processor) to provide safe Launch and Recovery, Sense and Avoid (SAA), GPS-denied Navigation and mission autonomy capabilities for increased UAS Autonomy. SAFESEE, the SAA component of OASES, provides essential collision threat detection and avoidance capabilities in the operational airspace. SAFESEE detects, tracks and analyzes probable collision threats in real time. The picture depicts SAFESEE reporting the orientation and time-to-contact (TTC) of a potential collision threat to the operator, along with a thumbnail image as viewed by SAFESEE.

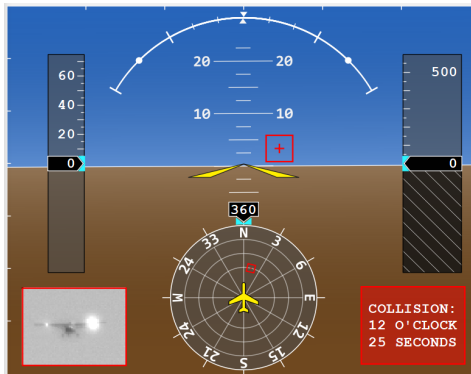


Image courtesy of Scientific Systems Company Inc.

## WHAT

**Operational Need and Improvement:** The Open Autonomy/Safety Enhancement System (OASES) is an SSCI commercial product that addresses the core safety challenges associated with autonomous operation of military and commercial UAS. Human pilots effectively detect collision threats using vision alone, without explicit range estimation. Potential collision threats are visually recognizable as constant-bearing, looming objects. The OASES SAFESEE systems employs this proven strategy via EO/IR sensors and advanced computer vision algorithms to give autonomous air vehicles the ability to identify aerial collision threats in an operational setting.

**Specifications Required:** SAFESEE employs proven strategy via EO/IR sensors and advanced computer vision algorithms. SAFESEE directly determines time-to-contact (TTC) as the time remaining before a perceived threat collides with the host aircraft. System high-level output is a semantically-meaningful characterization of the risk of a tracked threat colliding with the host at some point in the future if both aircraft maintain their current flight trajectories. Output can be provided with additional outputs of bearing, time-to-contact, imagery of the threat (or threat features).

**Technology Developed:** Unlike range-based air-to-air collision detection strategies, SAFESEE directly determines time-to-contact (TTC) as the time remaining before a perceived threat collides with the host aircraft. Time-to-contact is in fact the Collision risk is calculated by applying Bayesian statistics to the TTC in three-dimensional space to identify the probability of a collision posed by one or more non-cooperative aircraft. The OASES SAFESEE system is composed of computer vision, estimation, and optimization algorithms that detect potential threats from imagery, profile the behavior of likely threats over time, and evaluate the collision risk associated with each.

**Warfighter Value:** SAFESEE gives autonomous air vehicles the ability to identify aerial collision threats in an operational setting. SAFESEE output can be used by either an operator to command avoidance maneuvers or by an autonomous system to generate reactive maneuvers in a timely manner.

## WHEN

**Contract Number:** N68335-19-C-0018

**Ending on:** Oct 03, 2022

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Commercial Flight Test in relevant environment: "Host" Robinson R-44 helicopter, flown with either a fixed-wing and rotary-wing "Intruder" as the collision threat.	Medium	Cessna Caravan "Intruder" detected at a range of approximately 3.5nmi with 59 seconds estimated time-to-collision.	5	3rd QTR FY21
Develop a production-representative SAFESEE Basic Camera Array along with GPU-optimized SAFESEE software hosted on the OASES Processor.	Low	Suitable for mounting on MQ-8C Fire Scout	6	2nd QTR FY22
Flight Test Demonstration on MQ-8C Fire Scout	Medium	Similar or better results while fully integrated on the MQ-8C airframe	7	3rd QTR FY23
Develop the SAFESEE Smart Camera Array (image processing collocated with each higher resolution sensor).	Medium	Increased detection range with an extended (up to ~180 deg) field-of-regard	7	1st QTR FY24

## HOW

**Projected Business Model:** SSCI is motivated to provide the Open Autonomy/Safety Enhancement System (OASES) as a commercial product that addresses the core safety challenges associated with autonomous operation of military and commercial UAS. OASES combines an advanced suite of software modules with low SWAP-C hardware (rugged sensors and a processor) to provide safe Launch and Recovery, Sense and Avoid (SAA), GPS-denied Navigation and mission autonomy capabilities for increased UAS Autonomy.

**Company Objectives:** Because of our unique capabilities, SSCI wants to be funded as a sole-source Sense and Avoid system supplier for the prime contractors in the SAA markets. We would provide our unique and robust computation and analysis engine and sensors that produces safe SAA alerts and resolution advisories that have proven successful for mitigating the risk of collision with maneuvering, non-communicating threats.

**Potential Commercial Applications:** The SAFESEE system concept is broadly applicable across all UAS platforms and can be a valuable additional to commercial UAS to support Beyond Visual Line-of-Sight operations – SSCI is currently working on lower SWAP versions of the SAFESEE hardware to support these small, lightweight commercial UAS.

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