Assured Autonomy in Contested Environments (AACE) Center Overview

http://ncr.mae.ufl.edu/aacoe.php

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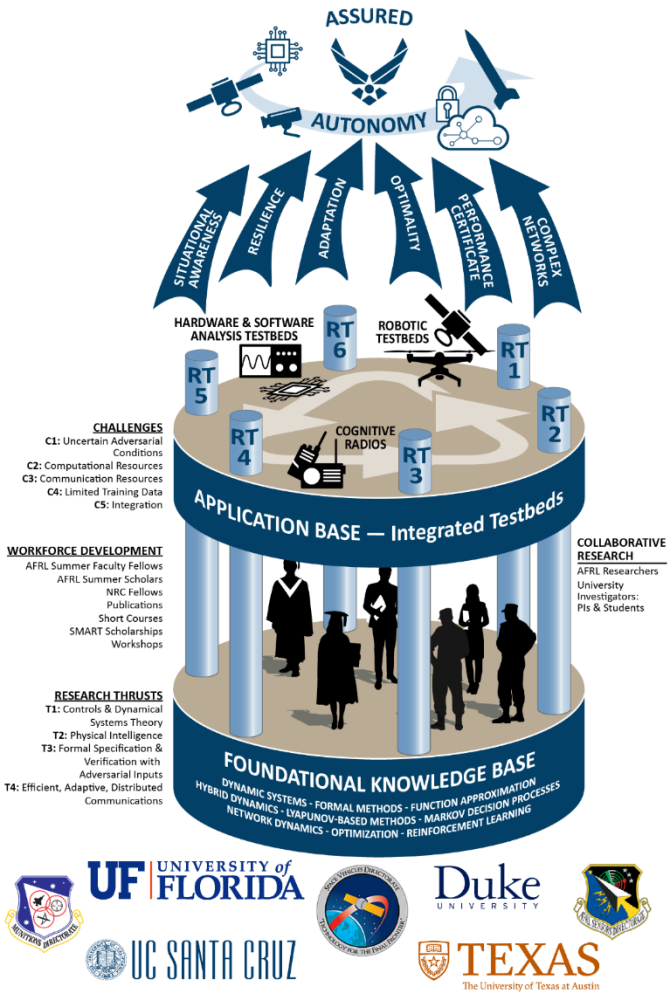
Center Overview



AFOSR Center of Excellence in Assured Autonomy in Contested Environments

- >$6M over 6 years (3 x 2 year increments)
- 9 PIs @ 4 Universities:
  - K. Butler (UF: cyber resiliency/privacy)
  - W. Dixon (UF: ADP, networks, hybrid)
  - N. Fitz-Coy (UF: optimal, games)
  - M. Hale (UF: networks, privacy)
  - M. Pajic (Duke: cyber resiliency/privacy)
  - R. Sanfelice (UCSC: hybrid, networks)
  - J. Shea (UF: networks, privacy)
  - U. Topcu (UT: formal, hybrid, optimal)
  - M. Zavlanos (Duke: ADP, networks, formal)
  - C. Petersen (UF: GNC spacecraft)
  - A. Petersen (UF: Space Physics)
- AFOSR provides 50% of funding
- AFRL (RV, RW, RY) provide 50%

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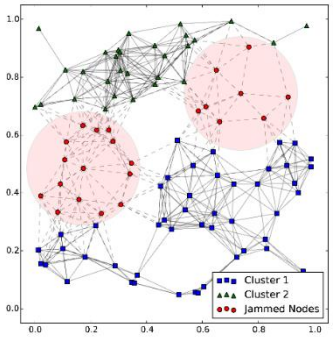
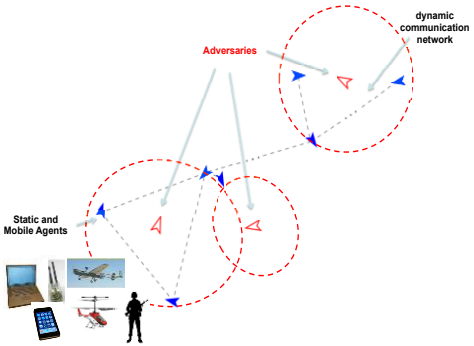
Center Motivation

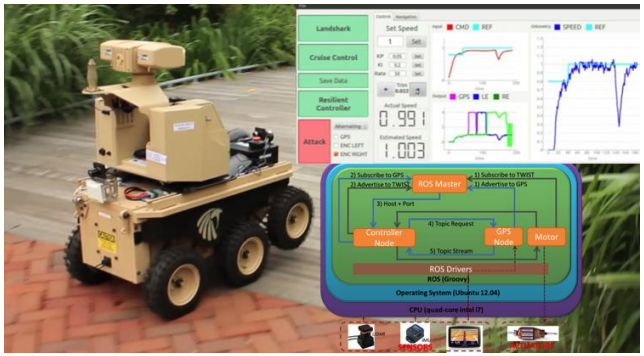
Research Topics

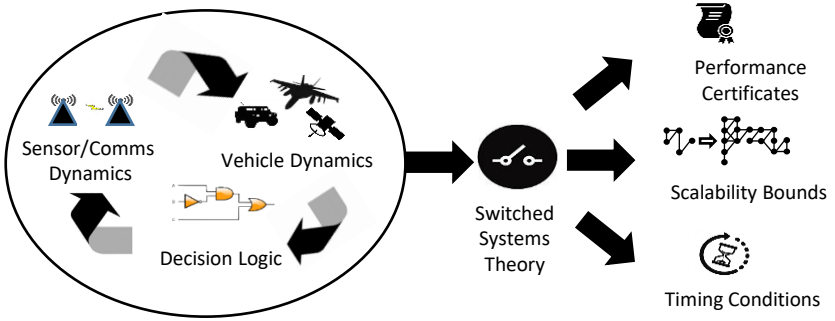
- **RT1:** Modeling and Analysis Methods for Nonsmooth Systems
- **RT2:** Adaptation/(Deep)Learning, Optimality, and Synthesis
- **RT3&4:** Analysis, Design and Control Synthesis Within and Over Networks with Intermittent or Asynchronous Information
- **RT5:** Attack-Resilient Design
- **RT6:** Protecting Safety-and Mission-Critical Information





Key innovations include analysis, design and synthesis tools that enable autonomous mission execution despite uncertainty within complex dynamics while accounting for the integrity and privacy of information on computationally constrained resources





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Recent Breakthroughs

- Developed new privacy approaches to provably protect information shared over networks and properties of networks themselves
- Developed a new distributed asynchronous non-convex optimization framework that is significantly faster than the state of the art
- Parameter identification algorithms for hybrid systems with relaxed persistency of excitation
- Learning-based control algorithms for asymptotic stabilization with robustness
- Adversarial perspective of semantic concept realization in a query-restricted setting, finding higher concentration of agent generalization errors than previous work
- Development of a privacy-preserving collision avoidance algorithm based on space dynamics for use with space vehicles
- Development of a rigorous mathematical framework to solve the swarm initialization problem and showing that it accurately characterizes a LISA-like three-satellite swarm

Recent Breakthroughs

- Incentive design in noncooperative multiagent systems
- Poisoning attacks against data-driven control
- Active sensor selection with applications to large-scale satellite constellations
- Developed Lyapunov-based accelerated learning method
- Developed hierarchal RL switching controller for hypersonic vehicles
- Leader in various Lyapunov-based real-time deep learning methods
- Exponential RISE controllers for nonlinear systems, including delayed systems
- Event Triggered Control in clustered networks

Workforce Dev. AFRL Collaborations Publications

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Collaborative Interactions

- Project partially supports
  - 4 postdocs/research scientists, >50PhD
- >30 Alumni (many more over the next 2 years)
  - 6 postdocs – NVIDIA, Univ. of Sherbrooke, Univ. of Arizona, Apple, Univ. Grenoble Alpes, UC Berkeley
  - >20 PhD – RW (x2), Ford, Qualcomm, Intel, Univ. of the Bio, Opener, Purdue University, Dematic, DJI, Amazon, Satellogic, Mathworks, Draper, JHU APL, University of Florida, Zoox, EpiSci, Samsung, U of Washington
  - 7 MS – Lockheed Martin (Orlando), Walmart Labs, UCSC, Zoox, Intel, AgroAI, Rain
- SMART Fellow for RV: S. Edwards (Dixon)
- >10 Summer 2022 AFRL/Space Scholar/interns
  - RV: G. Behrendt (Hale), A. Allen (Fitz-Coy), C. Fedele (Butler)
  - RW: W. Warke (Hale), A. Benvenuti (Hale), C. Makumi (Dixon), A. Lee (Dixon), C. Nino (Dixon), K. Sivakumar (Zavlanos), Z. Lamb (Sanfelice)
  - RY/Act3: W. Garcia (Butler)
- AFRL Summer Faculty Fellows program
  - Riccardo Bevilacqua (2019 & 2020 RW, 2021 RV)
  - Matthew Hale (2020 RW)
- AFOSR just executed a plus up for additional space focus
- AFRL workshop on Assured Autonomy at RV
- Hosted the visits of Marcus Endler, Bruno Olivieri, Thiago Lamenza (Puc Rio)
- M. Pajic hosted Gen. Brown, Chief of Staff of the Air Force, to brief him about AACE

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Additional Activities

- Publications
  - ~300 total, 50 published or accepted to appear so far in 2022
  - Joint publications
    37 w/ PIs, 34 w/ AFRL

- Testbed Development
  - Now Open!
  - Certification courses and other educational outcomes?
  - Interest by AFRL, USAFA, Northrup Grumman, Draper, JHU APL….

Additional Activities

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Additional Activities

Autonomous Assets

- 5G Networking w Starlink
- GPS RTK sensing
- Onboard Cameras
- IMU & LIDAR
- Heterogeneous collection of air and ground robots

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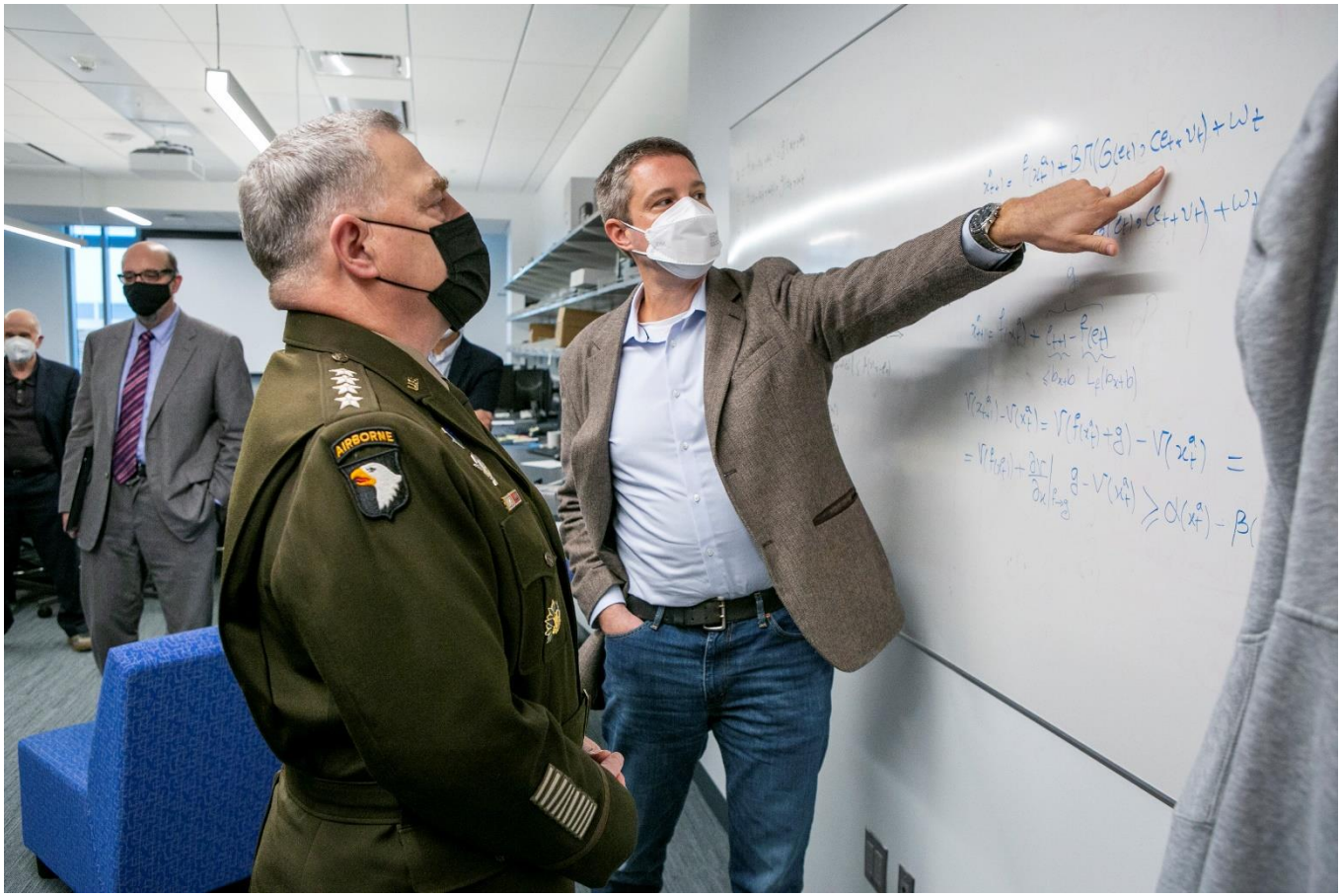
Additional Activities

- **(Pajic)** updated Gen. Mark Milley, Chairman of the Joint Chiefs of Staff, on the AFOSR CoE efforts in the domain of assured autonomy in contested environments



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