

CAREER: Theoretical Foundations of the UAS in the NAS Problem

(Unmanned Aerial Systems in the National Air Space)

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Description

Safe integration: UAS in the NAS by formal analysis and runtime monitoring.

Broader Goals of This Project:

- Scalable and comparative analysis of NASA's design for automated NAS; FAA standards
- New modeling algorithms and tools; relationships with aircraft communication, air-traffic control, faults.
- New frontiers for system health monitoring (SHM) during runtime, and synthesis on physical UAS platforms enabling real-world implementation



Holistic view in three integrated thrusts: on-board UAS, fleet-level reasoning, theoretical foundations.



Findings

Formal Analysis

Formal modeling of NASA's NextGen air-traffic control system (CAV 2016) Brute-force model checking does not scale

New symbolic model checking algorithms to check design spaces (FMCAD 2017, TACAS 2018, CAV 2018) 900% faster analysis, more scalable





Runtime Verification

Real-time Realizable, Responsive, and Unobtrusive Unit (R2U2) provides SHM capabilities (VSTTE 2016, RV 2017, RV 2018 Signal processing, temporal logic observers, Bayesian reasoning

Model predictive verification on embedded platforms, formal specification encoding Synthesizable on modern FPGAs, and SHM platforms