Integrated Network Design and Demand Estimation for Passenger AAM

Yu Yu Zhang, PhD
Professor, CEE
NICR Director, CUTR

Transportation Systems Management and Operations (TSMO) Advisory Committee Meeting

Metroplan Orlando

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Smart Urban Mobility

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Advanced Air Mobility

Smart Urban Mobility Lab at USF

- **Advanced Aerial Mobility*:** Network Design and Multimodal Planning; Integrated National Airspace System; Automated Air Traffic Management System; Trajectory Planning
- **Shared Micromobility** and Shared Automated Vehicles:** Efficient and Equitable Micromobility Program Design and Regulation; Performance Evaluation of Micromobility Program; Emerging of Shared Automated Vehicles.
- **Air Transport Management:** Airport Planning and Management, Air Transport Economics, Air Traffic Management, Emerging Technologies, Environmental Issues in Aviaiton
- **Resilient Cities:** Criticality Analysis of Roadway Network and Freight Transportation System; Integrated Mitigation and Restoration Planning for Transportation and Freight Movement; Resiliency of Interdependent Critical Infrastructures

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**Advanced aerial mobility involves the emergence of transformative and disruptive new airborne technology supporting an ecosystem designed to transport people and things to locations not traditionally served by current mode of air transportation, including both rural and the more challenging and complex urban environment." --Advancing Aerial Mobility: A National Blueprint*

***Micromobility: namely docked and dockless sharing programs with bike, electric bikes and electric scooters.*

NSF

Department of Transportation United States of America

Federal Aviation Administration

State of Florida Department of Transportation

U.S. Department of Transportation Federal Highway Administration

Federal Transit Administration

TRB Transportation Research Board of the National Academies

ACRP Airport Cooperative Research Program

NASA

amazon research awards

Florida high tech Corridor

City of Tampa Florida

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Tampa International Airport

PSTA

Center for Urban Transportation Research

- In 1988, the Florida Legislature created the Center for Urban Transportation Research at the University of South Florida. CUTR is a part of the College of Engineering at the University of South Florida in Tampa, Florida.
- Since its inception, CUTR has become internationally recognized in transportation research, education and technology transfer/training/outreach center, with a focus on producing products and people.

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National Institute of Congestion Reduction

- The National Institute for Congestion Reduction (NICR) is a national leader in providing **multimodal congestion reduction strategies** through **real-world deployments** that leverage advances in technology, big data science and innovative transportation options to optimize the efficiency and reliability of the transportation system for all users.

AAM Research Program at USF

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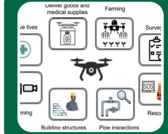
Advanced Air Mobility

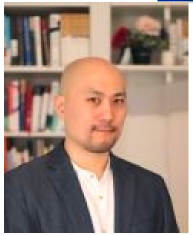
Passenger AAM

Cargo AAM



UAS Applications







What is Urban Air Mobility/Advanced Air Mobility?

Future UAM Network

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

https://www.faa.gov/uas/advanced_operations/urban_air_mobility/

Urban Air Mobility (UAM) envisions a **safe** and **efficient** aviation transportation system that will use **highly automated** aircraft that will operate and transport passengers or cargo at **lower altitudes** within urban and suburban areas.

UAM will be composed of an **ecosystem** that considers the evolution and safety of the aircraft, the framework for operation, access to airspace, infrastructure development, and community engagement.

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.

Major Advantages of AAM Compared to Existing Transportation Modes

Commercial Aviation

- Short-haul markets
- More frequent service
- Potentially lower fare

Helicopter service

- Less noise
- More reliable
- Requires less space
- Electricity-powered

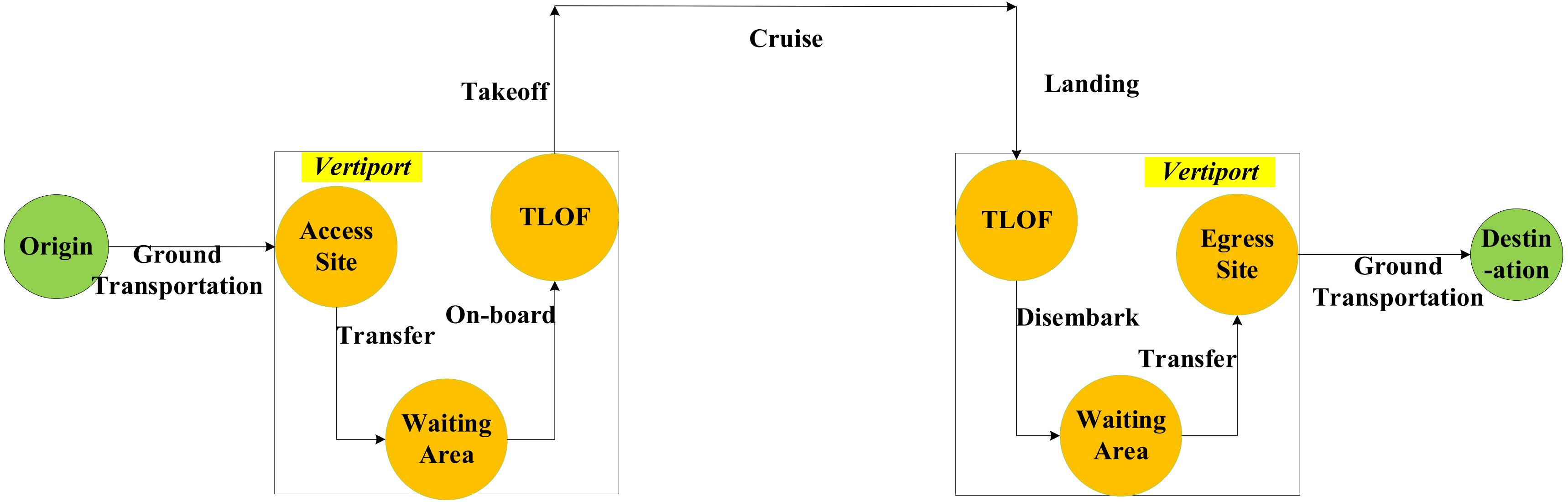
Ground transportation

- Faster
- Avoiding road congestion

Potential Applications of AAM

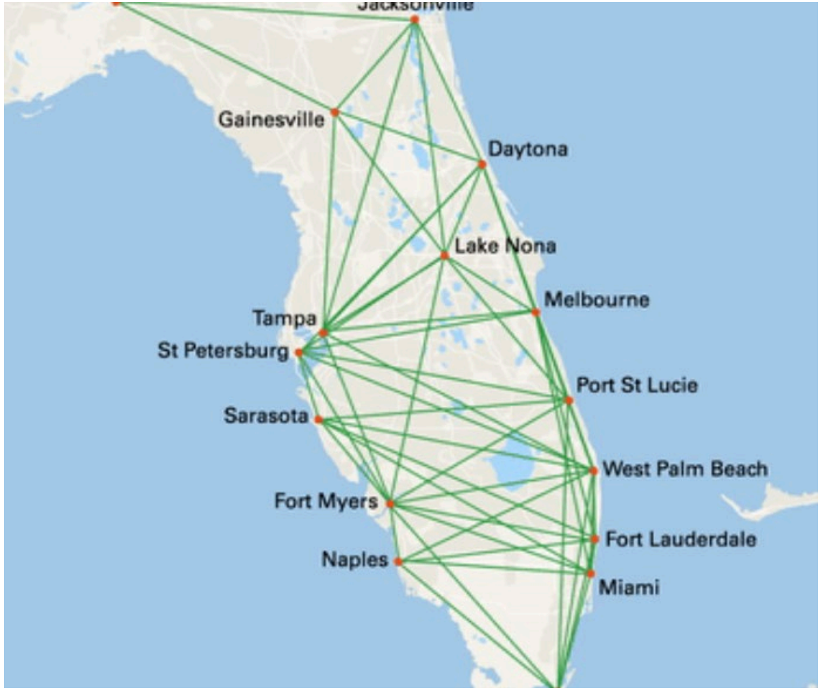
Market Category	Market Type
First Response	Ambulance; police; firefighter;
Air Commute	Privately owned; **on-demand**
Air Shuttle	Airport shuttle; company shuttle
Entertainment and Media	Film/TV/Radio stations; tourism
Real Estate and Construction	Aerial Showcasing; inspections; survey
Asset/Building Maintenance	Utilities asset maintenance

Multimodal Passenger AAM Service Process



Reference: (Antcliff et al., 2016; Vascik & Hansman, 2017; Vascik & Hansman, 2019)

Early Stage of Passenger AAM



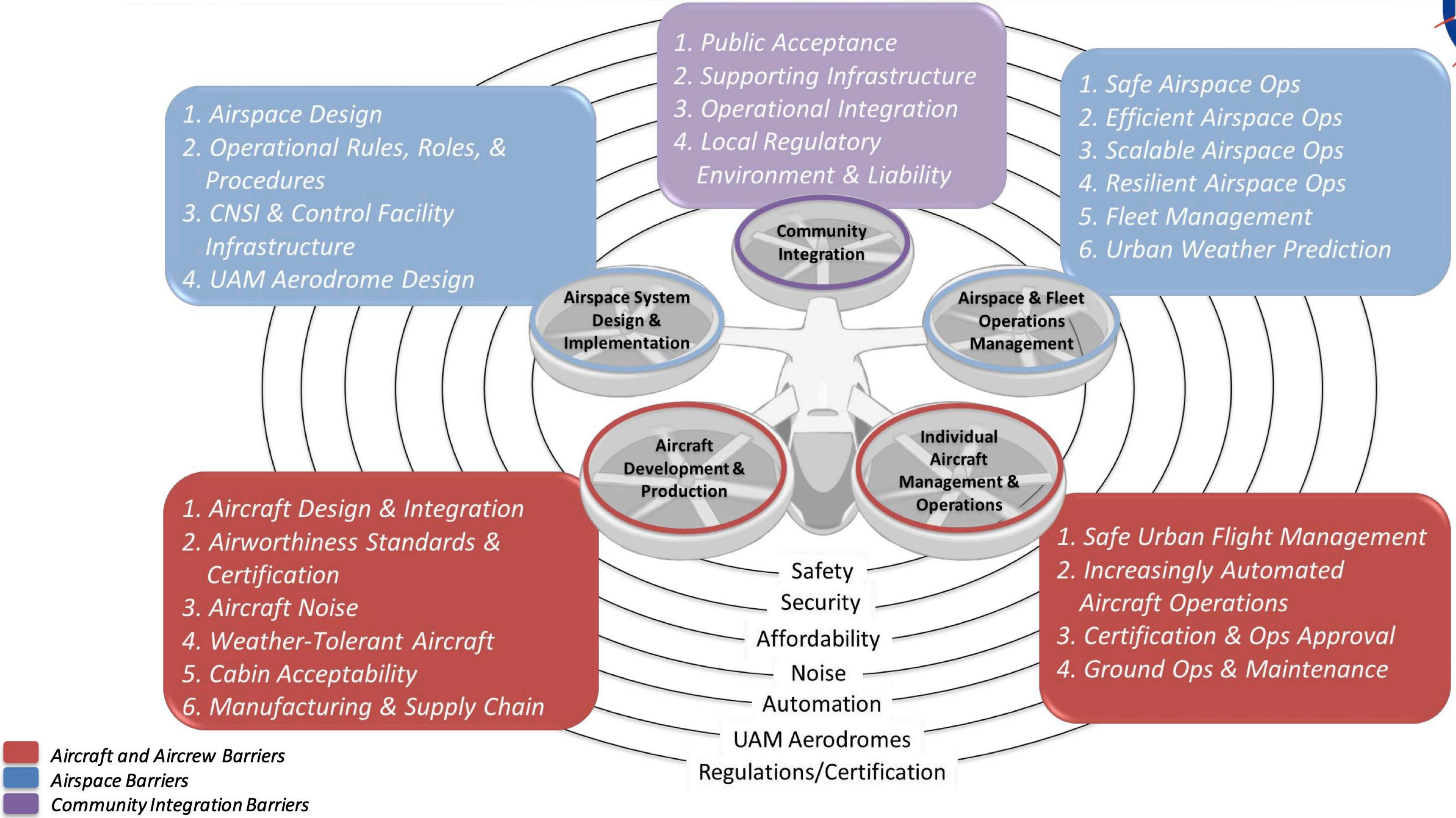
- Regional Air Mobility
  - Utilize available underused GA airport and follow GA procedures/Build private vertiports
  - Piloted electric aircraft
  - Relative frequent services to compete with commercial flights
  - Attract people from several hours driving for intra-state travel.

Major Challenges of Embracing AAM

- Aircraft: Certification
- Airspace: Integrated airspace with existing users
- Operations: Flight information, Collision detection and resolution
- Infrastructure: Aerodrome (vertiport), charging, communication
- Community: Awareness, Multimodal transportation integration

Photo source: https://www.avweb.com/news/embraer-introduces-evtol/

UAM Framework and Barriers



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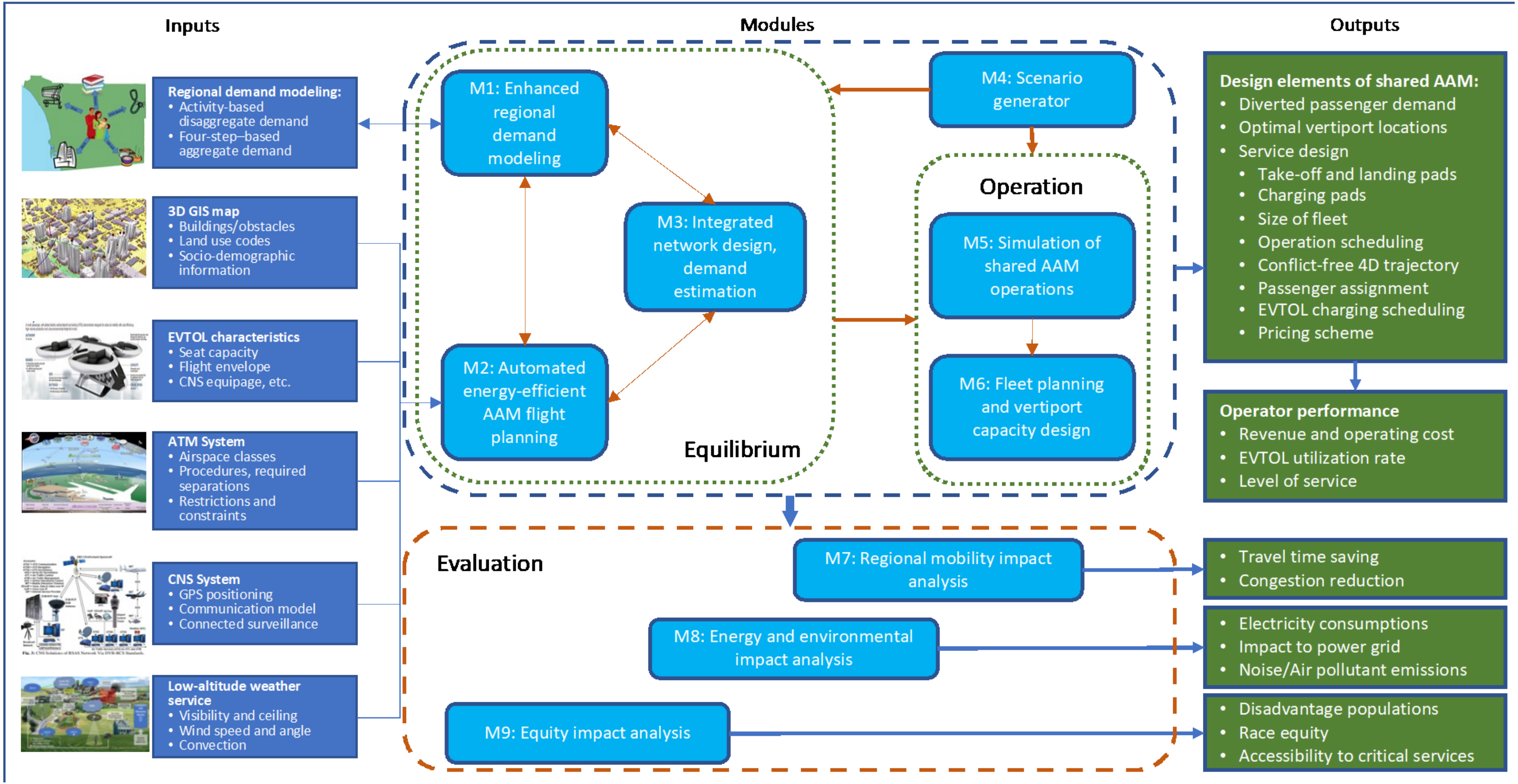
A Platform for the Design and Evaluation of Advanced Air Mobility (AAM-DE)



Integrated Network Design and Demand Estimation for On-Demand UAM

Zhiqiang Wu and Yu Zhang

Zhiqiang Wu, **Yu Zhang^** (2021). Integrated Network Design and Demand Estimation of on-Demand Urban Air Mobility. Engineering, https://doi.org/10.1016/j.eng.2020.11.007.

Introduction

Fig 4. Vertiport Designs

Functions for Future Vertiports:

- Aircraft **final approach** and **takeoff** areas
- **Passenger boarding** areas
- Aircraft **charging facilities**
- Space and facilities to accommodate various ground transportation modes
- Integrate other business services
- …

Photo Source: https://imgs.6sqft.com/wp-content/uploads/2018/05/10140456/UberAIR-skyports.jpg

Summary of Literature Review

1. Lack of research studying the mutual effects between vertiport locations and potential UAM adoption.

2. Lack of research integrating travelers' mode choice in a multimodal transportation network into vertiport placement modeling.

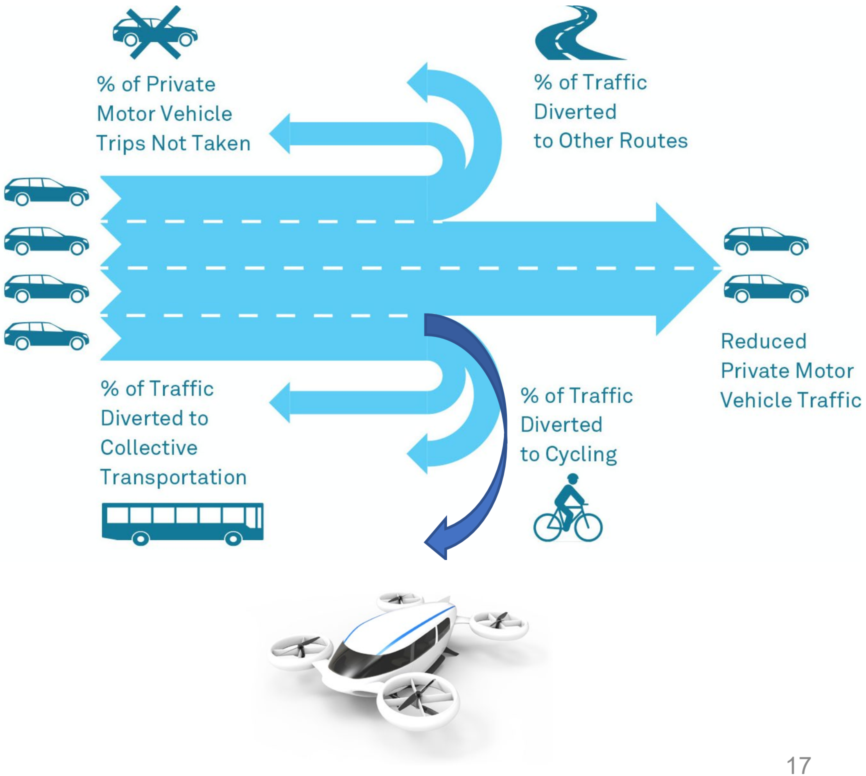


Photo sources:
https://globaldesigningcities.org/publication/global-street-design-guide/design-controls/design-year-modal-capacity/

Network Design and Travel Mode Choice

Network Design

Vertiport Placement
Number of available vertiports are restricted in practice due to eVTOL operation requirement, budget limit, etc.

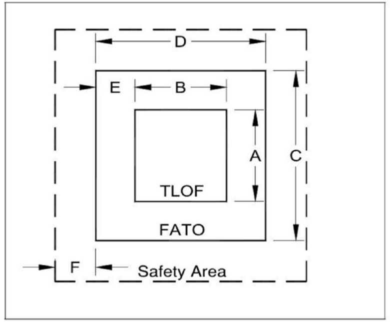
User Allocation
UAM service involves multimodal trips: ground trip access to or egress from vertiports and air trip between vertiports. Each user will always select route with minimum travel time.

Travel Mode Choice

Price & Time Tradeoffs
Compared with pure ground transportation, UAM service can greatly reduce travel time with higher travel cost.

Value of Time
As long as the value of saved travel time is greater than the additional cost, they will use UAM service.

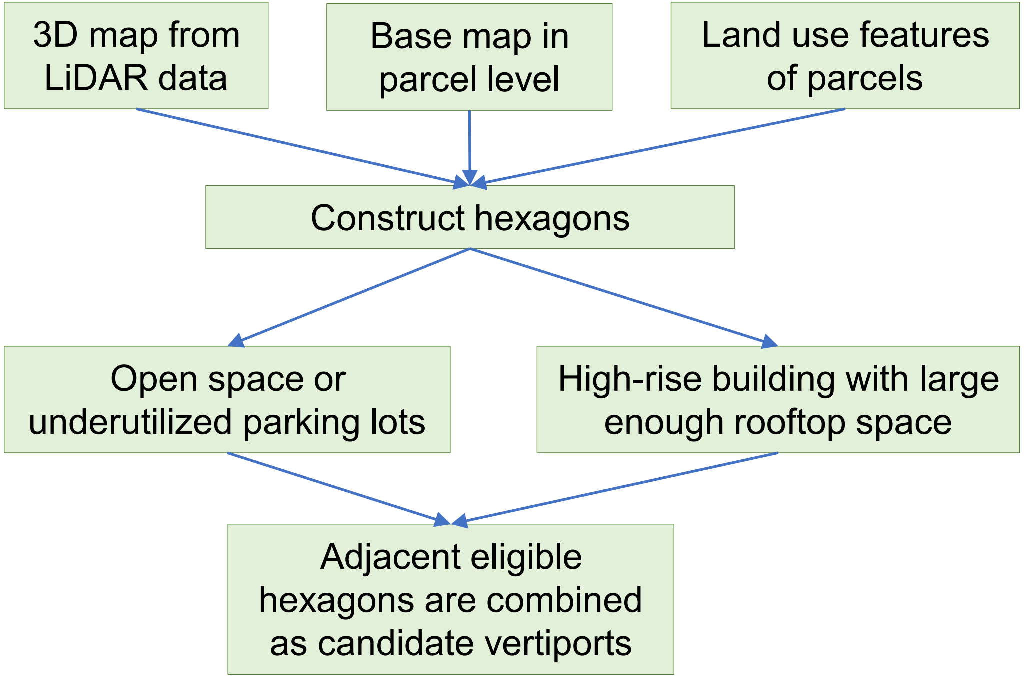
Identify Candidate Vertiport Locations



A – Minimum TLOF Width: 1.0 RD
B – Minimum TLOF Length: 1.0 RD
C – Minimum FATO Width: 1.5 OL
D – Minimum FATO Length: 1.5 OL
E – Minimum separation between the perimeters of the TLOF and the FATO: [0.5 (1.5 OL – 1.0 RD]
F – Minimum Safety Area Width:

RD: Rotor diameter of the design helicopter
OL: Overall length of the design helicopter

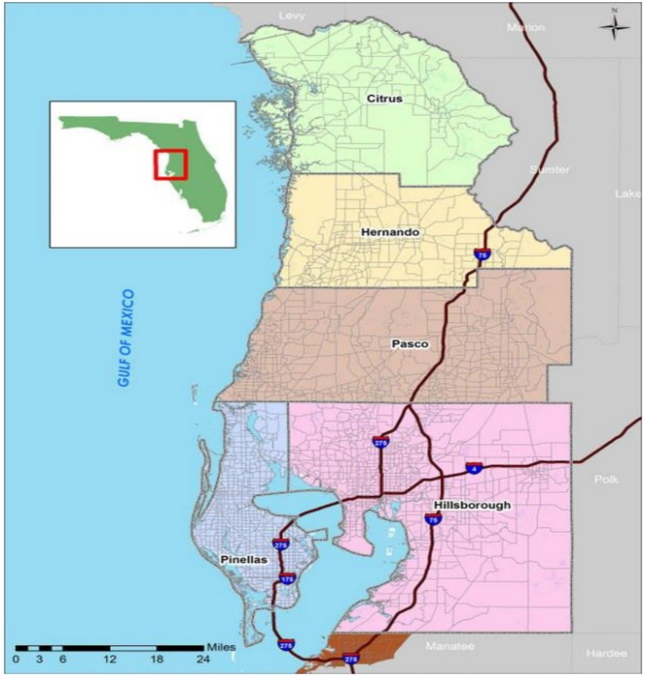
NOTE see AC 150/5390-2 for further guidance



Jonathan Torres, Vertiport Design Standards for eVTOL/UAM Vehicles, FAA Presenation.

Case Study: Tampa Bay Region

- **Study Area:** Hillsborough , Pinellas, Pasco, Hernando, and Citrus Counties of Florida.
- **Data Source**: Travel demand data simulated for a typical weekday from Tampa Bay Regional Planning Model (TBRPM).
- **Individual Data Info:** origin and destination coordinates, travel time, travel distance, travel mode, trip purpose, departure time, etc.
- **Filter Criteria :** Travel time ≥ 30 min and distance ≥ 10 miles. 266,734 daily trips.

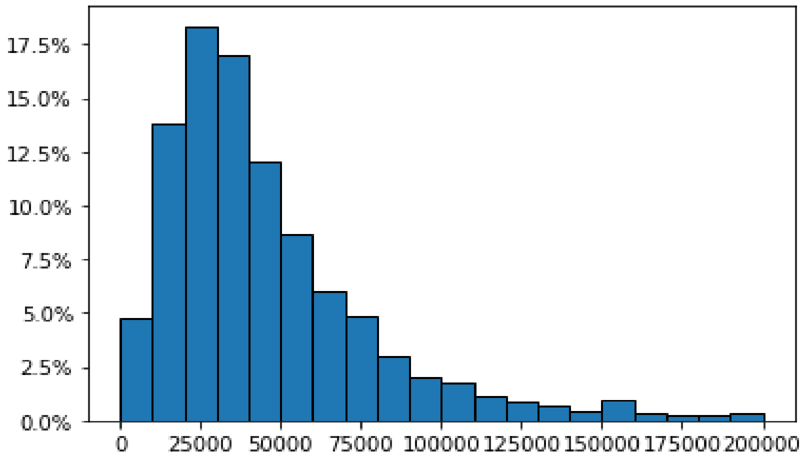


Tampa Bay Regional Planning Model Study Area

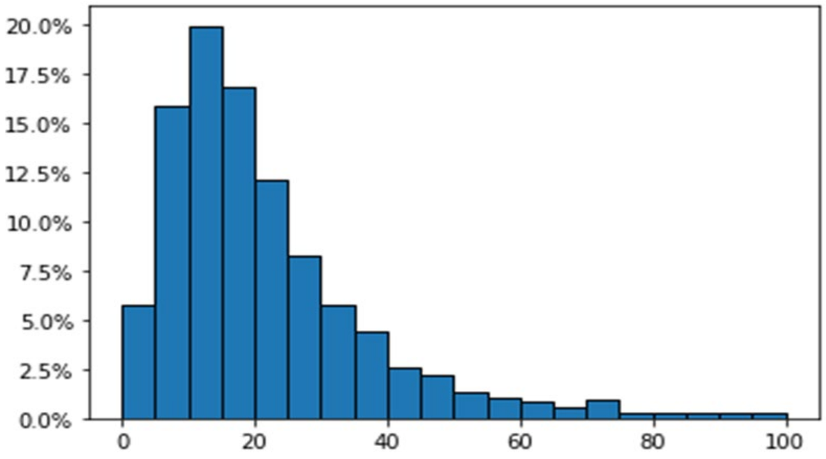
Pricing Scheme and Costs of Different Modes

Travel Mode	Pricing Scheme	Values
EVTOL	Base cost + unit distance cost * trip distance	Base cost: $30, unit distance cost: $2
Transit	With transit pass	$1
	Without transit pass	$2
Personal Vehicle	Gasoline cost per mile * trip distance + parking cost	Gasoline cost per mile: $0.11
For-hire Service	Base cost + unit time cost * trip time + unit distance cost * trip distance	Base cost: $2.3, unit time cost: $0.28 per minute; unit distance cost: $0.8
Bike Sharing	Base cost + unit time cost * trip time	Base cost: $1, unit time cost: $0.25
E-scooter Sharing	Unit time cost * trip time	Unit time cost: $0.29

Value of Time Distribution of Travelers



Average wage distribution of travelers in study region($)



Value of time distribution of travelers in study region($/hour)

Optimal Vertiport Locations and Trip Allocations

$$\frac{532 \text{ trips}}{\text{of } 266{,}734} = 0.20\%$$

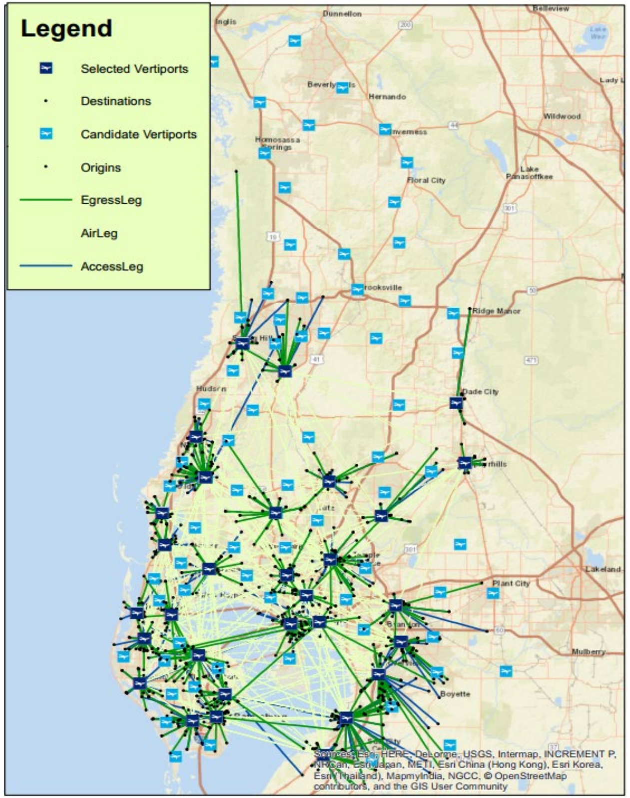
- Vertiport demand unevenly-distributed
- Northern region under-served

Number of trips served by each vertiport

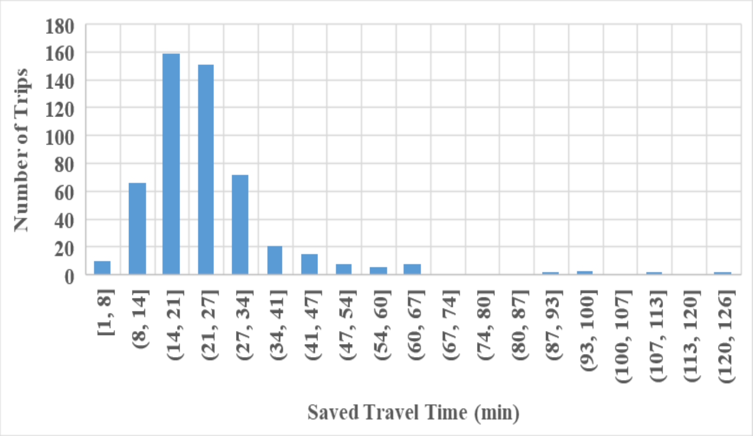
Vertiport Index	1	2	3	4	5	6	7	8	9	10
Demand	52	64	39	45	21	25	35	39	64	48

Vertiport Index	11	12	13	14	15	16	17	18	19	20
Demand	31	43	27	30	41	20	34	26	33	42

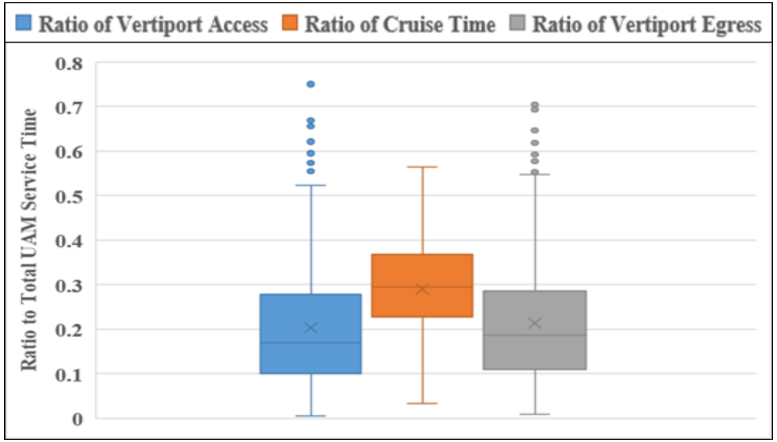
Vertiport Index	21	22	23	24	25	26	27	28	29	30
Demand	26	36	54	25	21	25	32	13	65	27



Significant Time Saving for AAM Passengers

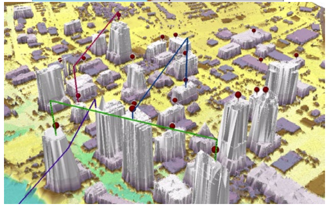


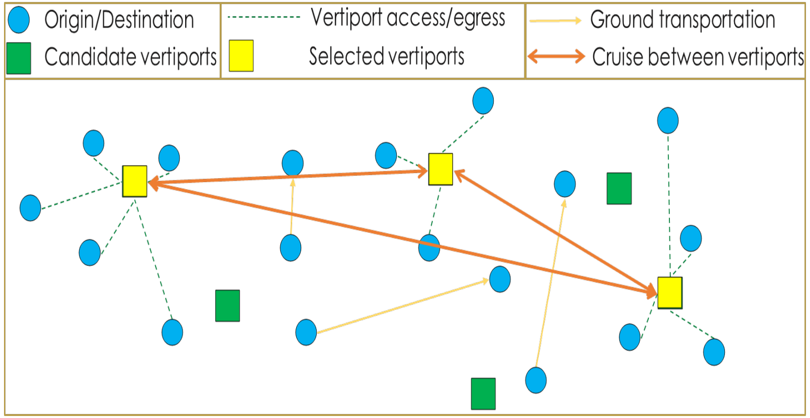
UAM travel time saving distribution

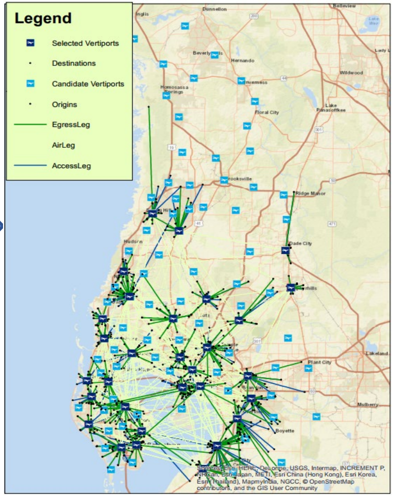


Time of different phases of UAM trips

Vertiport Locations and Demand Estimation of Passenger AAM



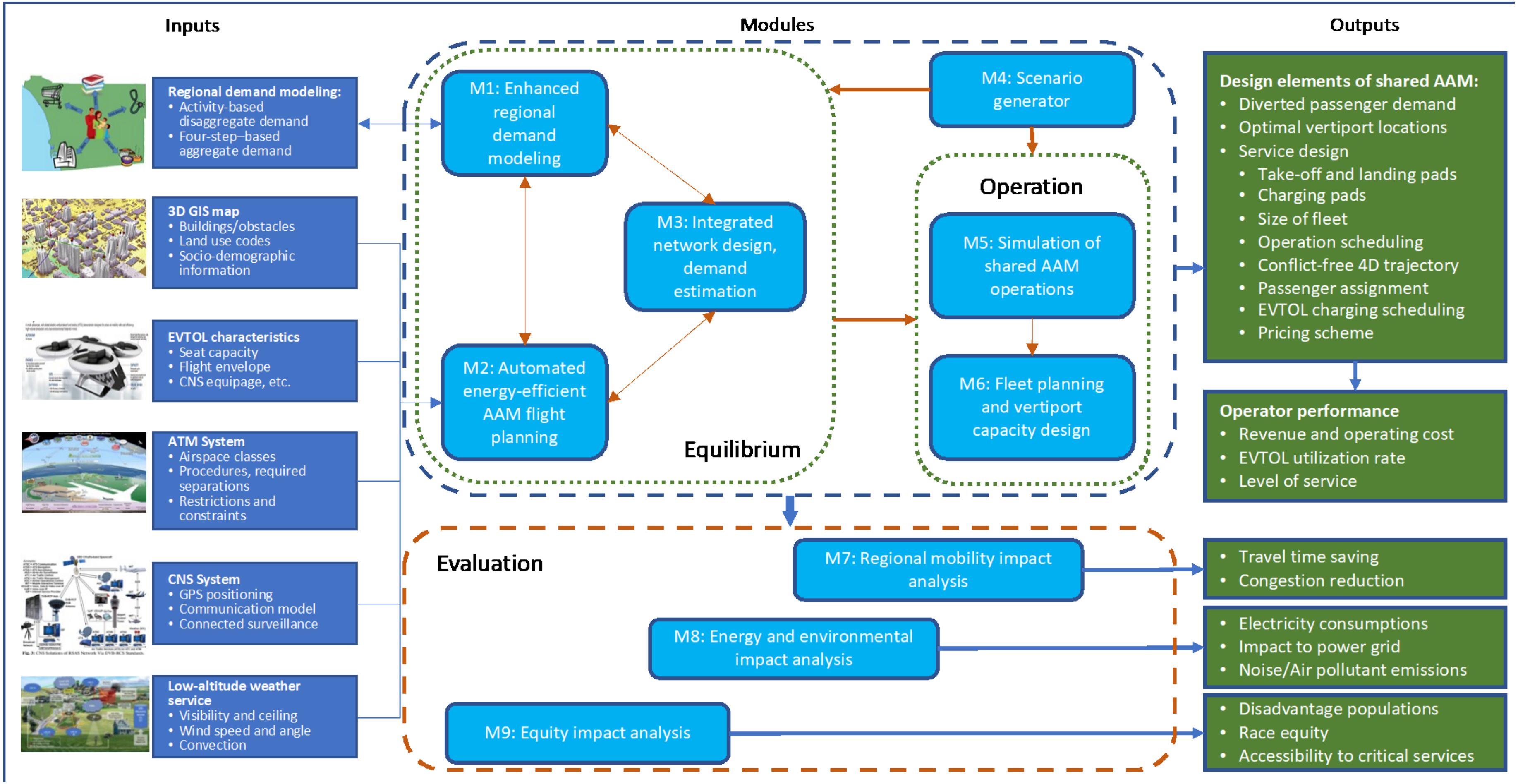




- Optimal locations of vertiports
- Passenger allocation to vertiports
- Access and egress modes of each passenger

- Diverted demand in the region
- Saved travel time and reduced system generalized cost
- Optimal number of vertiports to serve the region

A Platform for the Design and Evaluation of Advanced Air Mobility (AAM-DE)



Module 1: Integrating AAM in State Demand Modeling and Evaluating the Impacts to Transportation System

The objective of this proposed project is to introduce emerging passenger AAM in statewide demand modeling, develop scenario generator for future passenger AAM settings, to evaluate the the impacts of emerging passenger AAM in the Tampa Bay Region. The impacts could include operational impacts, such as mileage travelled, average speed in the roadway system, total travel time, air pollutant emissions, and transportation equity.

Module 7: Regional Mobility Impact Analysis
Module 9: Equity Impact Analysis

Thank You!

yuzhang@usf.edu
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