



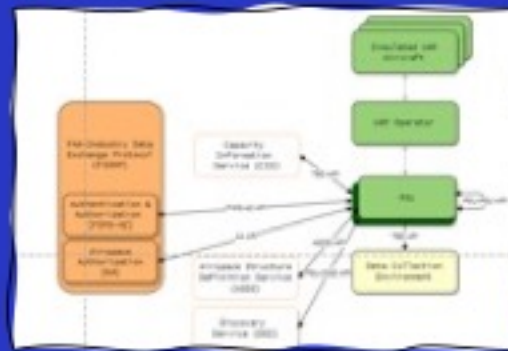
UAM Separation Standards Research
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NASA Langley Research Center
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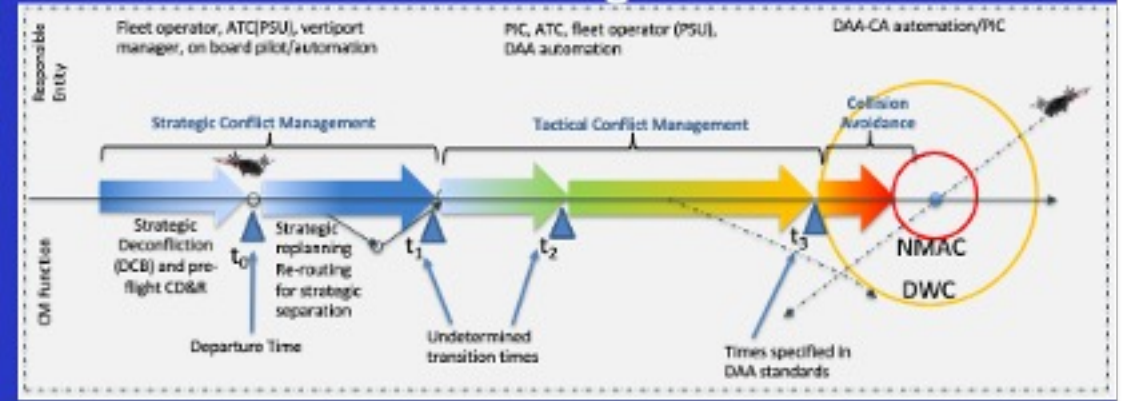
Per ICAO 9854

Strategic Conflict Management consists of (1) Airspace organization and management, (2) demand and capacity balancing, and (3) traffic synchronization. Separation provision is the tactical process of keeping aircraft away from hazards by at least the appropriate separation minima.

NASA current simulation for National Campaign-1 and UAM Airspace Services research focus is on strategic conflict management and PSU functionality



NASA's Separation Standards research focus is on separation provision, cooperative tactical/DAA deconfliction, performance-based separation standards, V2V and V2G technologies

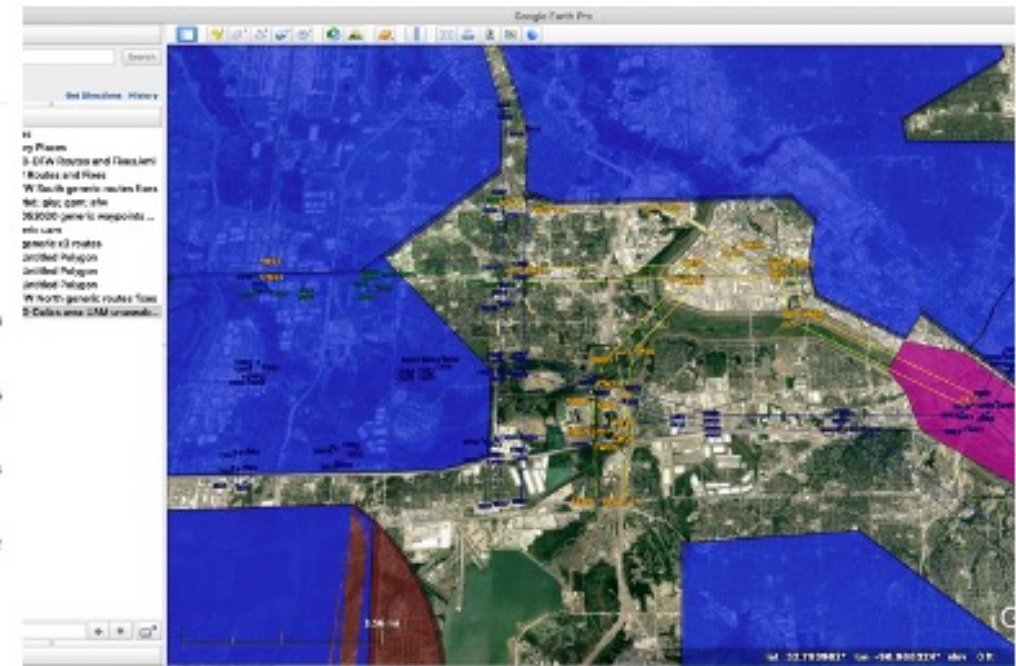
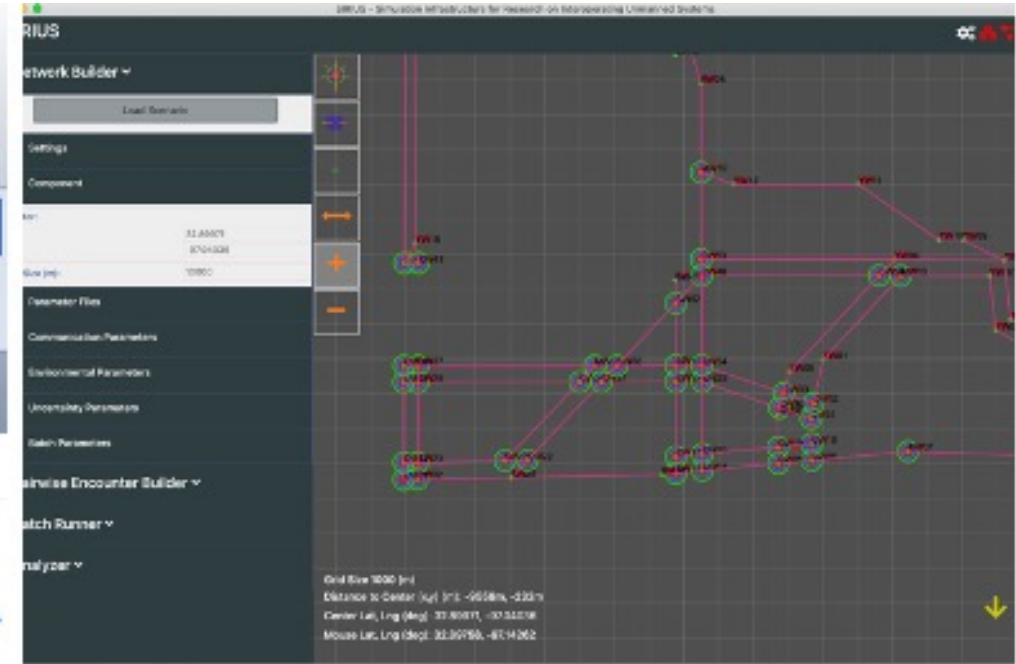
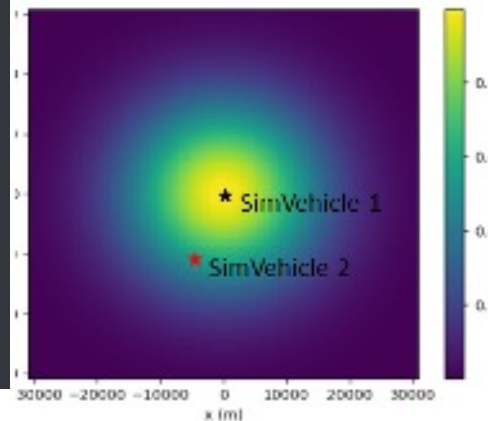
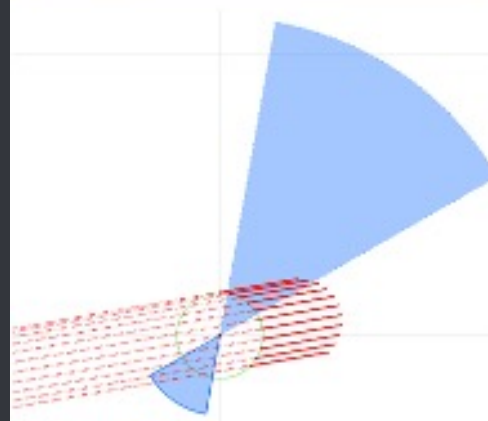
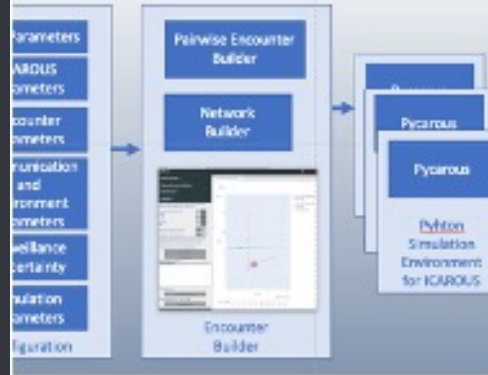


SIRIUS Simulation Tools

The SIRIUS simulation framework was developed for UAM Separation Standards research.

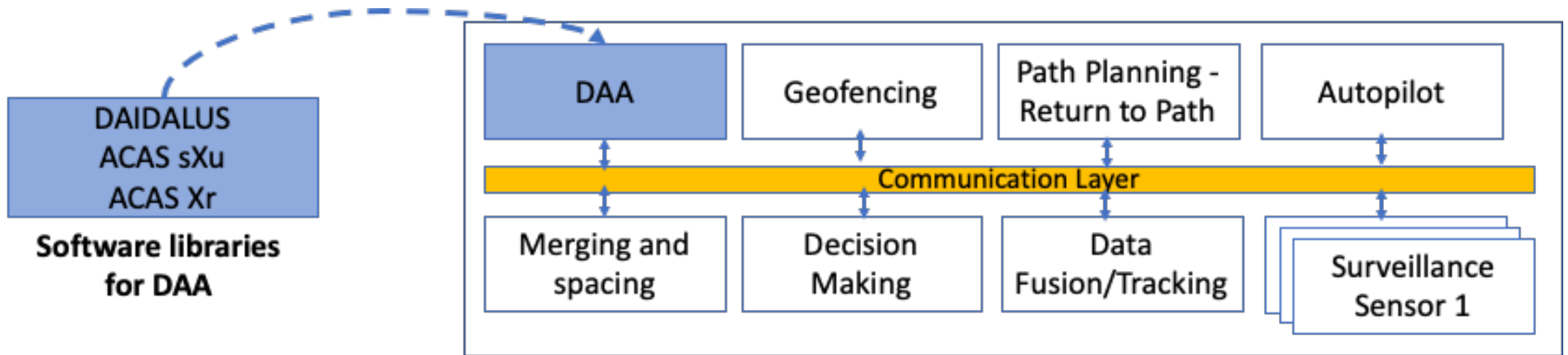
- Fast time/MC simulation
- Designed to study traffic encounters and interactions between complex route networks or pairwise conflicts with randomly generated geometries.
- DAA-equipped aircraft can be configured with different DAA capabilities (ICAROUS)

High Level Architecture



ICAROUS

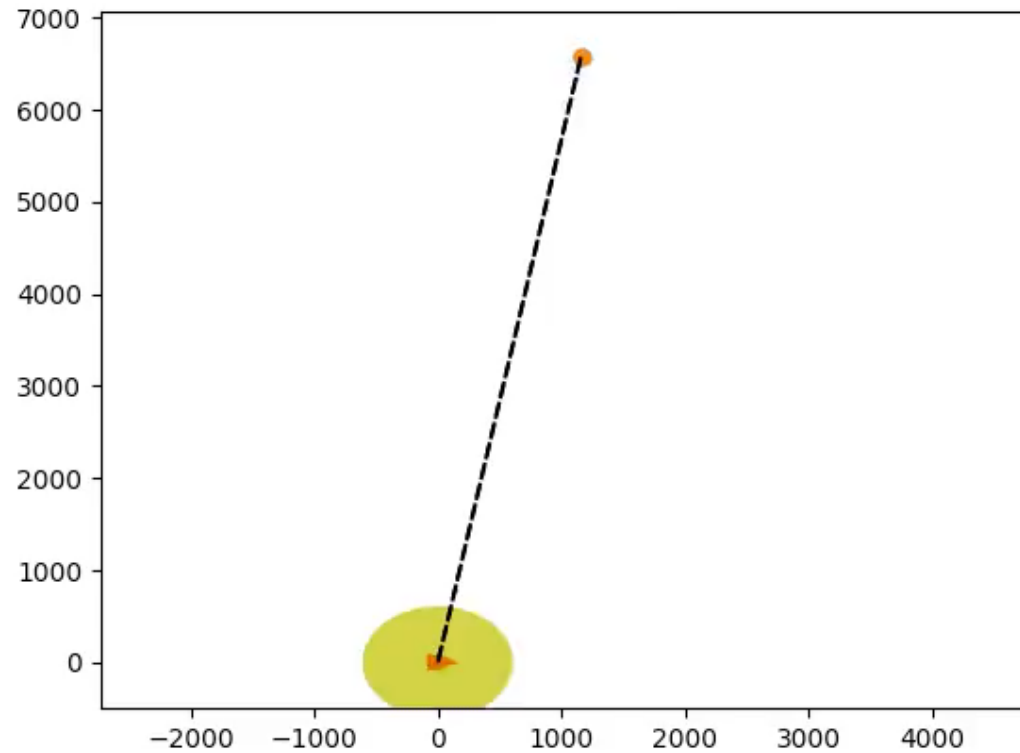
- A suite of algorithms that provide autonomous capabilities for UAS/UAM vehicles.
- Modular software architecture enables the integration of new functionality
- ICAROUS-equipped aircraft can be configured with DAIDALUS (default) or ACAS sXu/Xr



ICAROUS is a research software application that includes DAA

DAA Comparisons with SIRIUS

Head-on encounter between ACAS Xr (bottom) and DAIDALUS (top), X and Y axis units are meters.



Assistive DAA Automation for Pilot in Command

The DANTi concept developed as a safety enhancement capability for pilots to remain well clear and avoid potential collisions.

- 2015-2016: DANTi v1.0 EFB Prototype developed by NASA
- 2016-2017: Two successive flight tests conducted by NASA evaluated overall usability of the DANTi EFB and collected preliminary pilot assessments of well clear parameter distances
<https://shemesh.larc.nasa.gov/fm/DANTi/>
- 2020-present: DANTi v2.0 prototype developed by NASA
- MC evaluations of safety impact on conflict severity



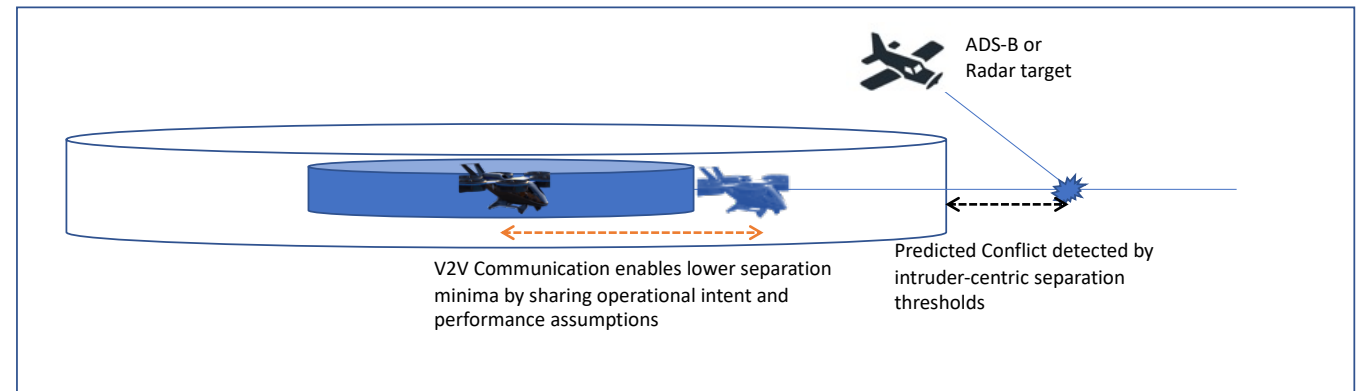
Simulation Results

Scenario	No loss of well clear	Severity				Collision
		Minimal	Minor	Major	Near Mid-air collision	
C172 ownship horizontal	0	0.01%	0.98%	8.39%	90.62%	0
C172 ownship vertical	2.44%	23.10%	33.90%	24.64%	15.92%	0
Sabreliner ownship horizontal	0	79.9%	16.6%	2.72%	0.79%	0
Sabreliner ownship vertical	13.20%	66.50%	16.50%	2.73%	0.97%	0

Performance Based Separation - CNS Requirements

Goal: Evaluate reduced separation minima for aircraft (pairs) satisfying minimum performance requirements for:

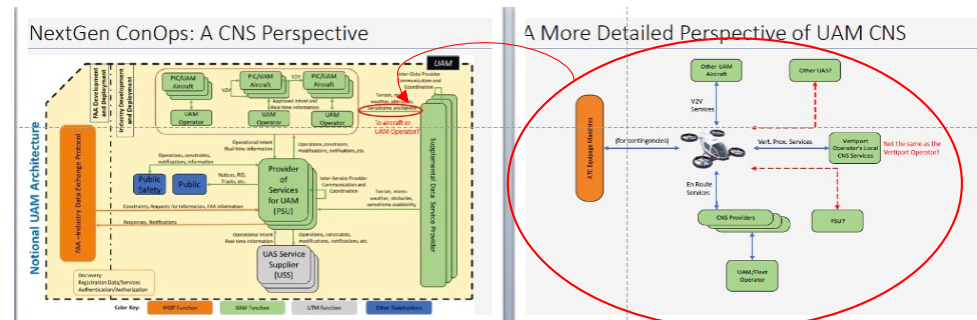
- Navigation (RNP)
- Communications (RCP)
- Surveillance (RSP)
- Detect and Avoid (DAA)



Aircraft with a high performing V2V equipage may fly closer to one another but may have to stay farther away from an aircraft with lower performing (or unknown) equipage

CNS Challenges

Limiting reliance on new spectrum allocation requirements and favor pre-deconfliction and cooperative separation to avoid most air-ground signal problems.



New Technologies

“V2V is a proximity radio system, decentralized by nature, that is applicable nationwide” and can support cooperative separation functions.



Questions/Feedback