University Research of Advanced Air Mobility at USF

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Exploring the Horizons of Advanced Air Mobility: USF's Research Efforts

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Photo sources:
https://www.nasa.gov/sites/default/files/thumbnails/image/uam-3-4x3-v2-sm.jpg

Tampa Bay Smart Cities AAM Conference
September 12, 2023
Tampa International Airport

UNIVERSITY of SOUTH FLORIDA

Advanced Air Mobility/Urban Air Mobility

Future UAM Network

Photo Source:
https://www.nasa.gov/sites/default/files/thumbnails/image/uam-3-4x3-v2-sm.jpg

Urban Air Mobility (UAM) focuses on the transition from the **traditional** management of air traffic operations to the **future** passenger or cargo-carrying air transportation services **within an urban environment**.

Advanced Air Mobility (AAM) Mission is to help emerging aviation markets to safely develop an **air transportation system** that moves people and cargo between places **previously not served or underserved** by aviation **– local, regional, intraregional, urban –** using **revolutionary new aircraft** that are only just now becoming possible.

Updates on Aircraft Certification in the US

In Nov. 2022, FAA released proposed airworthiness criteria for Joby Aviation, Inc. (JAS4-1 eVTOL)

- Six tilting electric engines with 5-blade propellers
- Maximum gross takeoff weight of 4,800 lbs
- One pilot and up to four passengers
- Intended to be used for part 91 and part 135 operations, with a single pilot onboard, under visual flight rules.

https://www.federalregister.gov/documents/2022/11/08/2022-23962/airworthiness-criteria-special-class-airworthiness-criteria-for-the-joby-aero-inc-model-jas4-1

Updates on Aircraft Certification in the US (Cont'd)

In Dec. 2022, FAA released proposed airworthiness criteria for Archer Aviation. (M001 eVTOL)

- 12 electric engines powered by onboard batteries
- Six engines with five-bladed variable-pitch propellers are mounted on the forward edge of the main wing
- six electric engines drive two-bladed fixed-pitch propellers and are mounted on the aft edge of the main wing
- Maximum gross takeoff weight of 6,500 lbs
- One pilot and up to four passengers
- Intended to be used for part 91 and part 135 operations, with a single pilot onboard, under visual flight rules.

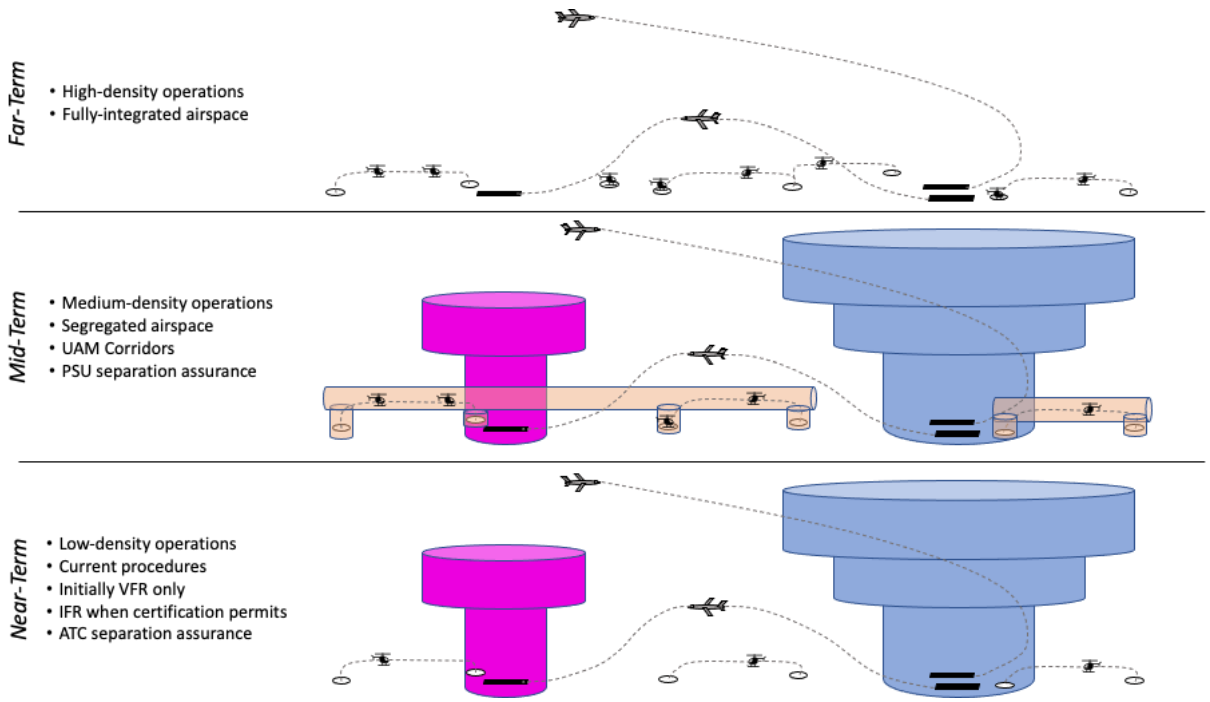
https://www.federalregister.gov/documents/2022/12/20/2022-27445/airworthiness-criteria-special-class-airworthiness-criteria-for-the-archer-aviation-inc-model-m001

Updates on Aircraft Certification – EU vs. US

- Collaboration with international agencies and understanding different expectations is crucial to ensure safety in Advanced Air Mobility (AAM).
- **Safety Certification Standards**: The European Aviation Safety Agency (EASA) insists on using the same standards as commercial technology, while the FAA adopts a case-by-case approach, allowing negotiations with companies based on the complexity and usage of the aircraft.
- **Harmonization and Transferability**: Achieving complete regulatory harmonization is challenging. The focus of cooperation between regulators is on the transferability of type certificates rather than achieving 100% harmonization.

FAA Envisions Three Evolutionary Stages of UAM Operations

1. Initial operations – Low operational tempo, with no new airspace structures. Aircraft comply with current ATC rules and regulations. Low level of aircraft automation (pilot on board).
2. Midterm operations – Low (but higher) operational tempo. Dedicated UAM corridors, with corresponding changes to rules and regulations. Higher level of aircraft automation, with the possibility of remote pilots.
3. Mature state operations – High operational tempo. Dedicated UAM corridors that may form a network. High level of aircraft automation with frequent remote piloting.



A three-phased evolution of airspace integration

AAM Safety Initiatives of NASA

- NASA AAM mission: ensure the vehicles used by AAM are safe to operate
- System-Wide Safety project: In-time Aviation Safety Management System (IASMS)
  - Collect data on in-flight aircraft, air traffic management, airports, ground conditions, and weather
  - Improve situation awareness of stakeholders and assess potential risks
  - Offer recommendations for action to air traffic controllers and pilots or integrate pre-panned actions automatically.

https://drive.google.com/file/d/1QhTJIOBrrXlHJMOlWOcRKhsGN4b06pR4/view?pli=1

IASMS Roadmap 2025-2045

- Safety Data and Resilience Analysis
- Strategic Conflict Management
- Tactical Conflict Management
- Individual Vehicle Flight Management
- Aviation Weather
- System & Vehicle Design Assurance and Validation
- Cross-cutting Research and Development

IASMS
IN-TIME AVIATION SAFETY MANAGEMENT SYSTEM
ROADMAP WORKSHOP

https://drive.google.com/file/d/1QhTJIOBrrXlHJMOlWOcRKhsGN4b06pR4/view?pli=1

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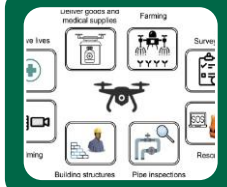
CENTER FOR URBAN TRANSPORTATION RESEARCH

AAM Research Program at USF

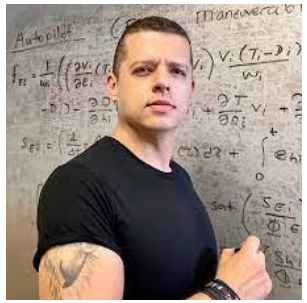
AAM
Advanced Air Mobility

Passenger AAM

Cargo AAM



UAS Applications



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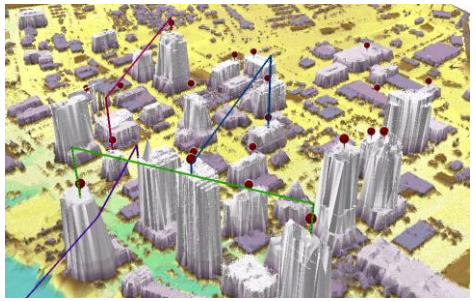
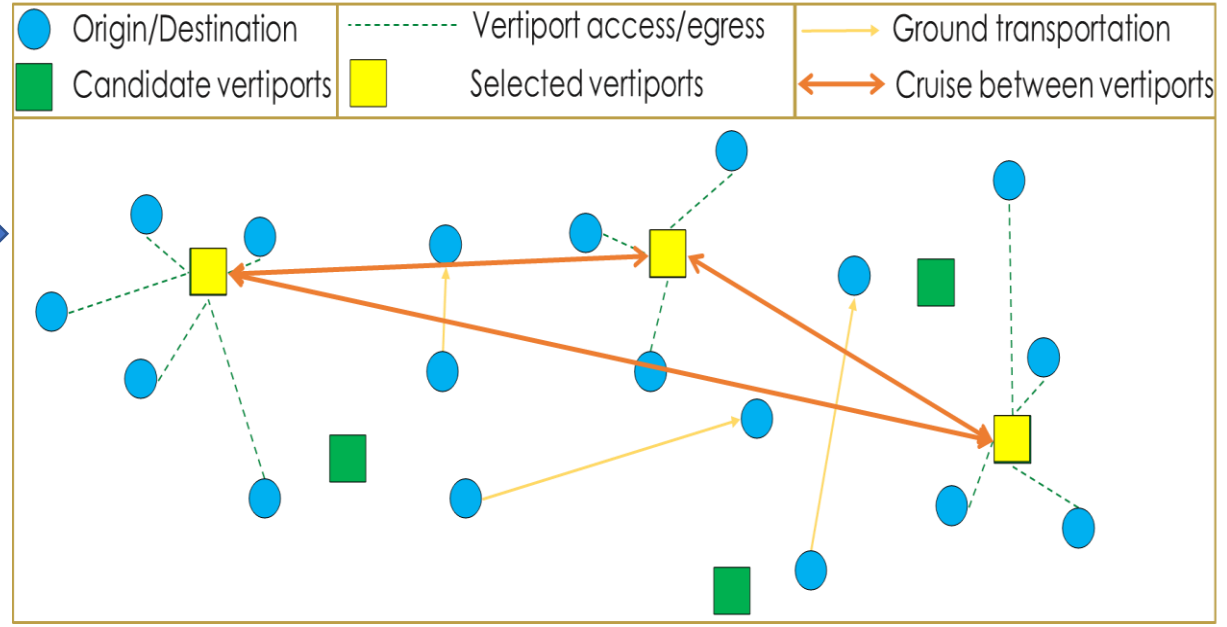
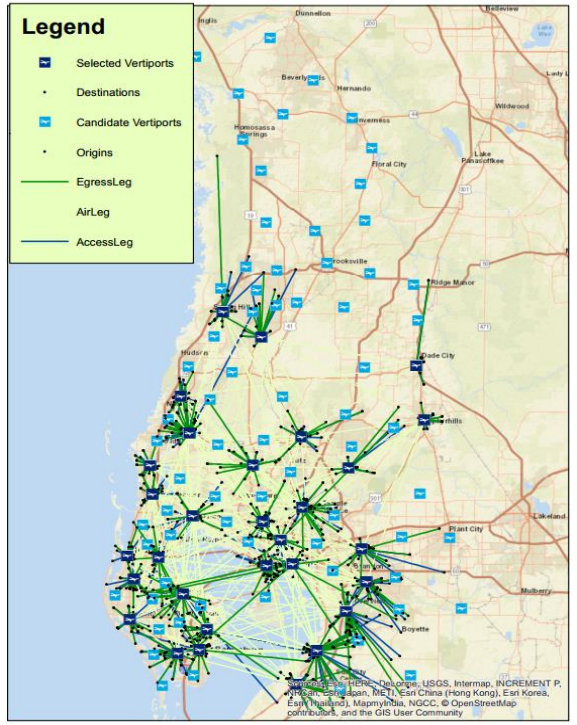
Sample Project 1: Integrated Network Design and Demand Estimation of Urban Air Mobility



Extended Single-Allocation Hub-Spoke Modeling for Vertiport Siting and Demand Estimation of Multimodal UAM

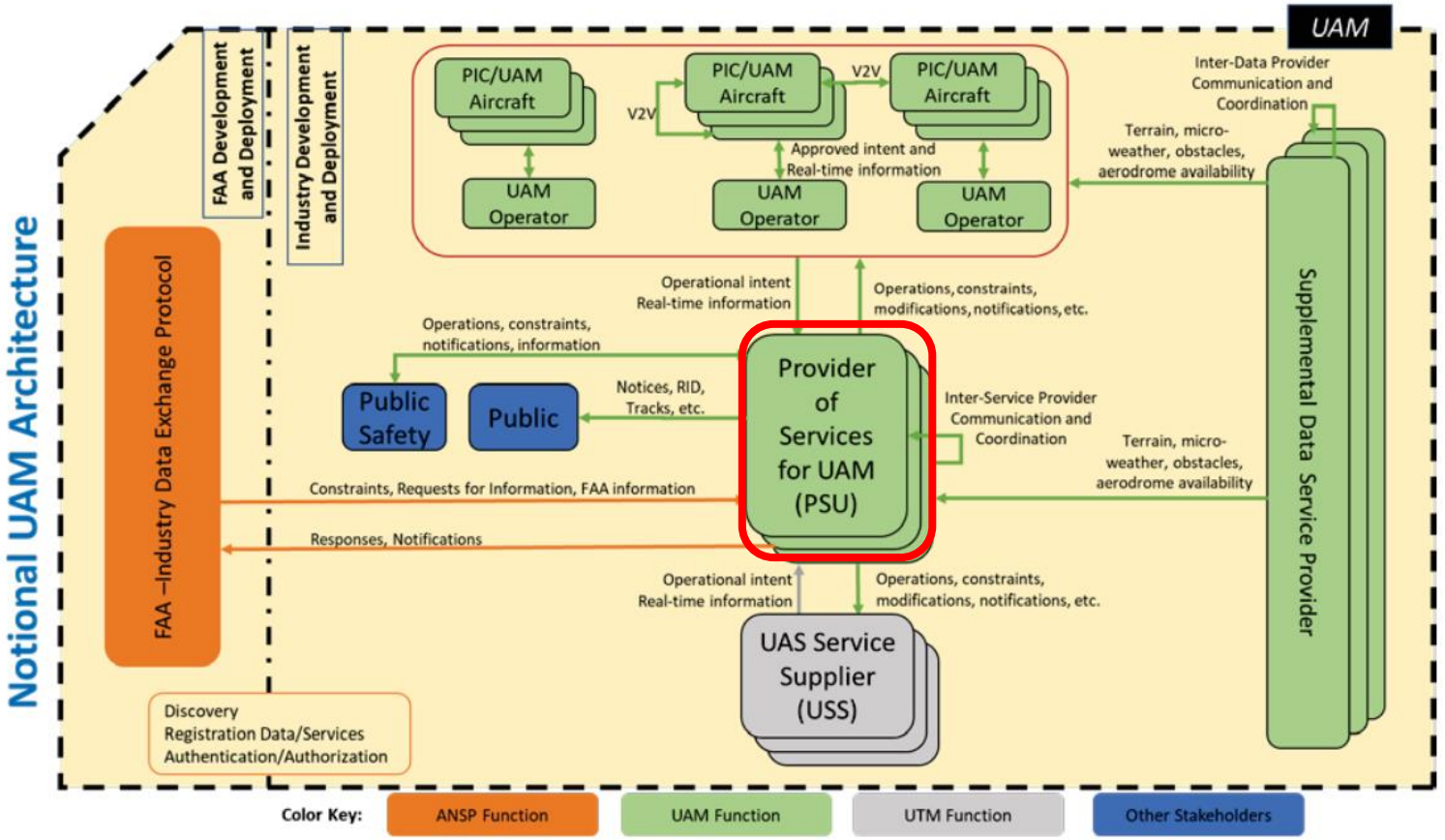




Outcomes of the Research

- Optimal locations of vertiports and diverted passenger demand
- Passenger allocation to vertiports
- Access and egress modes of each passenger
- Saved travel time and reduced system generalized cost
- Sensitivity analysis results:
  - Optimal number of vertiports to serve the region
  - Impacts of pricing schemes
  - Impacts of intermodal efficiency

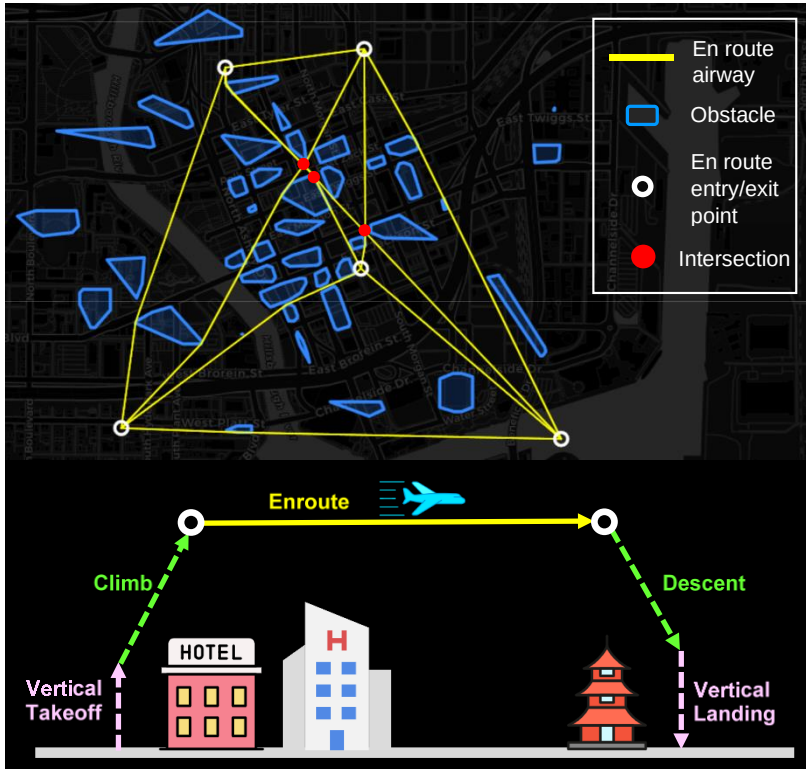
Sample Project 2. Automated AAM Flight Planning



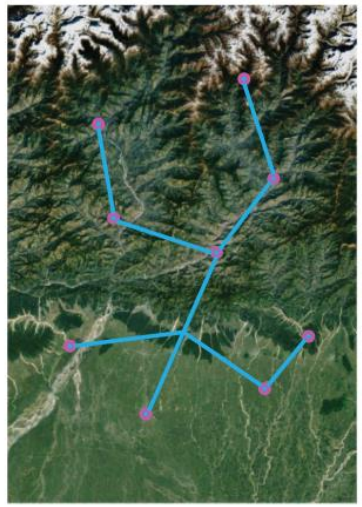
FAA NextGEN, 2020. UAM ConOps V1.0

Key Challenges of Pre-departure Flight Planning:

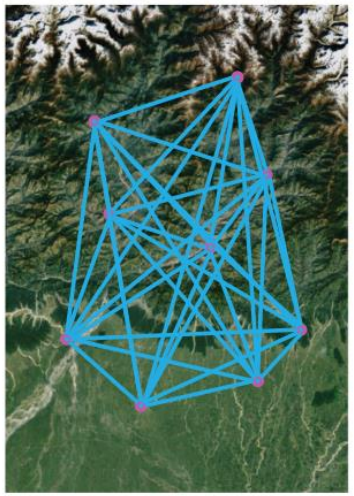
- Airspace structure design
- Strategic deconfliction

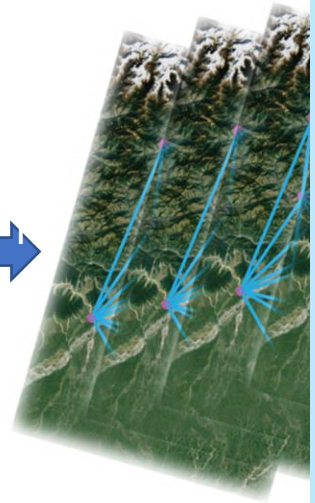


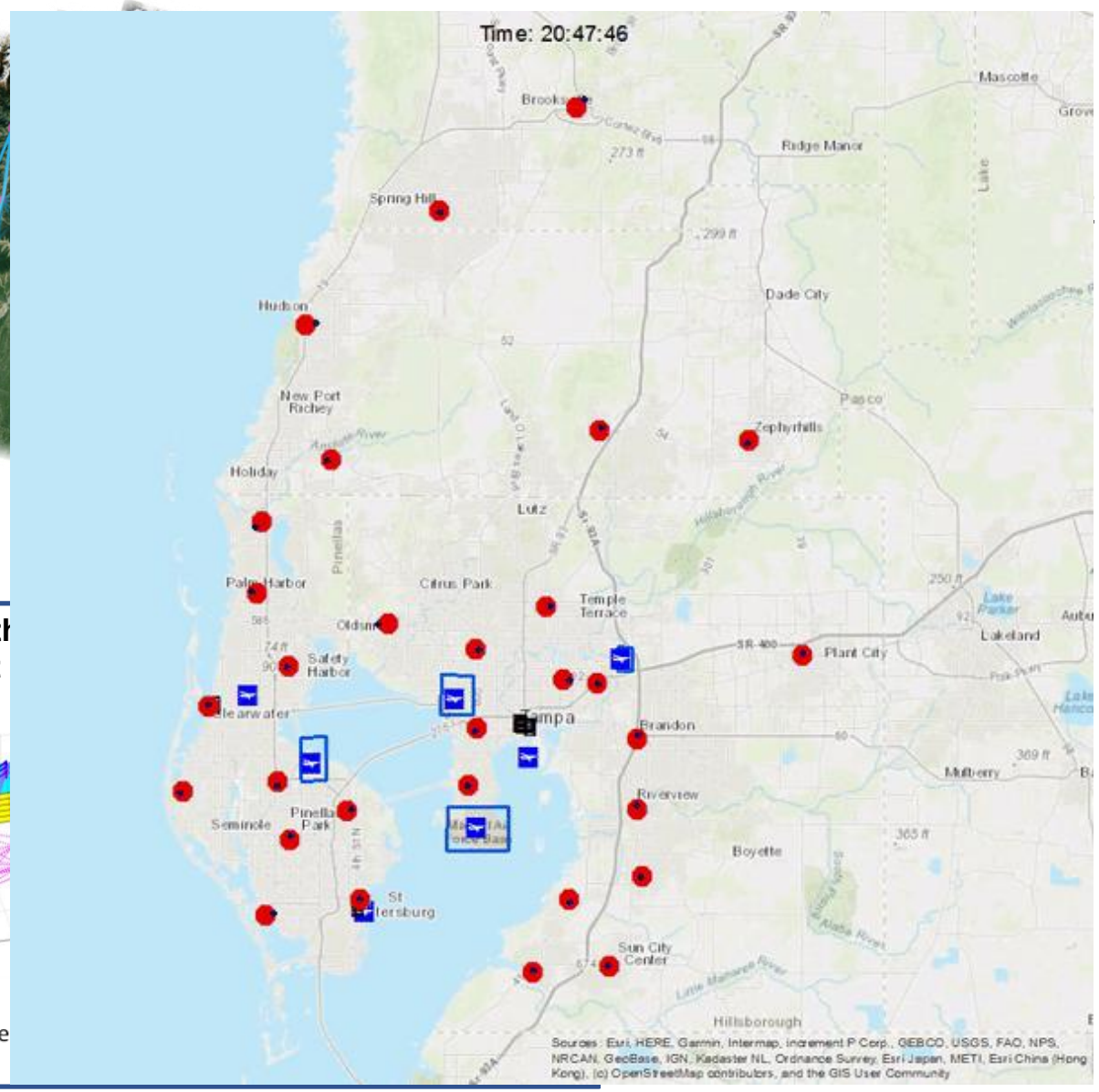
Airspace Management and Strategic Deconfliction



vs.



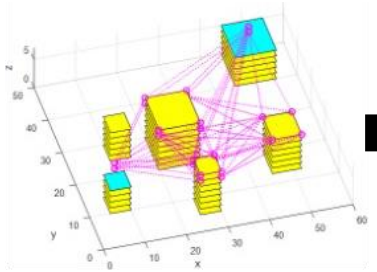




Define UAM operational environment

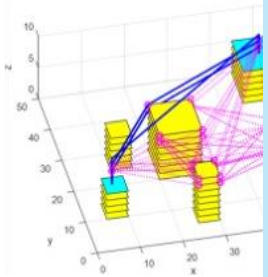
Construct a 3D map of available airspace

Generate candidate routes



Construct visibility graphs for any enroute entry and exit points

Shortest Path Different Flight



Obtain the shorte

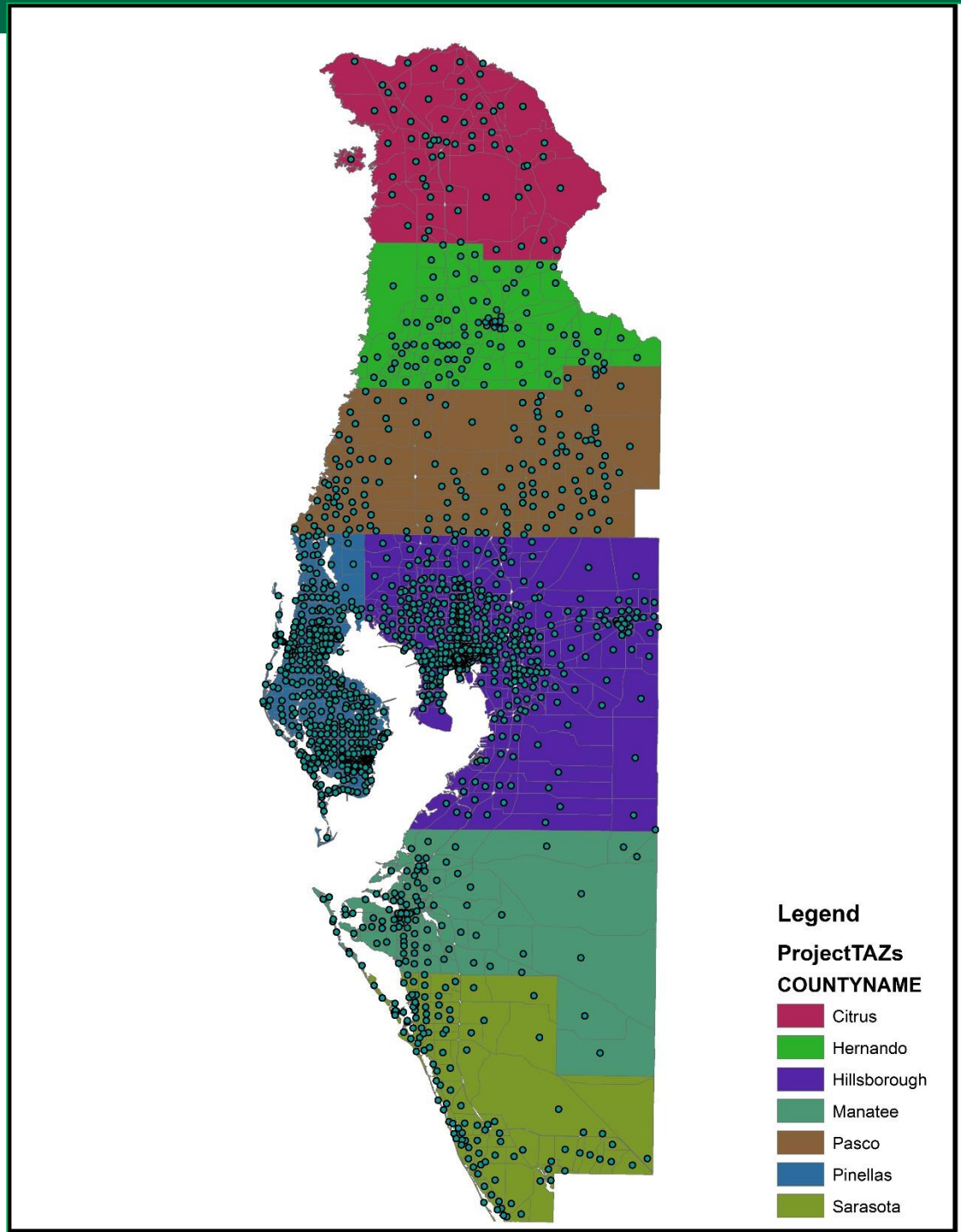
Outcomes of the Research

- Pre-departure conflict free 4D trajectories for high-density UAM operations
  - Flight level assignment
  - Departure delay (limited)
  - Local speed control
- Ensure the fairness among different operators
  - Market share
  - Flight distance
  - Operational times

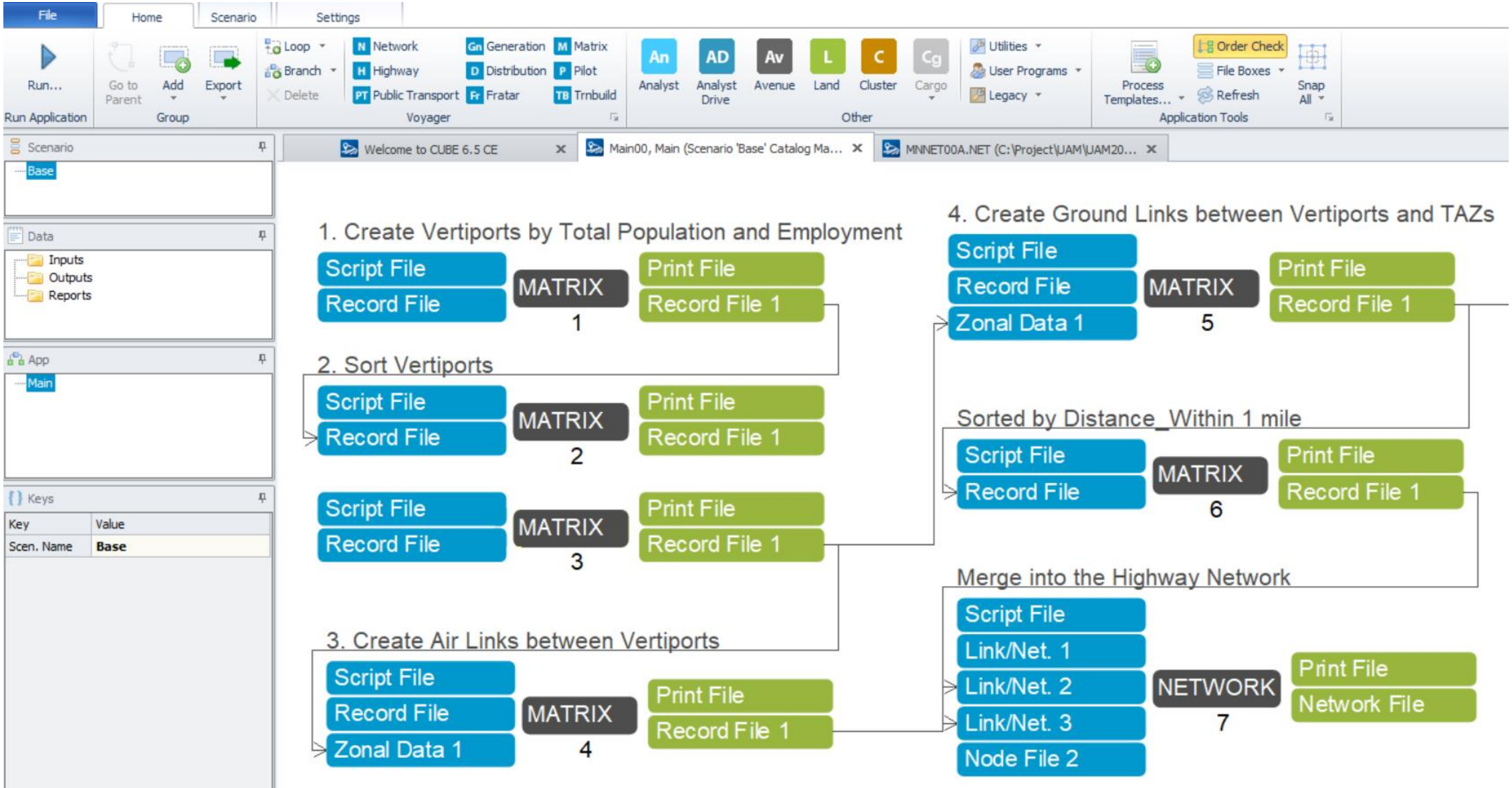
http://www.sum-lab.org/

On-going Efforts to Embracing AAM

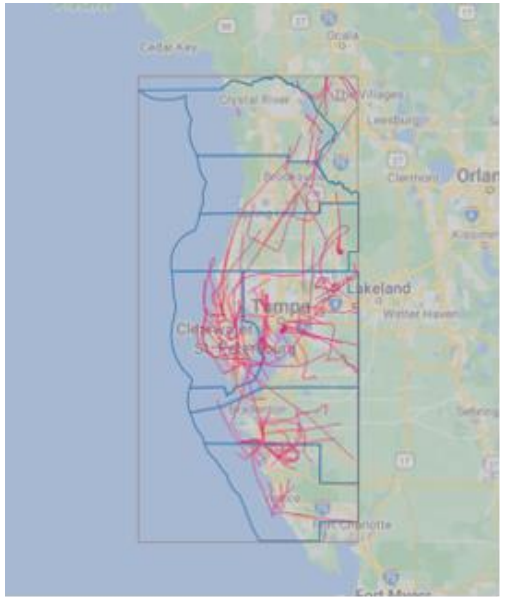
- Evaluating the Impacts of Emerging Advanced Air Mobility on the Transportation System in the Tampa Bay Region
  - Enhancing statewide demand modeling to include the new mode
  - Generating AAM route network for planning purposes
  - Vertiport location optimization
  - Before and after comparison and impact analysis



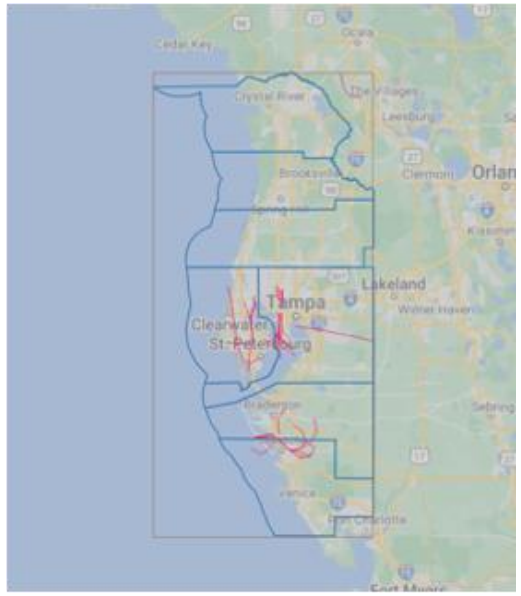
Enhancing FLSWM



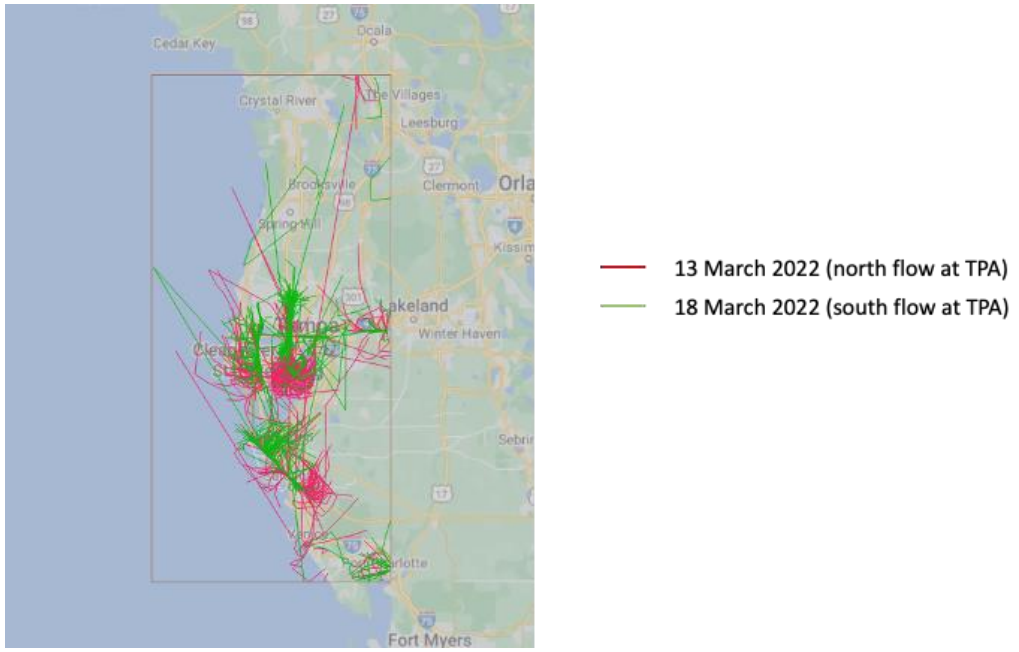
Collecting and Analyzing Historical Flight Trajectory Data



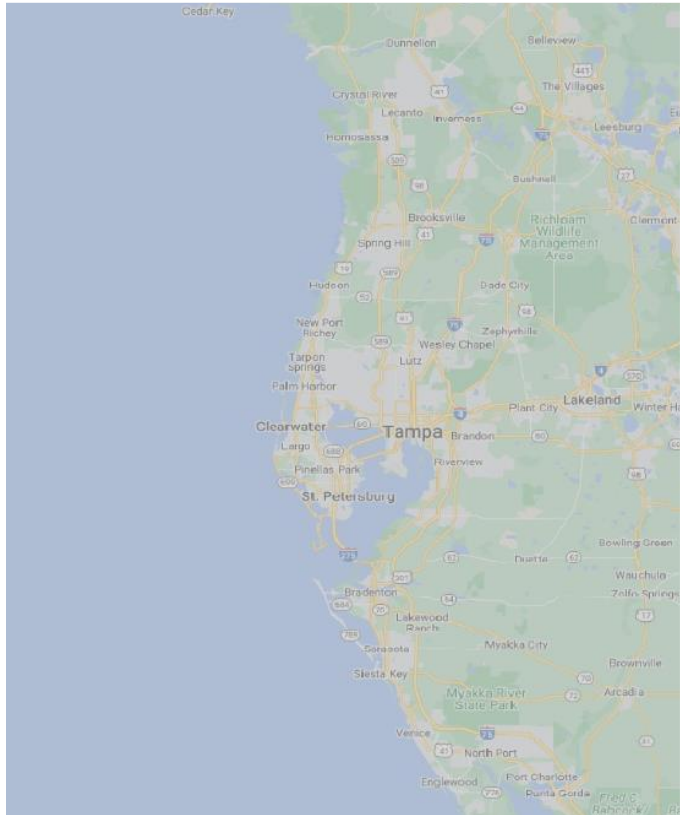
All flight tracks below 3,000 ft.,
13 March 2022, 1200-1300 local



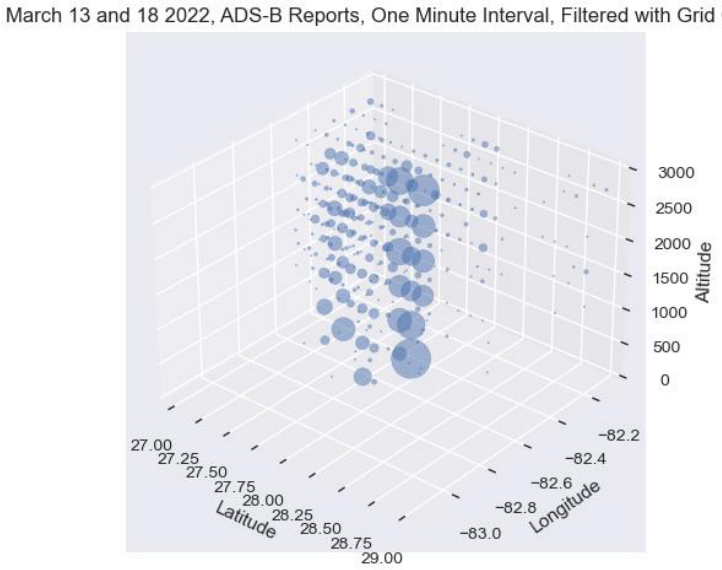
Filtered flight tracks below 3,000 ft.,
13 March 2022, 1200-1300 local



Identifying Discouraged Airspace

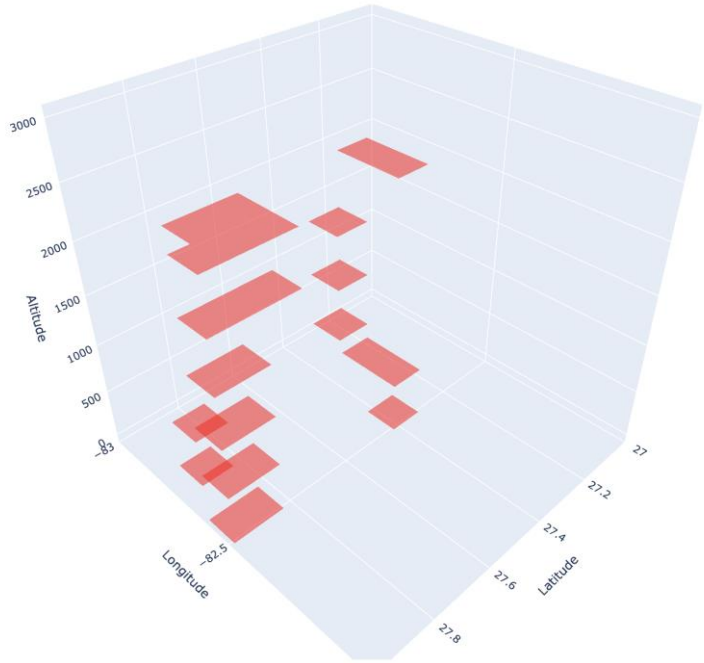


Traffic density between 2,500 and 3,000 ft MSL. (Only those cubicles with more than 40 flights are shaded.)

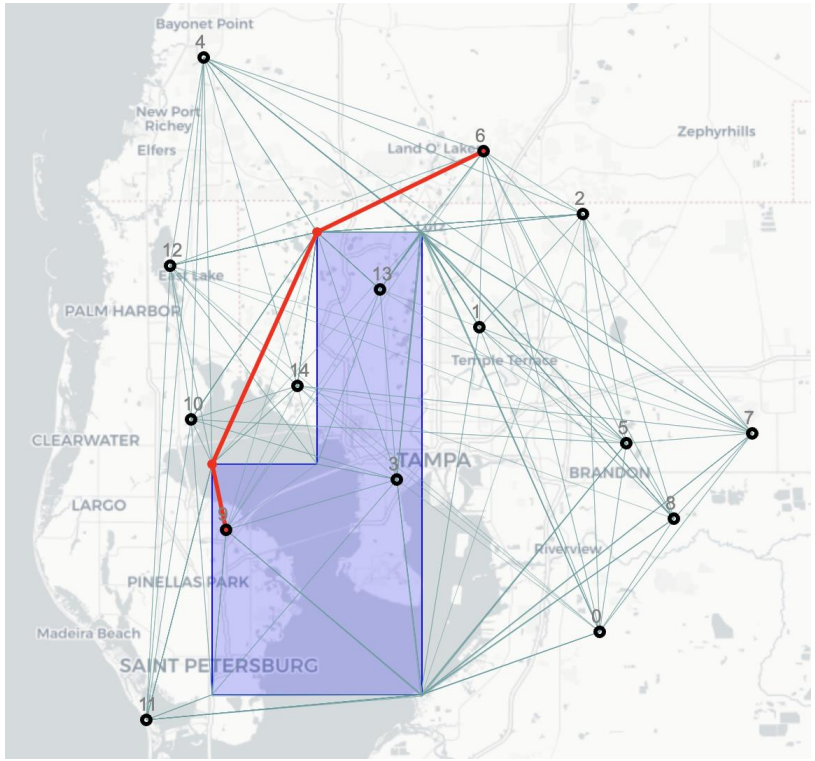


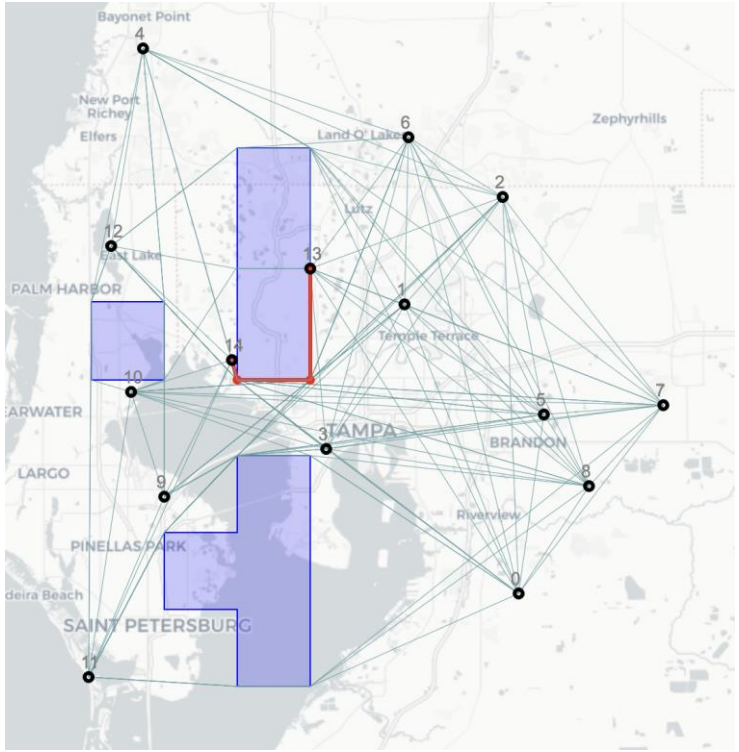
Flight traffic density of FY2022

Discouraged airspace at different flight levels

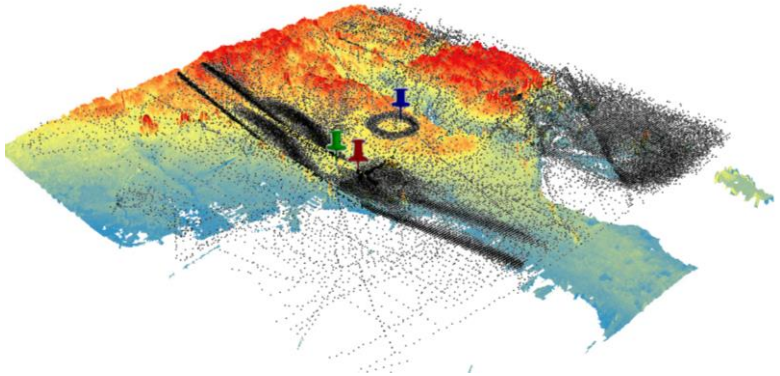


Sample AAM Route on Different Flight Levels

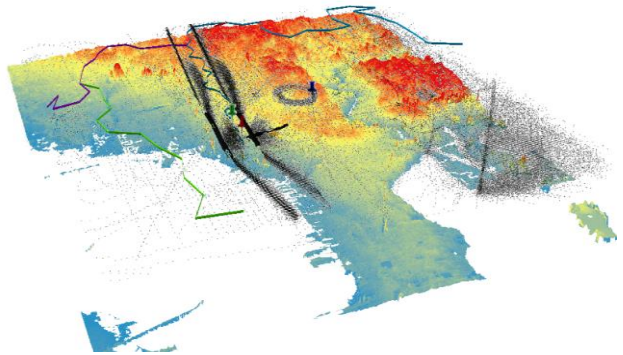




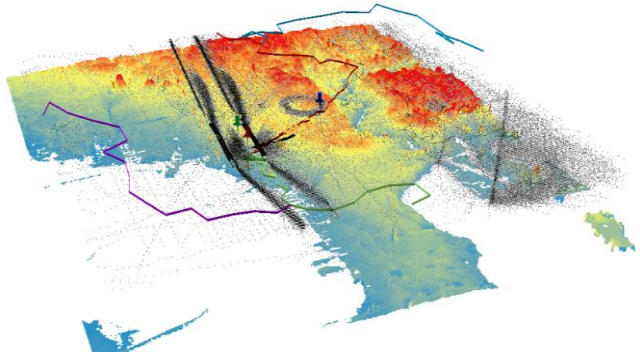
On-going Efforts to Embracing AAM (Cont'd)



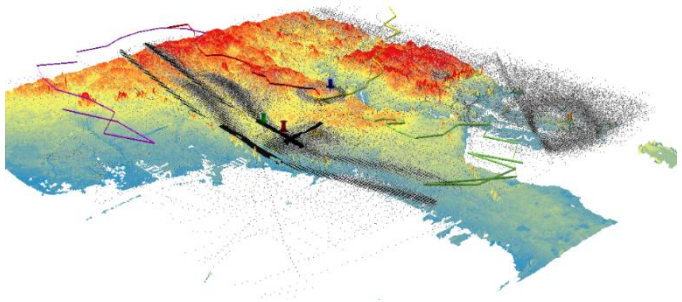
Three vertiports at Tampa International Airport



VTOL Routes from/to Vertiport 2 - Clearance 100 ft



VTOL Routes from/to Vertiport 1 - Clearance 75 ft



VTOL Routes from/to Vertiport 3 - Clearance 100 ft

- Understanding dynamic capacity for accommodating AAM operations from tower controllers' perspective

Thank you for your attention!

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https://www.cutr.usf.edu/advancedairmobility/

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