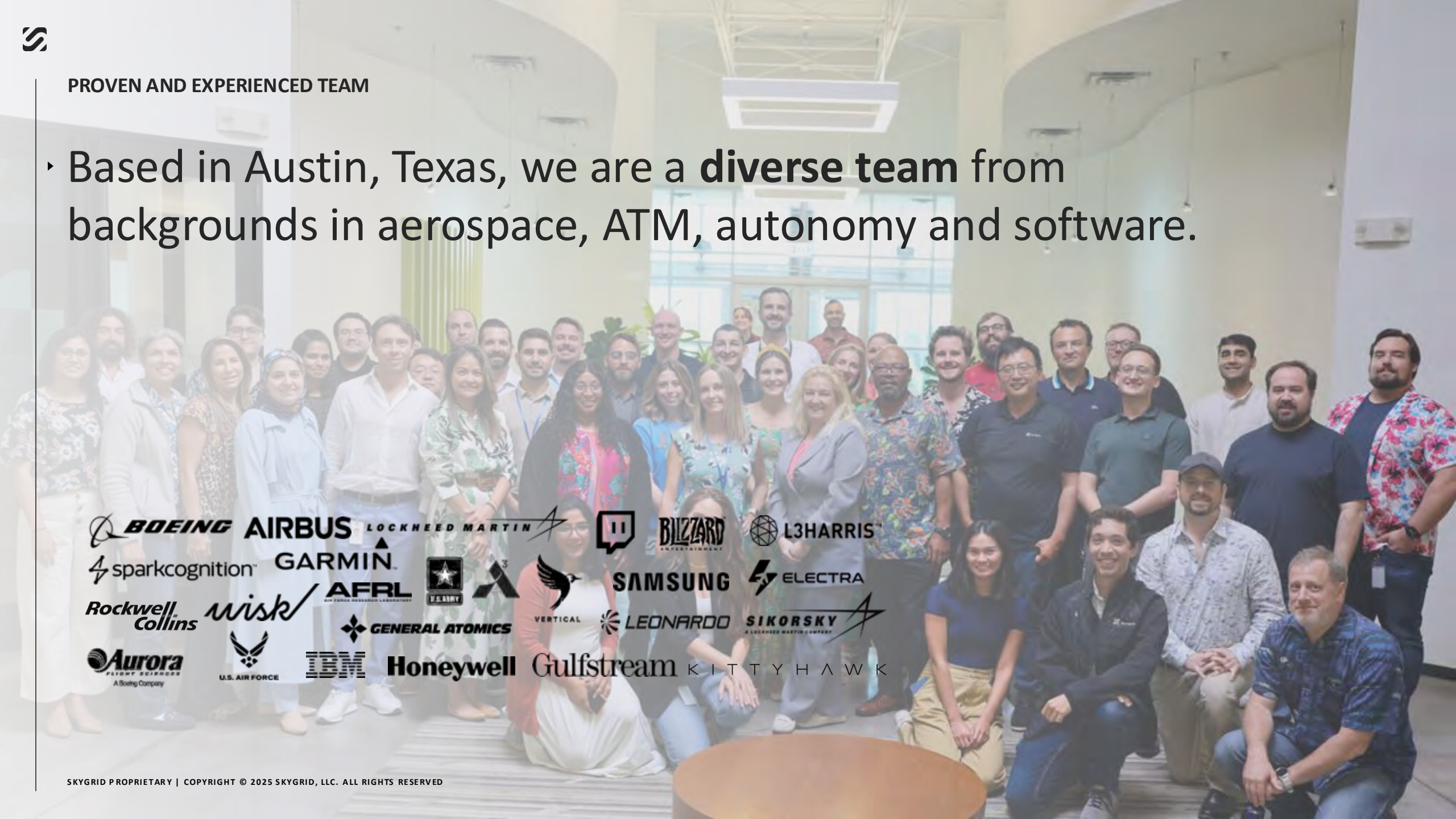
SKYGRID

Supporting the airspace integration of remotely supervised operations and Advanced Air Mobility

PROVEN AND EXPERIENCED TEAM

- Based in Austin, Texas, we are a **diverse team** from backgrounds in aerospace, ATM, autonomy and software.



WHO WE ARE

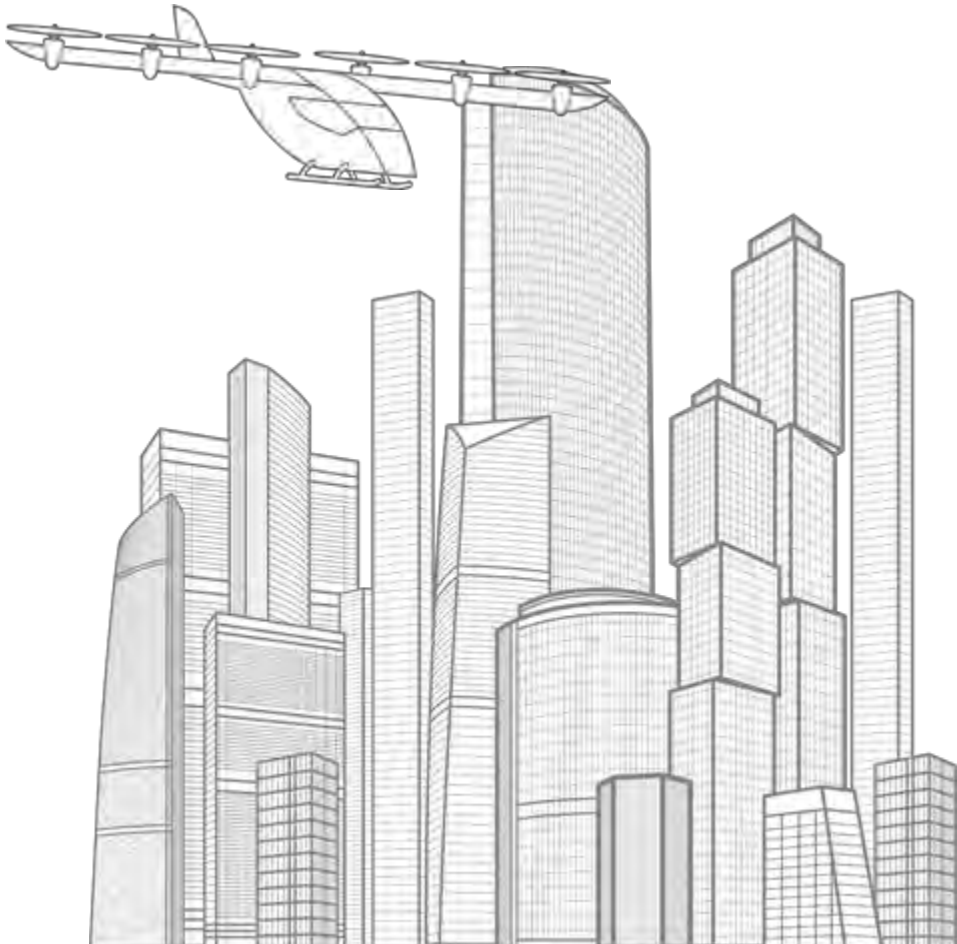
- SkyGrid builds **high-assurance** third-party services to enable the safe and efficient integration of AAM operations into the current airspace.

SKYGRID VISION

SkyGrid believes ground-based, third-party services will be a key enabler of Advanced Air Mobility (AAM) and remotely supervised operations.

SkyGrid services will support AAM in key objectives:

1. Support the airspace integration of AAM operations in the **current** NAS.
2. Support the **future scaling** of AAM operations, potentially beyond the constraints of the current NAS.
3. Support operational efficiency of AAM operations.



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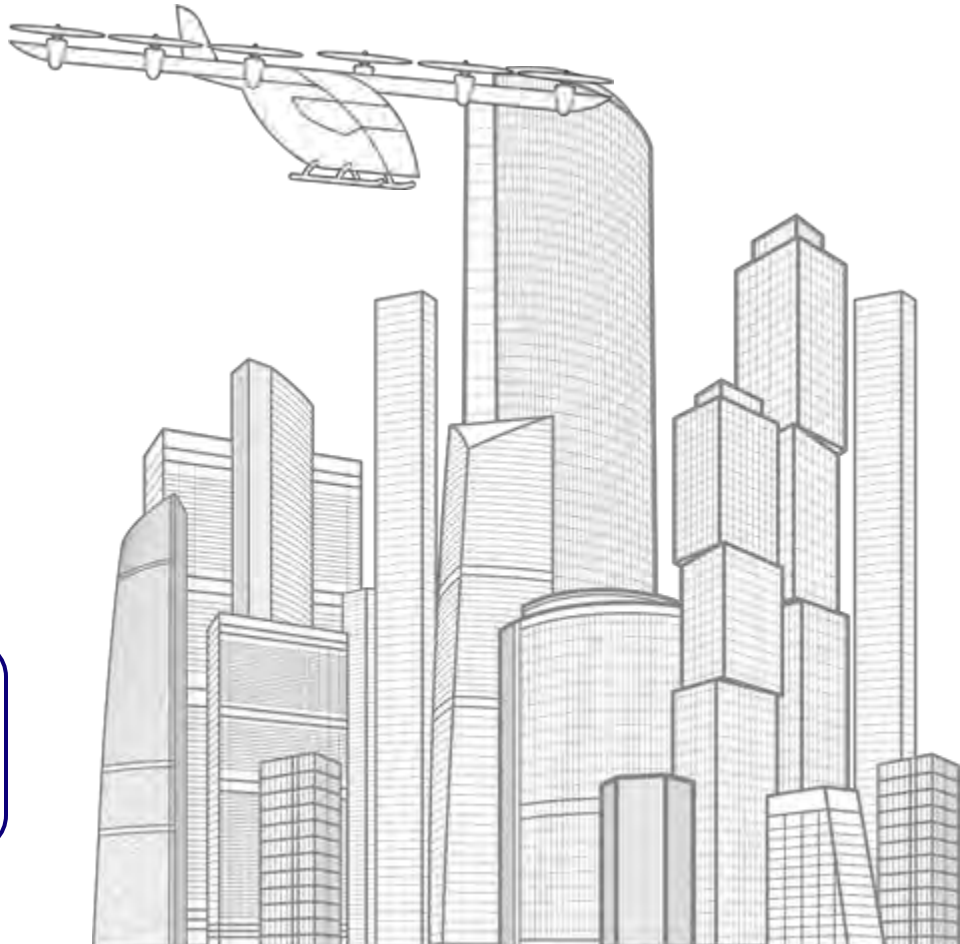
1. Support the airspace integration of AAM operations in the **current** NAS.
2. Support the **future scaling** of AAM operations, potentially beyond the constraints of the current NAS.
3. Support operational efficiency of AAM operations.

SkyGrid is contributing to these objectives by developing a **high-assurance** platform that will provide **data** and **decision support** services to AAM operators.



AAM MARKET SEGMENTS

Segment		Example Use Case	Integration Challenges and Opportunities
1.	 High assurance sUAS	BVLOS delivery and inspection in populated areas	• Meeting strict safety targets in dense airspaces. • Real-time traffic and DAA in low-altitude env.
2.	 Uncrewed CTOL	Middle-mile and regional cargo operations over remote areas and hub airports	• Reliable traffic awareness in areas with limited infra. • Seamless ATC coordination across diverse regions.
3.	 Crewed eVTOLs	Intra and inter-city short-range passenger operations Secondary cargo missions	• Safe, energy-efficient ops in congested airspaces. • Predictable flights to ensure customer satisfaction. • Scaling without overloading airspace systems.
4.	 Uncrewed eVTOLs		• Ensuring comprehensive low-altitude data coverage. • Integrating safety critical data into a reliable system. • Real-time monitoring and decision-making support.

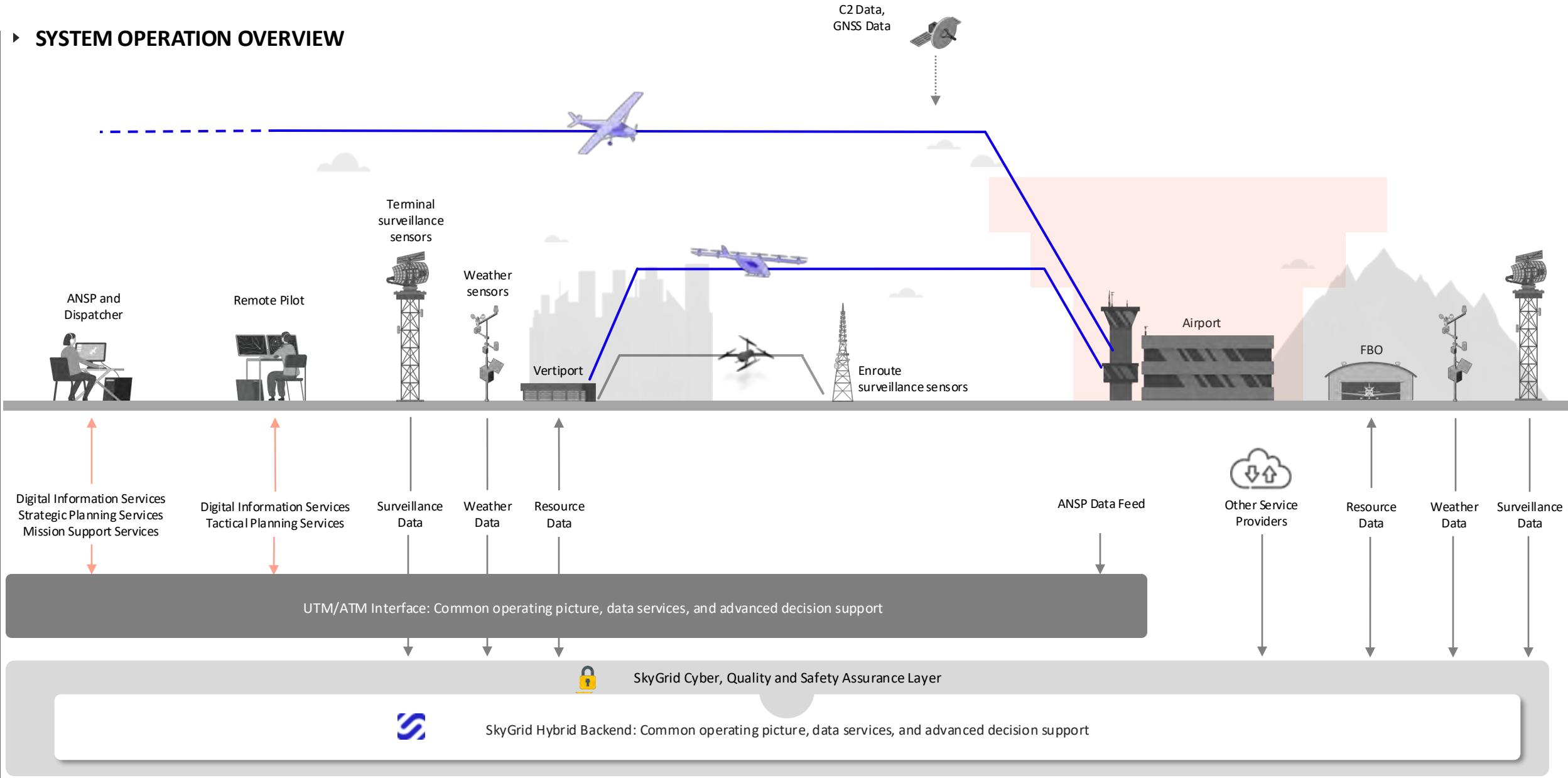
SKYGRID TSP VS. UTM

UTM	SkyGrid TSP
Support **low-risk operations** with simplified approval	Will be certified for **safety-of-life** operations
Enterprise software development paradigm	Aeronautical pedigree and system **design assurance**
Primarily support **sUAS**	Support **AAM and UAS** with aviation-grade functions
Primarily **volume-based** operations	Primarily **trajectory-based** operations (4DT)
Designed for low-altitude **segregated** airspace	Designed for **integrated** airspace and corridors

Provided by Third Parties or ANSPs

Natively digital, federated, connected, and automated to enable scaled operations

SYSTEM OPERATION OVERVIEW



SKYGRID SERVICES FOR AAM INTEGRATION

*SkyGrid seeks to assure data **quality**, **latency**, and **traceability** to enable safety-critical applications.*

Digital Information Services

Provide operators with a high-fidelity “digital twin” of their operating environment on a high-assurance platform.

- Terrain and Obstacles
- Weather
- Ground-Based Traffic Surveillance
- Aerodrome and Airspace Data
- Notice to Air Missions (NOTAMs)
- CNS Coverage and Status

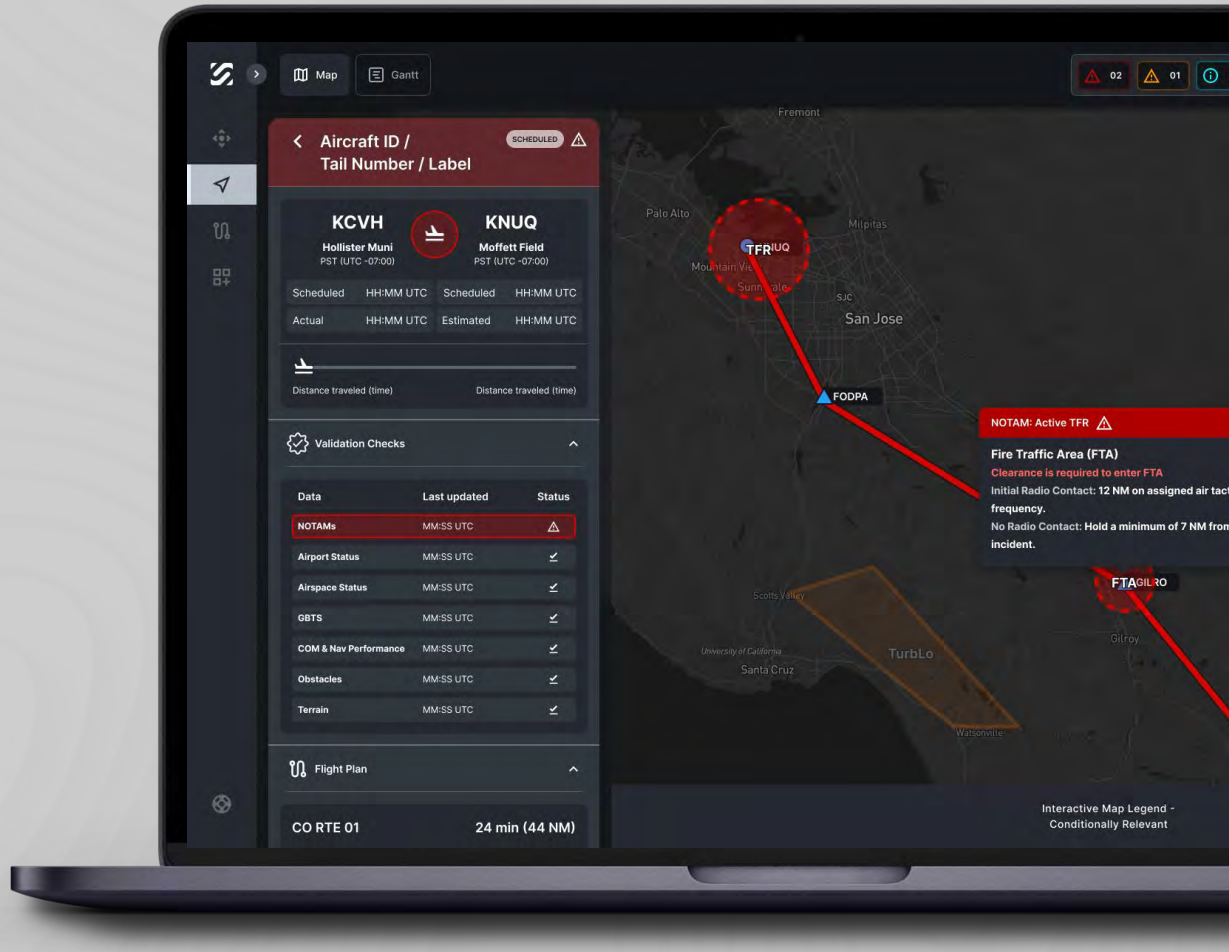
SKYGRID SERVICES FOR AAM INTEGRATION

*SkyGrid seeks to assure data **quality**, **latency**, and **traceability** to enable safety-critical applications.*

Strategic Planning Services

Help operators plan safe, efficient, and optimized AAM operations utilizing our trusted digital information services.

- Flight Plan Validation
- Advanced Flight Planning
- Demand-Capacity Balancing
- Traffic Synchronization



SKYGRID SERVICES FOR AAM INTEGRATION

*SkyGrid seeks to assure data **quality**, **latency**, and **traceability** to enable safety-critical applications.*

Tactical Planning Services

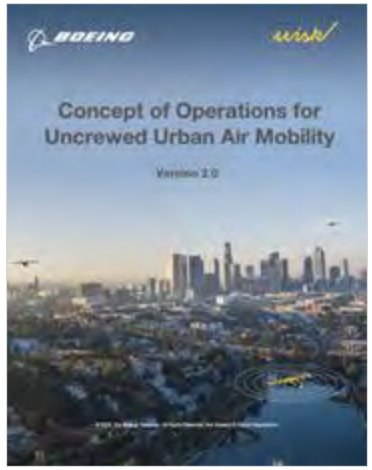
Help operators monitor live operations and make real-time decisions against complex airspace constraints and hazards

- Ground-Based Detect and Avoid
- Dynamic Rerouting
- Hazard and Constraint Monitoring
- Flow Management
- Conformance Monitoring

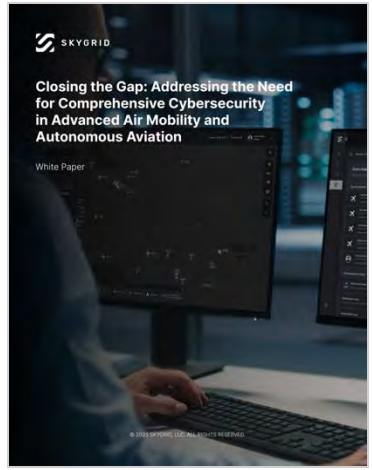
CURRENT PUBLICATIONS

- **Approval Basis**: define remote digital systems as a new certification category

- **CONOPS**: clarify product intent, system boundary and integration approach



- **White Papers**: ID opportunities and gaps in AAM integration and operations



- **Help needed:** regulatory feedback. Rulemaking for safety-of-life third party services and PSU functions to enable AAM.

TIMELINE TO COMMERCIALIZATION & OPERATIONS AT SCALE

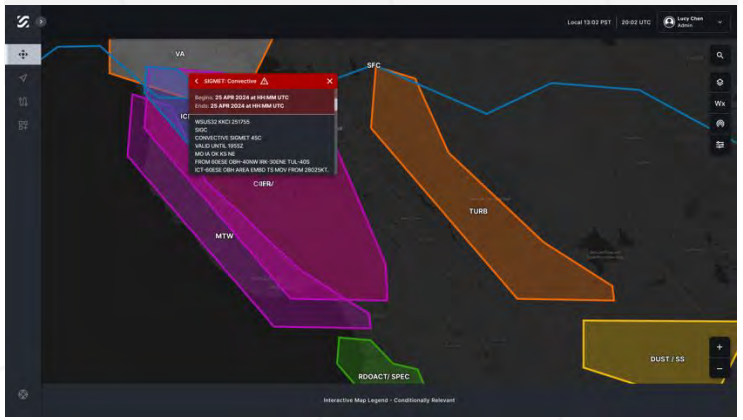
2026

Assured Foundation

Build **foundational** third-party services platform to improve safety and efficiency

> Autonomy is business

> Plumbing matters



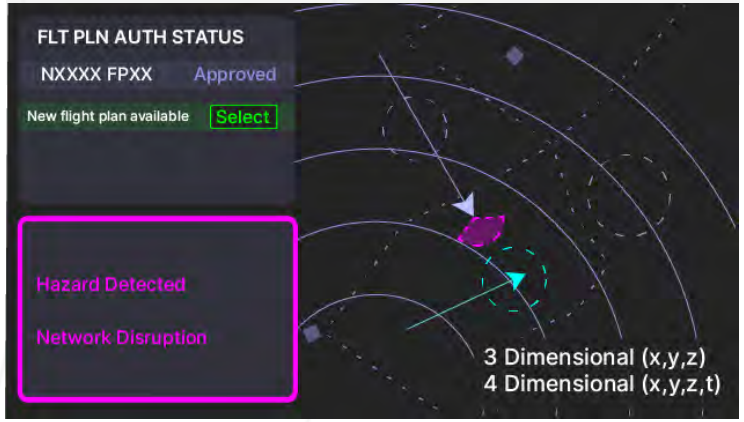
2028

Advanced Functions

Deliver **approved** tactical and strategic functions. Enable aviation autonomy

> AAM needs an approved platform

> Rethink data, functions for autonomy

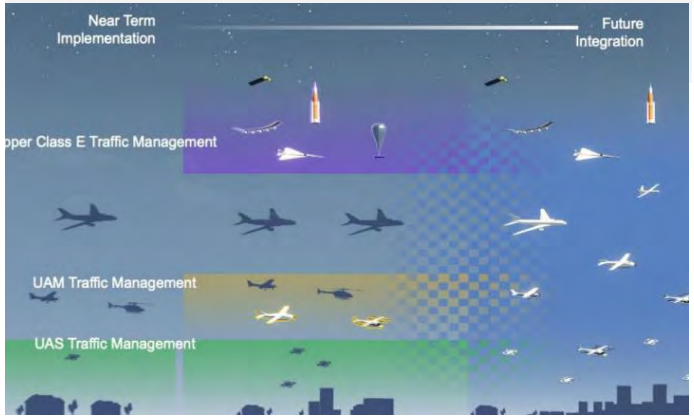


2030

Aviation Unleashed

Deliver **airspace automation** for ANSPs and as a TSP. Improve airspace safety and efficiency

> ATM must scale with advanced aviation



OPERATIONAL APPROVAL FOR EIS

- SkyGrid TSP system **will**:
  - Help operators satisfy FAA Part 135 and Part 91 requirements
  - System validated and verified to operations defined in ConOps
  - Address operational risks and build a complete safety case
  - Address cybersecurity for critical Infrastructure
  - Address aviation-grade quality assurance

- SkyGrid is seeking operational approval **for novel distributed digital services**

- CASA can help **advance the operational approval** framework for a Third-Party Service Provider.

Texas Defense Aerospace Manufacturing Community

Texas Defense Aerospace Manufacturing Community (TDAMC) DFW Regional Kickoff

APRIL 2025

U.S. Department of Defense
Office of Local Defense Community Cooperation

TEES | Texas A&M Engineering Experiment Station

Agenda

1. **Welcome & Introductions**
   Opening remarks & attendee introductions
2. **Purpose & Goals**
   Importance of smart manufacturing in defense aerospace
3. **Community Feedback**
   Discuss key challenges & opportunities
4. **Action Items & Next Steps**
   Assign responsibilities & set next meeting date
5. **Current Offerings**
   MIIs
   Contractors

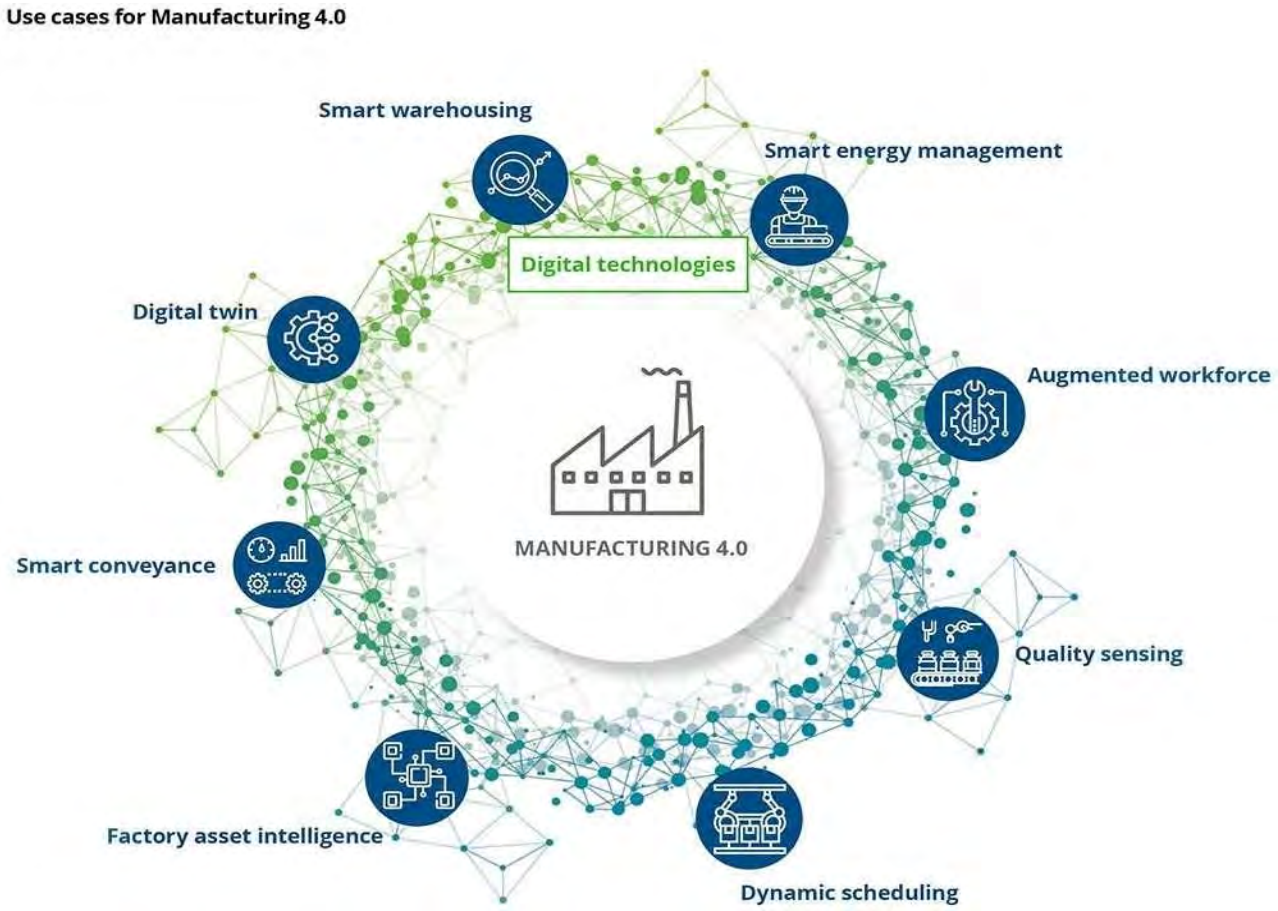
Texas A&M Engineering Experiment Station

Introductions

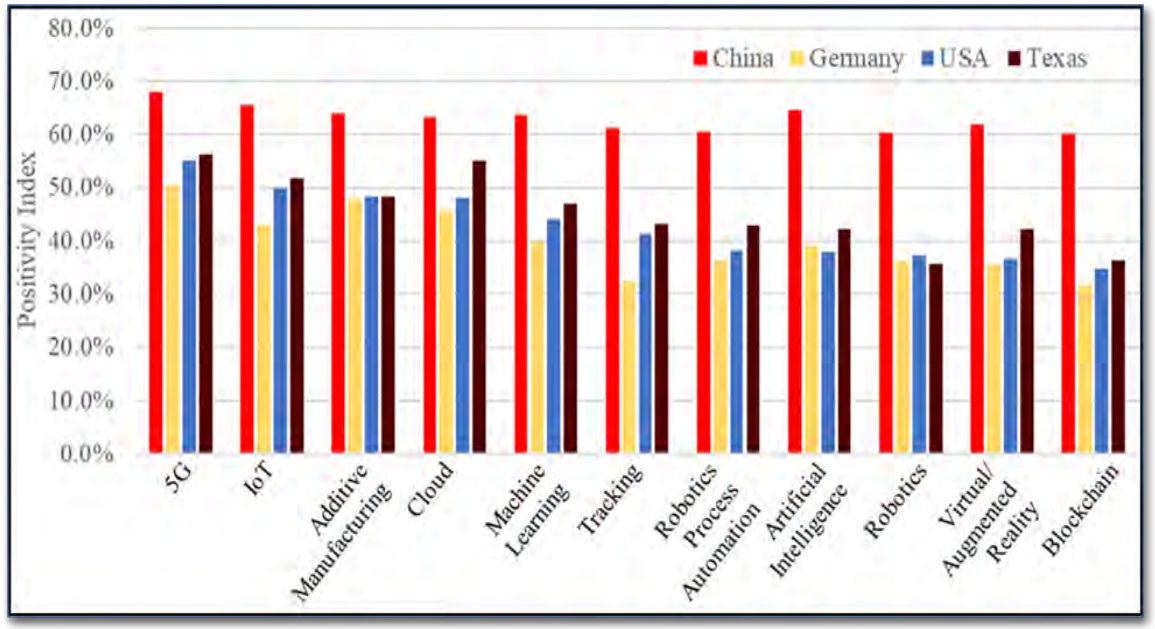
Texas Defense Aerospace Manufacturing Community

TDAMC Mission

TDAMC will galvanize a **Smart Manufacturing (SM) ecosystem** for defense aerospace manufacturing in Texas by **injecting SM skills and technologies** to **accelerate the growth of a strong, resilient, responsive and competitive supply chain.**



Why Smart Manufacturing?

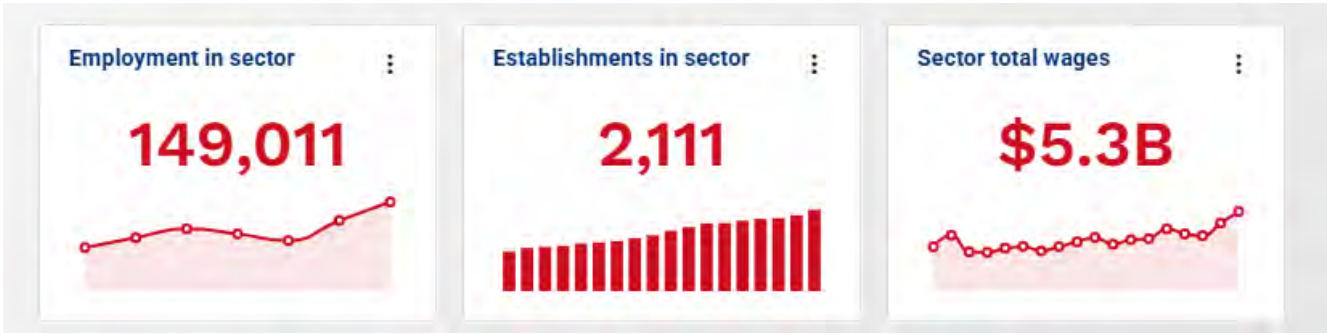


Data collected in a 2022 survey conducted by TEES and Deloitte finds that the U.S. lags behind competitors, such as China, in technology positivity.

Why Texas?

Continued Growth!

AEROSPACE, AVIATION AND DEFENSE EMPLOYMENT GROWTH



133,444 in 2021

1,832 in 2021

$3.4B in 2021

TDAMC Regional Opportunities

- Incentivize and support smart manufacturing modernization
- Activate, align, integrate disconnected communities
- Leverage anticipated population growth
- Identify & narrow the skills gap
- Inject targeted SM skills & tech

TDAMC Regional Gaps

- Ineffective Smart Manufacturing adoption
- Industry slow to adopt smart manufacturing
- Failure to attract and retain talent
- Change-resistant culture
- Mis-aligned Skills

Key Priorities

Based on the community assessments and stakeholder input, TDAMC developed prioritized needs addressing the previous challenges to deliver impactful outcomes.

01

Regional Network & Support Services

A platform for SMMs who want to present their capabilities and certifications to new customers and DoD procurement teams, while discovering, connecting, and collaborating with new partners and suppliers, and provides a system that illuminates the supply chain for government contracts, and directly connects customers to manufacturers

02

DoD Policies & Opportunities

Training, workshops and consulting services to individual manufacturing or family of businesses that assist the owner/operator in understanding and meeting DoD policies, provides insights into DoD contract opportunities and best practices for contract bidding

03

Smart Manufacturing for SMMs

Training, workshops and consulting services tailored specifically to SMMs that helps owners/operators understand basics of advanced or smart manufacturing, demonstrates how it can be used to lower production costs and quality risks, illustrates ROI scenarios, and guides them through a step-by-step roadmap to implementation and system integration

04

K-12 Manufacturing Jobs & Careers Pipeline

A manufacturing skills workforce ecosystem that emphasizes sustained collaboration between local community, government, academia, and industry, promotes the positive perception of manufacturing, and accelerates students through STEM training and development, and and workers into re-skilling and up-skilling pipelines, at appropriate scale and velocity for the region

Community Feedback

- **What have you heard from your community and what is needed most?**
  - **Marketing – Breaking into new markets**
  - **CMMC Assessment / Certification**
  - **Funding Opportunity**
  - **Technology Training / Awareness / ROI**
  - **DoD Contracts**
  - **Building Smart Manufacturing Advocates**

Current Offerings – TEES

Texas Defense Aerospace Manufacturing Community

TDAMC Member Learning Lounge


Machining


Additive Manufacturing


Cybersecurity

Computing & AI


Project Management


Custom Training Request

Current Offerings – Apex Accelerator

Texas Defense Aerospace Manufacturing Community

GovCon 101: Prerequisite to 2.0

CROSS TIMBERS
APEX Accelerator

The University of Texas at Arlington - TMAC | COURSE

Thu, April 03, 2025 @ 09:00 AM — 03:00 PM (CDT)

Building opens at 8:00AM for breakfast and check in, no early entry.
9am – 3pm
UTARI Campus
7300 Jack Newell Blvd. S.
Fort Worth, TX 76118

Registration - $45.00
Includes:
Breakfast, lunch & parking
Receive Hands-On Assistance With:
- SAM.gov Registration
- Creating Capabilities Statements
- Level 1 Cybersecurity
- Marketing and Forecasting

…….. and more!

*It is recommended that you bring a laptop and or tablet and a refillable water bottle. Power outlets are available but limited. Drinks will be provided during breakfast and lunch. Vending machines are available in the cafeteria as well as a water machine and ice.

Current Offerings - CESMII

Explore	Assess	Focus	Roadmap	Execute & Sustain	Validate
What's possible?	**YOU ARE HERE**	**Challenges/Opportunities**	**Business Drivers**	**SM Foundation**	**Validate Success**
Attend Events	**Current State**	Business Drivers	Key Milestones	Establish Infrastructure	Business Value
Check Competitors	Competitiveness	Value Proposition	1-3 Year Plan	**Implement Solutions**	Impact
Understand Options	Market Readiness	**Future State**	**Project Definition**	Quick Wins – Agile	Timelines
Challenges Addressed	People/Process/Technology	Technology-enabled Strategy	Scope, Business Case	People/Process/Technology	
Success Stories	**Current Opportunities**	Select Solutions, Path		**Change Management**	
Why SM for us?	Educate Leaders	People/Process/Technology		**Knowledge Transfer**	
Democratized Technology				Training and Adoption	
Seek Demonstrations				**Support**	
Pilot Technology					

Current Offerings – Olympus Controls

Texas Defense Aerospace Manufacturing Community

Olympus CONTROLS

TEES Texas A&M Engineering Experiment Station

Current Offerings – MXD Learn

MXD Learn Sensor Kit – Smart Manufacturing for Small & Medium Manufacturers

🛠 What is It?

- A hands-on sensor kit designed to help **small and medium manufacturers** adopt **smart manufacturing**.
- Provides real-time data on **temperature, vibration, humidity, and more** for predictive maintenance.

Why It Matters?

✅ **Affordable & Easy to Use** – Plug-and-play setup with minimal training.
✅ **Industry-Ready** – Supports **digital transformation** with real-time insights.
✅ **Boosts Efficiency** – Helps prevent machine failures and reduce downtime.
✅ **Tech to SMMs** – Increase positive perceptions about SM to experienced shops.

Current Offerings - CYMANII

Texas Defense Aerospace Manufacturing Community

CYMANII Learning Library

Developed by leading cybersecurity experts, the Learning Library provides tailored on-demand cybersecurity training courses, webinars, and upcoming workforce initiatives for manufacturers and professionals in IT/OT

UTSA CYBER RANGE POWERED BY CYMANII

The Cyber Range is a state-of-the-art classroom and learning lab designed for hybrid learning aimed to upskill students and professionals in cybersecurity awareness. A series of training programs are available. **Live fire exercise - FREE**

MOBILE TRAINING VEHICLE

The Mobile Training Vehicle (MTV) provides all the advantages of the Cyber Range but in a remote capacity, giving manufacturers and university students the opportunity to detect, identify, and effectively mitigate cyber threats.

C4M HUB

The Cybersecurity For Manufacturing (C4M) facility supports manufacturers by providing access to applied research, engineering support, and hands-on workforce training in secure smart manufacturing.

Current Offerings – ARM Institute

- Smart Manufacturing Assessments
- Workforce Readiness
- De-risking robotics for manufacturing.

ARM Institute's Robotics Manufacturing Hub Delivers Free Proof-of-Concept for Keystone Ridge Designs, Leading to Robotics System Installation

Current Offerings – America Makes

- **Technology analysis tool**
  - **Simulated cost table ROI**
- **Microlearning for C-suite**
- **Mini expo – Machines**
  - **Metal additive**
- **Prepare to be profitable**
- **Tooling U**

APRIL 29-MAY 1: INTRODUCTION TO ADDITIVE MANUFACTURING WORKFLOW (3-DAY IN-PERSON)

In-Person Training

8:00 AM - 5:00 PM (MT)

- **Register Here (20 spots available):** https://utep.questionpro.com/IntrotoAMWorkflow04-29-25

This course will:

- Identify the seven process categories of Additive Manufacturing (AM)
- Understand the AM workflow (design, fabrication, etc.)
- Recognize the limitations of AM
- Design parts using Computer Aided Design (CAD)
- Prepare parts for printing using slicing software
- Apply concepts to a final project for evaluation

THIS COURSE IS PROVIDED THROUGH DRIVE AM FUNDING - NO FEE FOR DOD PARTICIPANTS.

NEW! GENERAL ADDITIVE MANUFACTURING FOUNDATION SMART COURSE (ASYNCHRONOUS)

Self-Paced Training

- **Register Here:** https://utep.questionpro.com/GAMSmartCourse

This course will:

- Compare traditional manufacturing methods to additive manufacturing, establishing a foundation for understanding key differences
- Explore the history, principles, and commonly recognized benefits of additive manufacturing
- Gain in-depth knowledge of the seven ISO/ASTM-defined process categories in additive manufacturing and their applications
- Analyze design considerations and the role of support materials across different process categories, including connections to reverse engineering techniques

THIS COURSE IS PROVIDED THROUGH DRIVE AM FUNDING - NO FEE FOR DOD PARTICIPANTS.

TDAMC: Next Steps

Please Distribute:

Industry Needs Survey

Questions?

City of Arlington Multimodal Delivery Demonstration

North Texas UAS Task Force

April 29, 2025

Project Overview

- Project Description:
  - Test and evaluate innovative, autonomous food delivery
  - Using electric, autonomous air and ground robots for deliveries
  - Study public adoption trends and energy benefits
- Two year project, with funding from the US Department of Energy
  - Promote innovation in transportation to deploy clean energy technologies
- Project Team:

ARLINGTON
THE AMERICAN DREAM CITY

North Central Texas Council of Governments

TARRANT AREA FOOD BANK

UNIVERSITY OF TEXAS ARLINGTON

airspacelink™

CLEVON

AERIALOOP
DRONE DELIVERY AIRLINES

First Delivery Demonstration

Dates: September 9 to 13, 2024
Location: East Arlington neighborhoods
Target Participants: Food Bank clients, other residents
Goal: 150 grocery box deliveries

1. Food Bank packs grocery boxes
2. Aircraft transports grocery box from hub to distribution point
3. Grocery box transferred to ground robot
4. Ground robot transports boxes to participant home

Vehicle: Aerialoop ALT 6 VTOL

- Speed: 50 mph
- Payload: 9 pounds
- Range: 25 miles
- Redundant rotors
- Built-in ballistic parachute
- Vertical take-off and landing, transitions to forward flight

Dimensions:

- Wingspan: 8½ feet
- Length: 6 feet

Demo 1 Aircraft Route

Air Robot Route (~0.45 miles)

Within City-owned park land

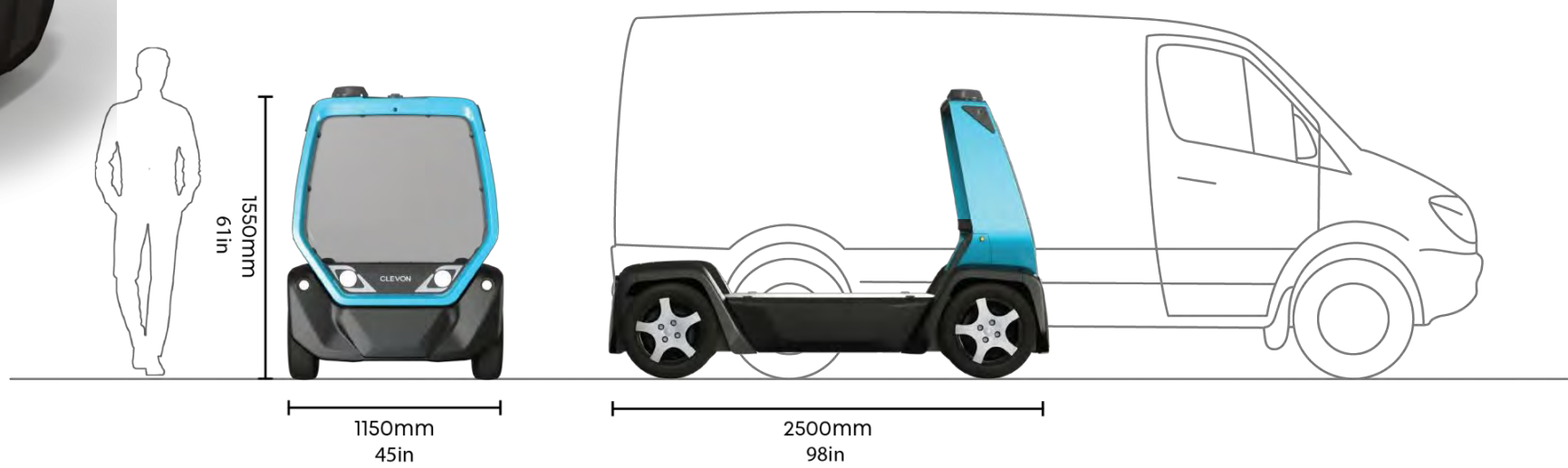
One street crossing, monitored

Pilot on each end of route, maintained visual line of site

No FAA waiver required

Vehicle: Clevon Autonomous Robot Carrier*

- Speed: 15 mph max on 40 mph roads
- Sensors: 360 degree view
- Power: fully electric
- Range: 50 miles per charge
- Charging: ~1 hour

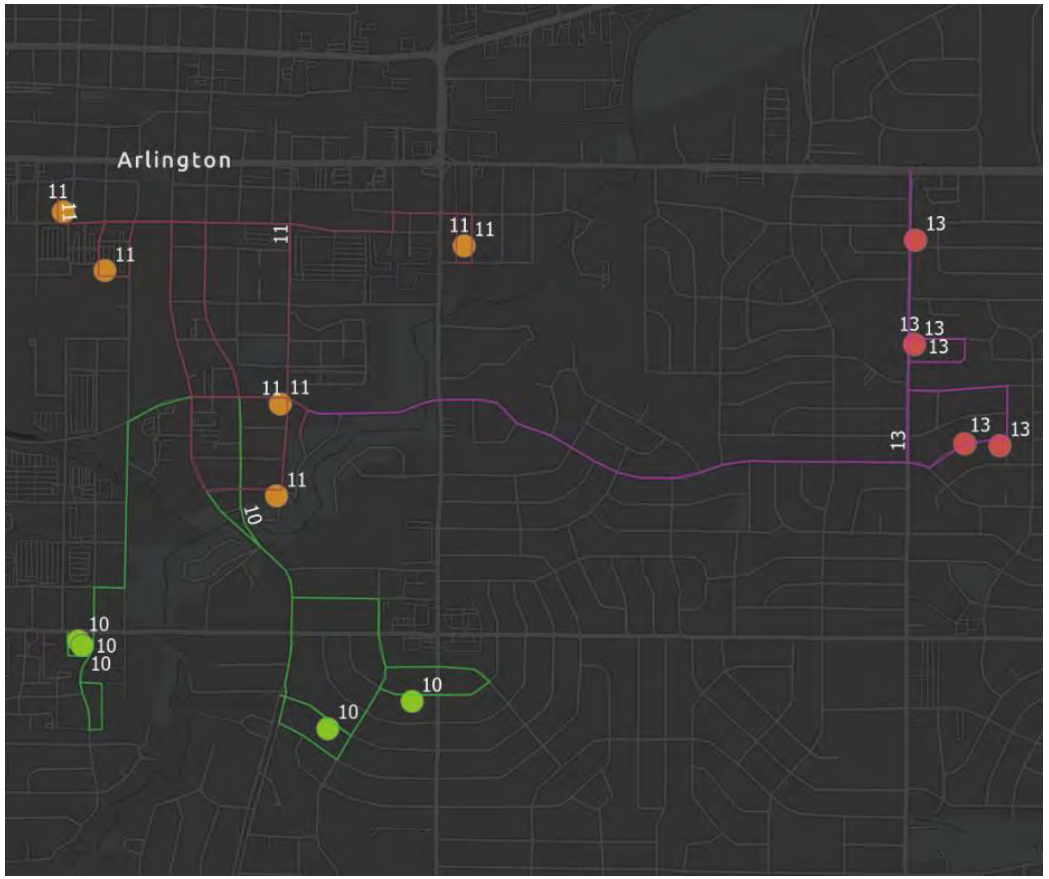


*Clevon is only participating in Demonstration 1

Ground Routes

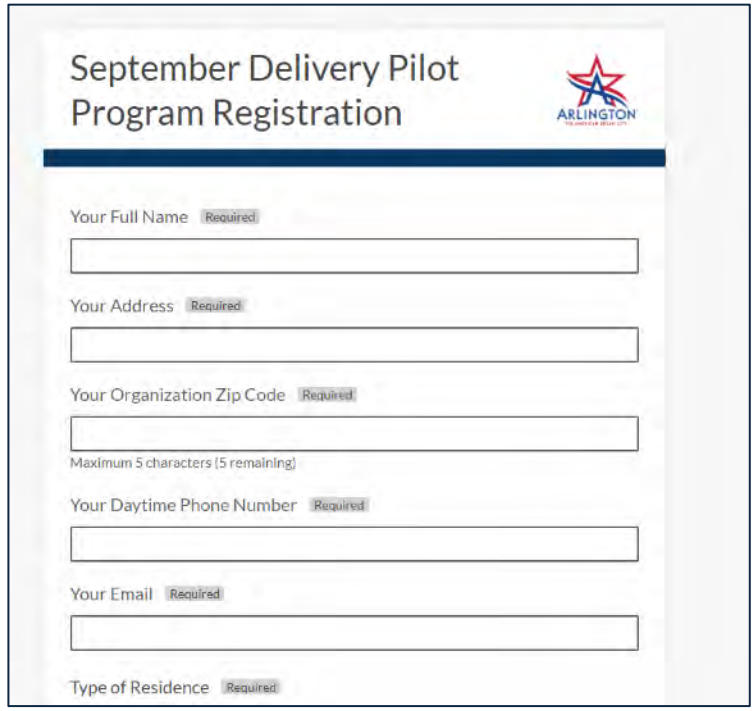
Eligible Delivery Zone (3.5 sq miles)

Ground Robot Example Routing



Participant Experience

1. Participants sign up online or by calling the City.
2. City verifies address and adds delivery to the route plan; participants notified of delivery date, time window, and code to open delivery bay.
3. On delivery date and time, participants wait for the ground robot to roll up to their residence.
4. Type in unique code to receive grocery delivery.
5. Fill out a quick survey about the experience.



Results – Flight Operations

81 grocery boxes transferred

162 flights total

Date	Time Range	Total Flights	Total Grocery Boxes	Battery Charges
Mon, Sept. 9, 2024	10:33 – 16:26	28	14	7
Tue, Sept. 10, 2024	8:34 – 16:40	38	19	10
Wed, Sept. 11, 2024	8:41 – 13:33	24	12	6
Thurs, Sept. 12, 2024	8:30 – 17:08	60	30	15
Fri, Sept. 13, 2024	8:42 – 11:04	12	6	3

Results – Ground Operations

139 grocery boxes delivered

26 routes total

Date	Time Range	Routes Completed	Total Grocery Boxes	Hand Delivered
Mon, Sept. 9, 2024	9:57 – 15:26	5	25	4
Tue, Sept. 10, 2024	10:00 – 14:59	6	33	9
Wed, Sept. 11, 2024	9:10 – 13:16	5	27	6
Thurs, Sept. 12, 2024	8:53 – 13:36	5	27	15
Fri, Sept. 13, 2024	10:14 – 14:32	5	27	13

Results - Participant Survey

Satisfied with delivery service?

94% very satisfied and satisfied

Easy to access groceries?

98% very easy and easy

Delivery process feel secure?

96% very secure and secure

Likely to use service again?

94% very likely and likely

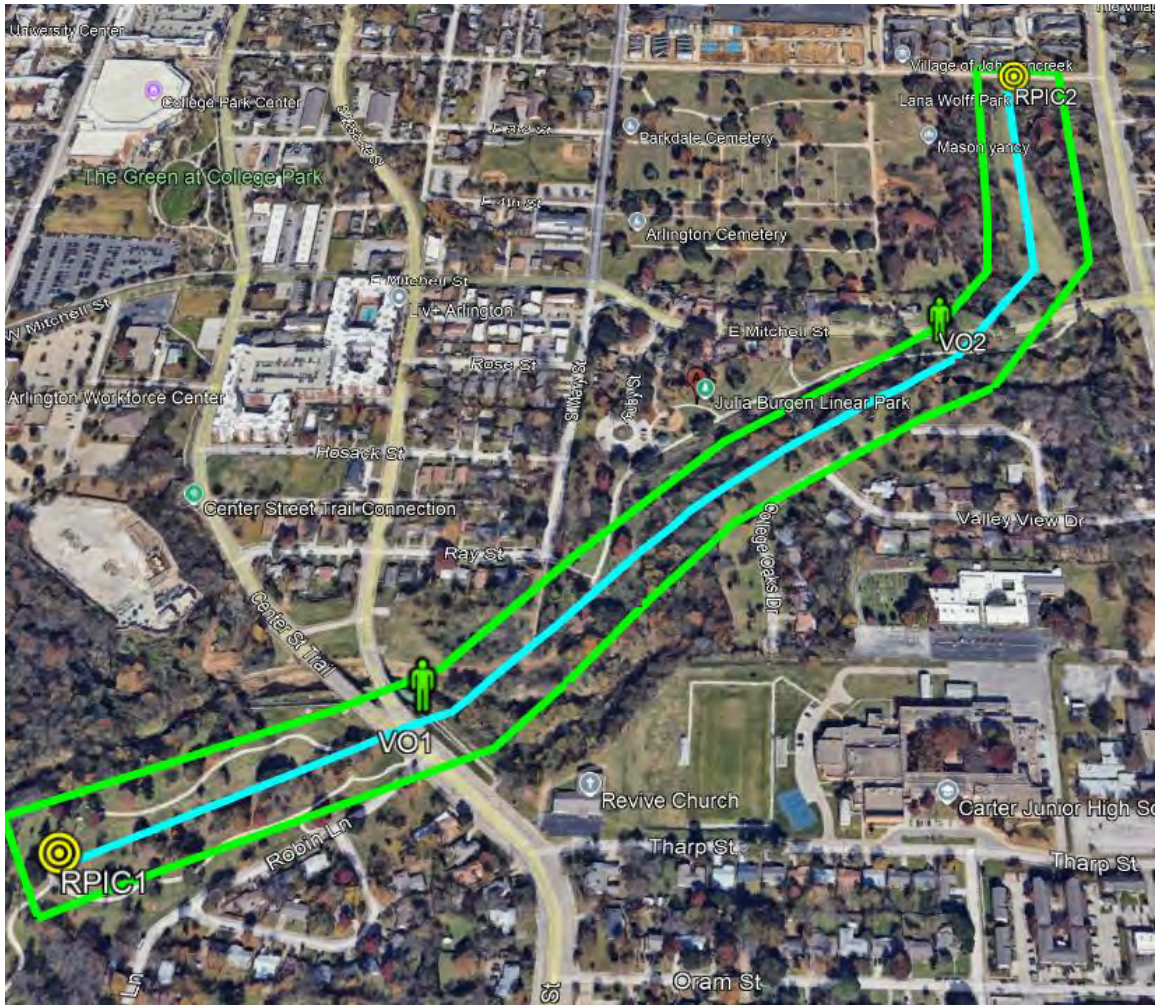
Demonstration 2 Plans

Goals:

- Complete >150 deliveries
- Onboard new ground robot provider - Mozee
- Expand flight path for aerial robot
- Allow participants more control over delivery times
- Gather more post-delivery survey responses
- Streamline food packaging process

Demo 2 Aircraft Route

Air Robot Route (~1 mile)



150+ more deliveries

Extension of original route

BVLOS, OOP, OOMV wavier from the FAA with two street crossings

Pilot on each end of route, visual observers strategically placed to maintain air safety

Next Steps

- Finalizing plans for Spring 2025 demonstration – May 12 to 16
  - Apply lessons learned from Demonstration #1
  - **Media and visitor event May 14 from 9am to 10am**
- Final reporting and deliverables
  - Cost Model
  - Energy and Emissions Analysis
  - Scalability and Replication Guide

Discussion

Jana Wentzel, AICP
City of Arlington
Jana.Wentzel@arlingtontx.gov

Bruce Briglia
Airspace Link
Bruce.Briglia@airspacelink.com

the technology event for

AUTONOMY

XPONENTIAL is the premier gathering for the uncrewed, autonomous, and robotic systems community, bringing together technologists, policymakers, and end-users to explore the latest breakthroughs and drive innovation.

XPONENTIAL™

MAY 19 - 22, 2025 | EDUCATION
MAY 20 - 22, 2025 | EXHIBITS
HOUSTON, TX

WHY ATTEND

- **Cutting-Edge Exhibits** | Explore the XPO Hall, featuring the latest innovations in uncrewed and autonomous technology.
- **Comprehensive Conference Programming** | Lead the way toward an autonomous future through daily keynotes, workshops, and breakout sessions. Experts from across the industry lend their perspectives and experiences to help you navigate changing regulations, constantly
- advancing technology, and integration hurdles. **Networking Opportunities** | Connect with

  global peers, industry leaders, and potential partners to share use cases, experience new

  technologies, and solve real problems together.

XPONENTIAL™

PROGRAM OVERVIEW

- **Keynotes |** Start each day with visionary insights on policy, technology, and industry trends shaping autonomy.
- **Breakout Sessions |** Explore industry-specific topics through expert panels and interactive discussi ons.
- **Workshops |** Gain hands-on experience in focused training sessions led by industry leaders.
- **AUVSI Defense |** Dive into national security and defense applications of uncrewed systems.
- **Innovation & Solutions Theaters |** Discover cutting-edge technologies and real-world solutions from industry pioneers.
- **Working Groups & Special Meetings |** Collaborate with peers on critical industry initiatives.
- **STEM Initiatives |** Support workforce development and education in autonomy and robotics.
- **Co-Located Events |** Extend your experience with specialized sessions alongside XPONENTIAL.

XPONENTIAL™

THE XPO HALL

- Technology Pavilions
- State and International Pavilions
- Solutions Theater + Innovation Theater
- Defense Technologies Zone + Defense Theater
- Industry Podcasts
- STEM

XPONENTIAL™

WHO ATTENDS

XPONENTIAL attracts researchers, executives, engineers, program managers, policymakers, and end users from various sectors, including defense, public safety, critical infrastructure, and transportation.

What Attendees Are Saying

"XPONENTIAL is a prime experience for understanding uncrewed technology and where it's heading."

"Our engineering team can learn about cutting-edge technology and gather crucial information over a few days instead of setting up numerous individual meetings over several months."

XPONENTIAL™

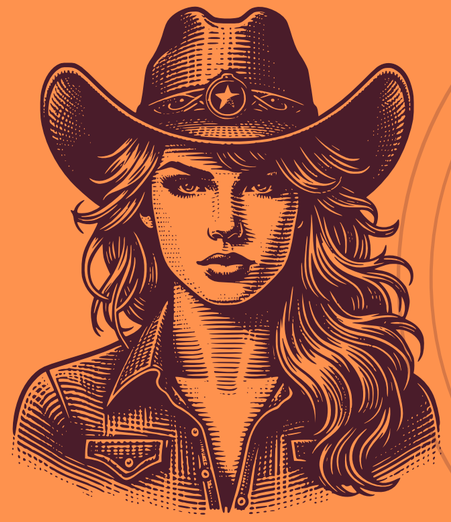
AUVSI
LONE STAR

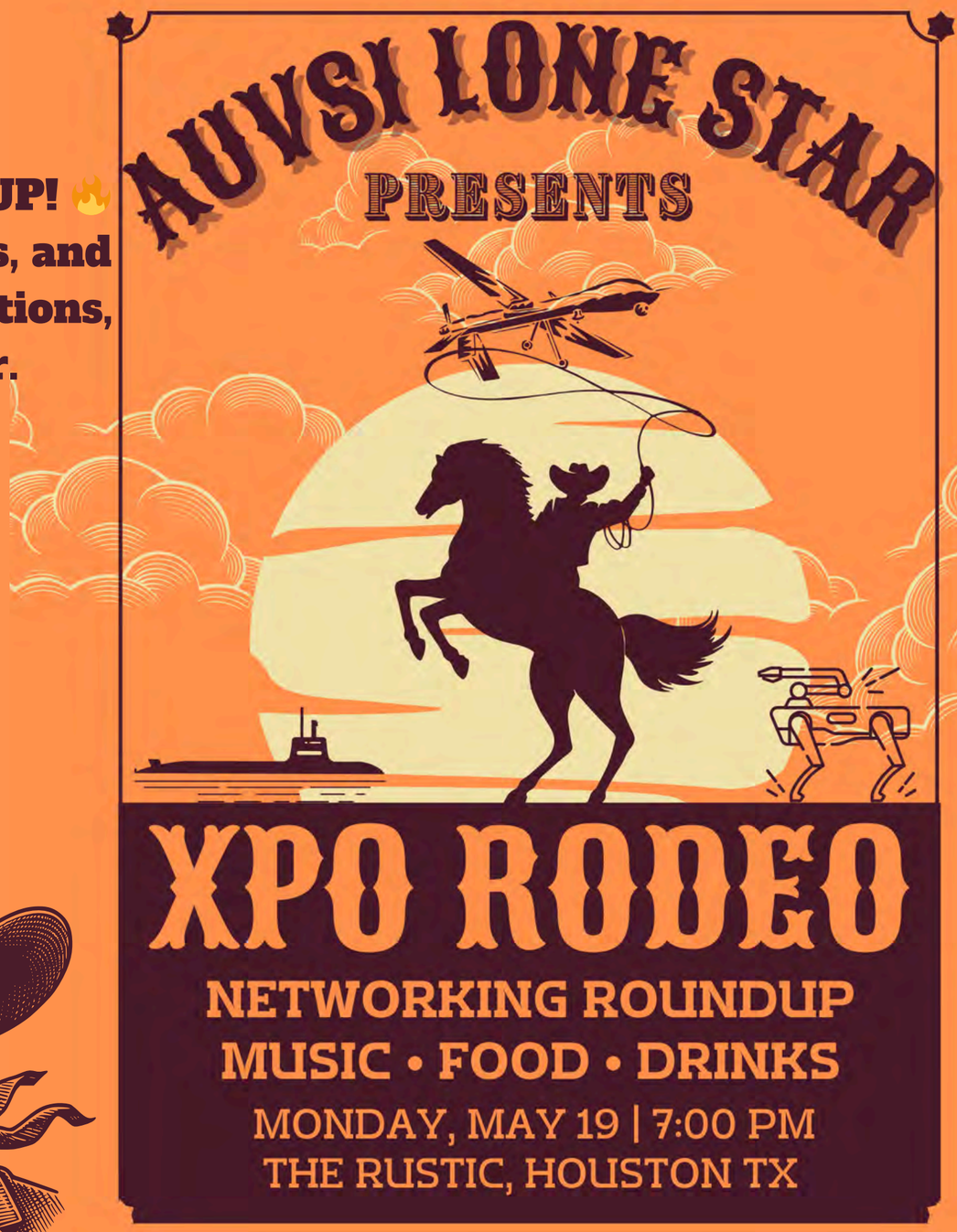
🔥 XPO RODEO – THE ULTIMATE NETWORKING ROUNDUP! 🔥

Saddle up for an unforgettable night of music, food, drinks, and networking! Meet industry leaders, make valuable connections, and enjoy a Texas-style rodeo experience like no other.

🌟 What to Expect:

🎵 **Live Music with Country Star Luke Whitney**
🌮 **Legendary Tex-Mex Food & Bar included**
🤖 **Cutting-Edge Tech Meets Cowboy Culture**
🤝 **Exclusive Networking Opportunities**
Houston's Biggest Drone Light Show
📅 **Monday, May 19 | 7:00 PM**
📍 **The Rustic, Houston, TX**





https://xporodeo.eventbrite.com

Don't miss the Xpo Rodeo — the premier networking event in the world's largest autonomy ecosystem! With over 25,000 square feet of dynamic indoor and outdoor space, you'll have unmatched opportunities to connect, collaborate, and innovate with top industry leaders, startups, and visionaries shaping the future of autonomy.

Benefits for our "Partners"

- Influential Decision Makers: The event will attract influential decision-makers from the industry, regulatory and community leaders creating an ideal platform for in person networking and strategic business opportunities.
- Brand Visibility: Associate your brand with credible, cutting-edge technology and innovation, gaining exposure to a global audience.
- Demonstrate Leadership: Showcase your commitment to technological advancements and thought leadership to the largest autonomous technologies ecosystem.

AUVSI CHAPTERS

CONTACT: ADRIAN DOKO EMAIL: ADRIAN@AUVSILS.ORG

About autonom"Us"

Chapters are the heart of AUVSI, and create a culture of opportunities for networking with other industry professionals, involvement in community activities, STEM, outreach, and much more!

All proceeds from the event will be used to support the overarching non-profit mission of the AUVSI Chapters dedication to advancing awareness, education, and continued adoption of uncrewed and autonomous systems.

VISION

- Get Connected - Build your database of "go to" people in the industry that help you expand your business and advance your goals.
- Get Informed - Access industry best practices and specific ways you can capitalize on uncrewed/autonomous systems market opportunities.
- Get Involved - Contribute to the unified voice of autonomous systems as we advocate for policies and funding that encourage industry growth and innovation.

MISSION

- We connect thinkers, designers, makers, operators and users to share insights and ideas, to turn questions into answers, and create an ecosystem that learns from each other.
- We convene buyers and sellers to create market opportunities and commercial capacity.
- We communicate the value and benefits of uncrewed systems technology to the public and stakeholders.
- We collaborate with policy makers to implement effective and appropriate legislation and funding to fully and safely maximize the benefits of emerging technologies.

Economic Feasibility Study for Denton Vertiport

Presented to
North Central Texas Council of Governments
UAS Task Force

4/29/2025

Dr. Clinton Purtell
Mr. Ryan Adams

Dr. Seock J. Hong
Mr. Ferhat Caliskan

Survey for Economic Feasibility Study of Denton Vertiport

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We need your help and input! Please take our survey.

Survey link: https://unt.az1.qualtrics.com/jfe/form/SV_a2BIrg15l4xMkKO

In this presentation…

We need your help! Please take our survey.
https://tinyurl.com/mjn3tjz3

Overview of our academic / industry research for vertiport economic feasibility

Introduction to Denton Enterprise Airport

Establish operational categories of “vertiports”

Introduce the approach to economic feasibility for *scalable* eVTOL / AAM cargo and passenger services

Research Purpose

- The City of Denton is exploring the economic feasibility of a vertiport near Denton Enterprise Airport.
- UNT is conducting a feasibility study to evaluate potential benefits, market demand, and infrastructure needs, involving consultants for technical expertise (Skyway).
- The study will also identify key questions for future vertiport development planning.

DENTON ENTERPRISE AIRPORT

DFW ACCESS. EXTRAORDINARY BUSINESS.

Research Objective

Conduct an economic feasibility analysis to support the City of Denton and stakeholders for economic development planning.

- **Evaluate the economic feasibility** of a vertiport in Denton, TX, focusing on eVTOL service demand and exploring design and operational targets.
- **Analyze potential locations, designs, and business models for vertiport operations**, considering regulatory and environmental factors in design and construction.
- **Identify key infrastructure requirements** and potential sites near Denton Enterprise Airport to inform future airport master planning.

Inform further studies related to airport master planning and secondary analyses.

2024 Data

- **928** Acres
- **64** businesses
- **110+** acres of leased property
- **200,000+** annual operations
- **140,000+** gallons of fuel/month

2018 Economic Impact Study

1,435 jobs supported

$45.8M in annual payroll

$156.3M local economic impact

Quick Facts

General Aviation Activities/Services:

- Corporate aviation
- Flight training
- Air ambulance
- Charter flights
- Recreational flying
- Aircraft maintenance
- Hangar Rentals
- Aircraft Painting and Finishing
- FBO Services

skyway

VERTIPORT INFRASTRUCTURE DEVELOPMENT

“Vertiport design and operational specification determine economic impact.”

But, what is a VERTIPORT?

(It is often used as a ubiquitous term.)

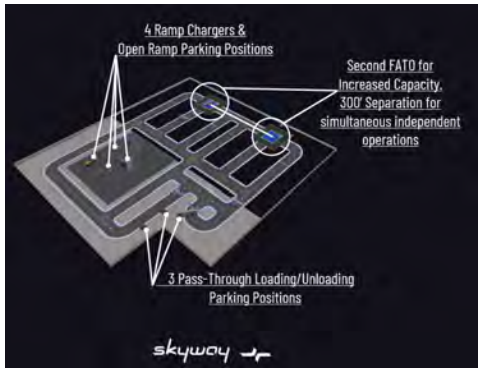
Type of Vertiports

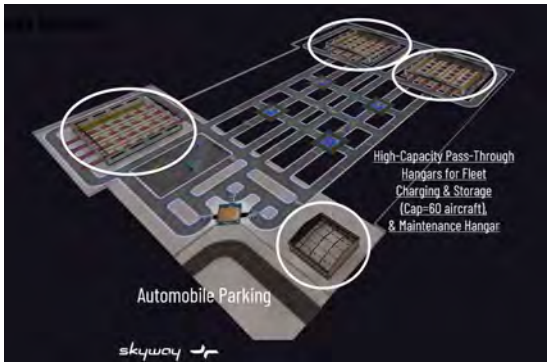
	Vertipad	Vertibase	Vertihub
Dimensions (in feet)	100 x 60	230 x 100	400 x 175 (over 2 floors)
Landing/take-off pads	1	3	10
Parking/charging spots	2	6	20
Capital expenditure, $m	0.2 - 0.4	0.5 - 0.8	6.0 – 7.0
Operating expenditure, $m	0.6 - 0.9	3.4 - 5.0	15.0 – 17.0

(Source, McKinsey & Company, 2020)

	Vertistop	Small Vertiport	Large Vertiport	Megaport
Classification	Landing pad, such as quick drop-offs with no parking possibility	Landing pad, with parking and such operations as charging & maintenance	Further enhancement of small vertiports with more space for parking, charging, maintenance, etc.	Envisions vertiport size that allows operations for 1,000 takeoffs and landings per hour
Landing/take-off pads	1	1	2	≤ 20
Parking/charging spots	0	3	6	≤100
Maximum capacity (turnaround/hour)	~6	~25	~50	~1,000

(Source, Lineberger et al., 2021)





Vertistop

REFERENCE NUMBER:	01

DESCRIPTION:
Single FATO (Landing Area) enclosed within secure fence and gate. Smallest possible facility.

OPTIONS:
Placement: Floating, elevated atop parking structure or other building.

FEATURES:
Lighted FATO (TLOF, FATO and Safety Area), Windcone, Remote Communications

SIZE:
Very Small <1 acre

FATO CAPACITY:
Very Low
2-6 Flights Per Hour
10-30 Minutes Per Flight

skyway

Vertistop

REFERENCE NUMBER:	01

DESCRIPTION:
Single FATO (Landing Area) enclosed within secure fence and gate. Smallest possible facility.

OPTIONS:
Placement: Floating, elevated atop parking structure or other building.

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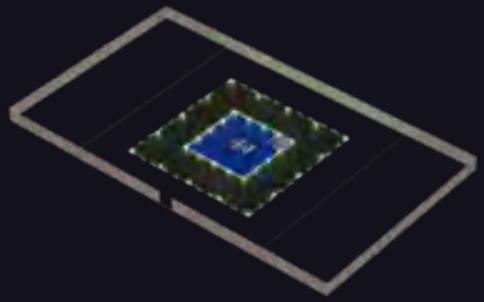

skyway

Vertistop

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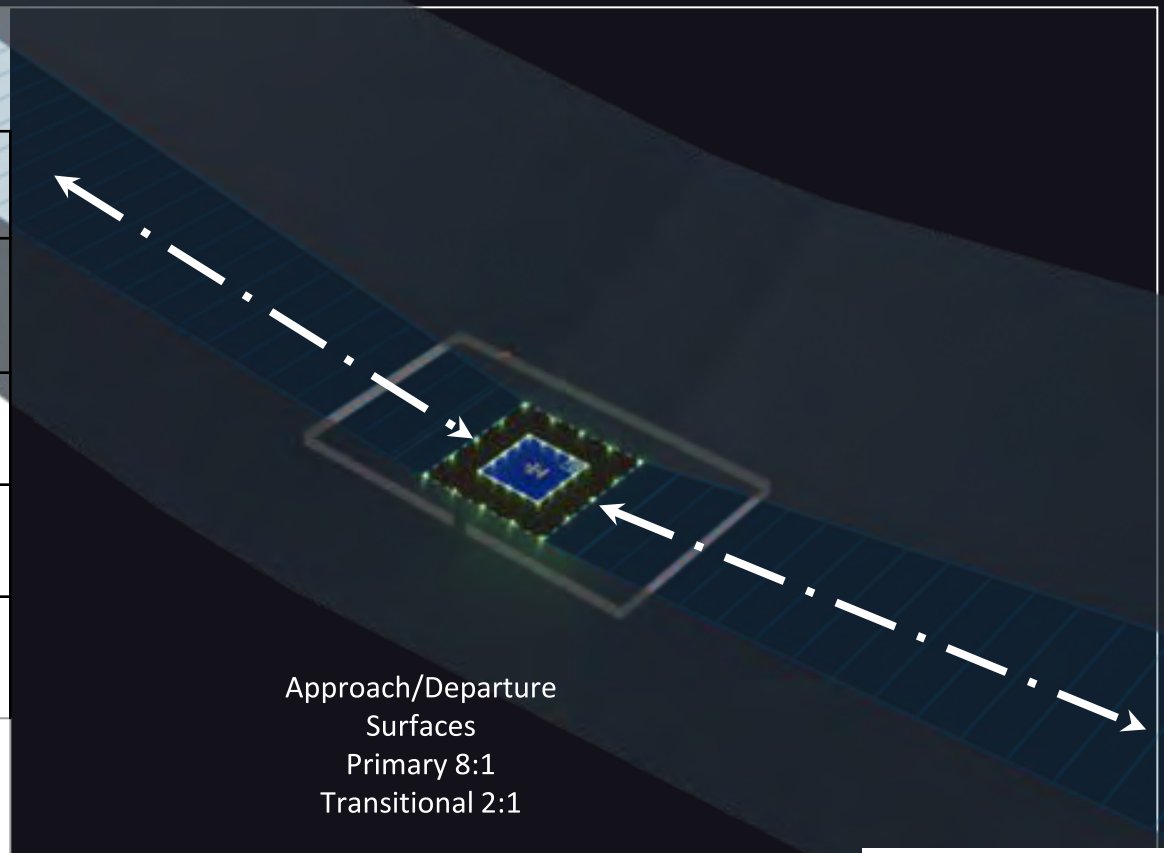


Approach/Departure
Surfaces
Primary 8:1
Transitional 2:1

skyway

Vertistop +

REFERENCE NUMBER:	01A

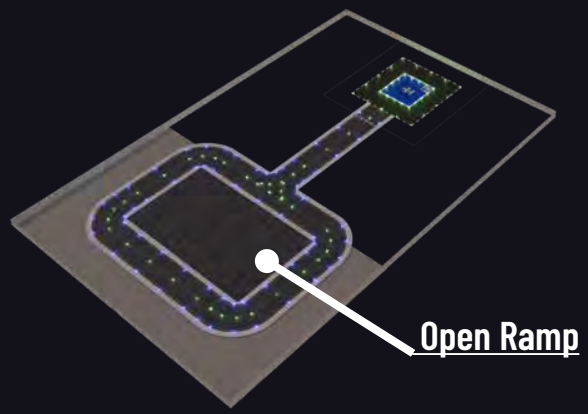
DESCRIPTION:
Single FATO (Landing Area) with single taxiway to open apron parking area.

OPTIONS:
Placement: Floating, elevated atop parking structure or other building. Additional development available on far side.

FEATURES:
All previous features plus improved capacity (by allowing vehicles to leave FATO area)

SIZE:
Small: 4 acres

FATO CAPACITY:
Low: 8-10 Flights/Hr
(Limited by Parking)



skyway

Vertistop +

REFERENCE NUMBER:	01B

DESCRIPTION:
Single FATO (Landing Area) with three taxiways to open apron parking area for reduced delay, increased capacity.

OPTIONS:
Placement: Floating, elevated atop parking structure or other building. Additional development available on far side.

FEATURES:
All previous features plus improved capacity (by allowing vehicles to leave FATO area, eliminating wait points)

SIZE:
Small: 4 acres

FATO CAPACITY:
Low: 8-10 Flights/Hr
(Limited by Parking)

skyway

Vertistop +

REFERENCE NUMBER:	01B

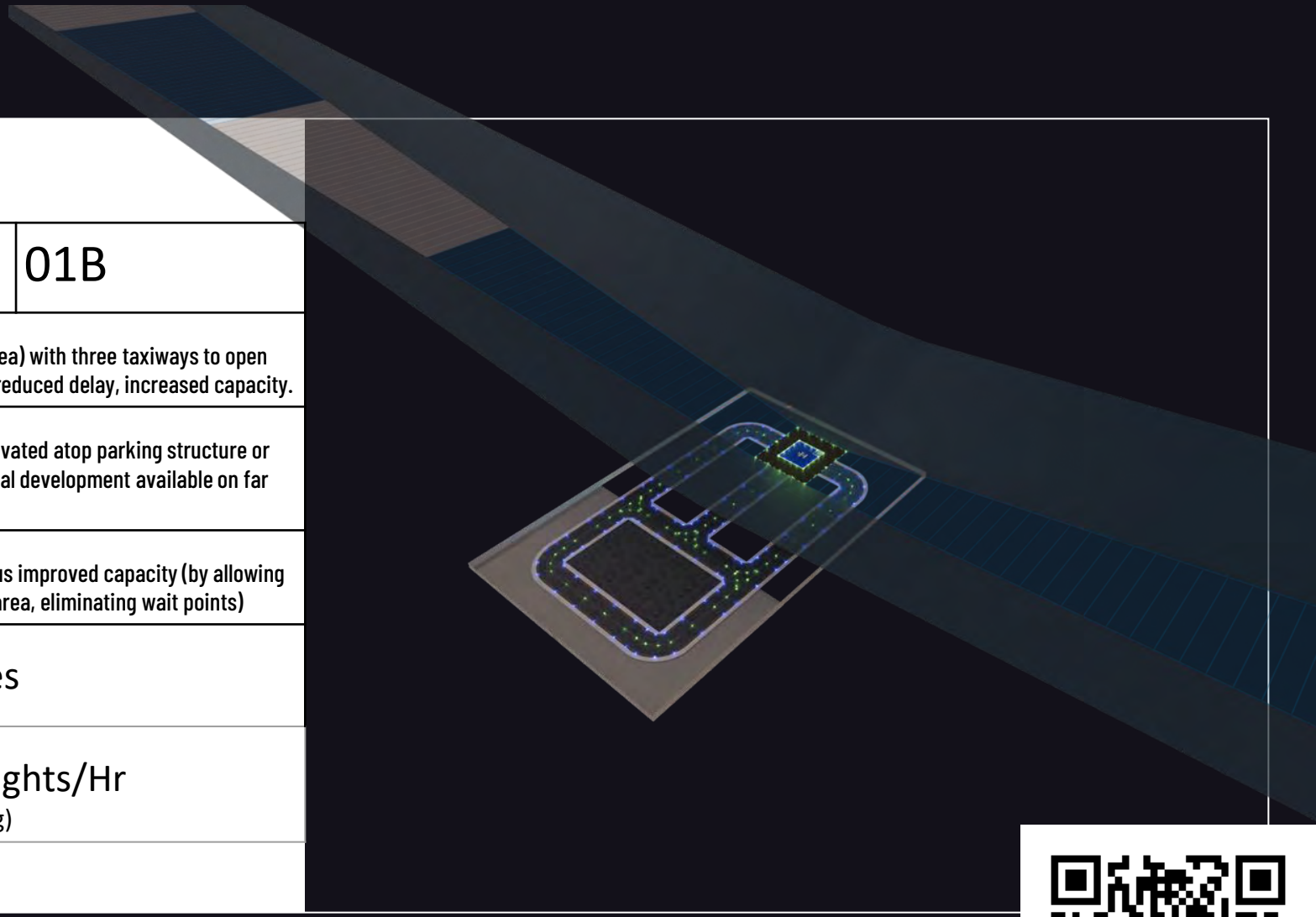
DESCRIPTION:
Single FATO (Landing Area) with three taxiways to open apron parking area for reduced delay, increased capacity.

OPTIONS:
Placement: Floating, elevated atop parking structure or other building. Additional development available on far side.

FEATURES:
All previous features plus improved capacity (by allowing vehicles to leave FATO area, eliminating wait points)

SIZE:
Small: 4 acres

FATO CAPACITY:
Low: 8-10 Flights/Hr
(Limited by Parking)



skyway

Vertiport: Small

REFERENCE NUMBER:	02

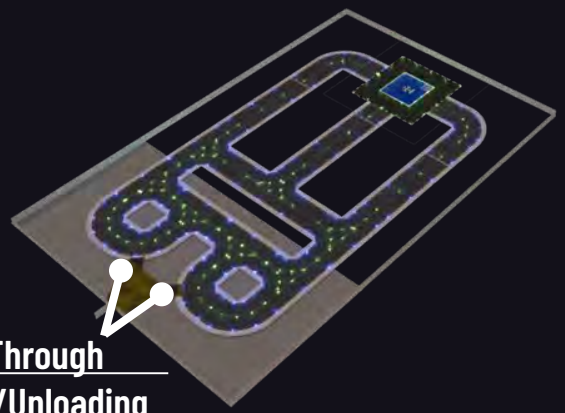
DESCRIPTION:
Single FATO (Landing Area) with taxiways to designated loading/unloading positions, increased safety and security.

OPTIONS:
Placement: Floating, elevated atop parking structure or other building. Additional development available on far side.

FEATURES:
All previous features plus improved capacity (by allowing vehicles to leave FATO area, eliminating wait points)

SIZE:
Small: 4 acres

FATO CAPACITY:
Low: 14-20 Flights/Hr



2 Pass-Through Loading/Unloading Parking Positions

skyway

Vertiport: Medium

REFERENCE NUMBER:	03

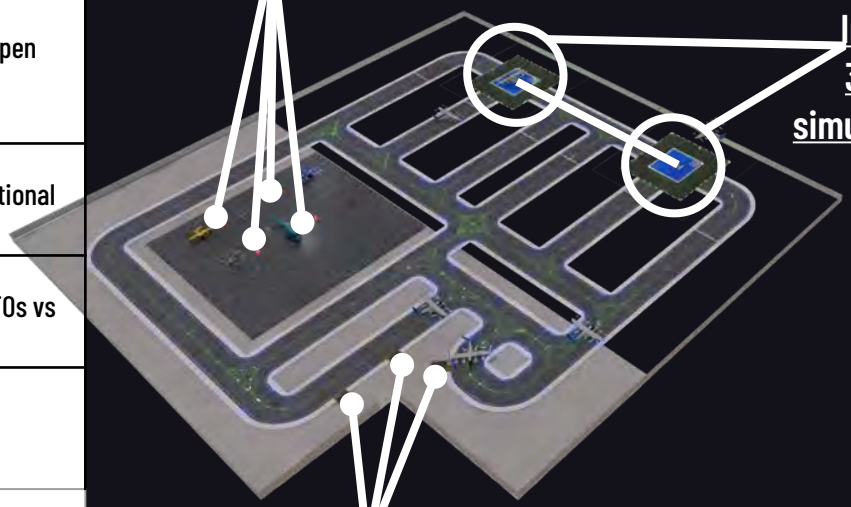
DESCRIPTION:
Dual FATOs (1 arr, 1 dep) with multiple taxiways to open ramp AND designated loading/unloading positions, increased safety, security.

OPTIONS:
Placement: Too large for floating or elevated. Additional development (cargo?) available on far side.

FEATURES:
All previous features plus improved capacity (2 FATOs vs 1). No terminal building (yet).

SIZE:
Moderate: 11 acres

FATO CAPACITY:
Low: 23-38 Flights/Hr



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Vertiport: Medium

REFERENCE NUMBER:	03

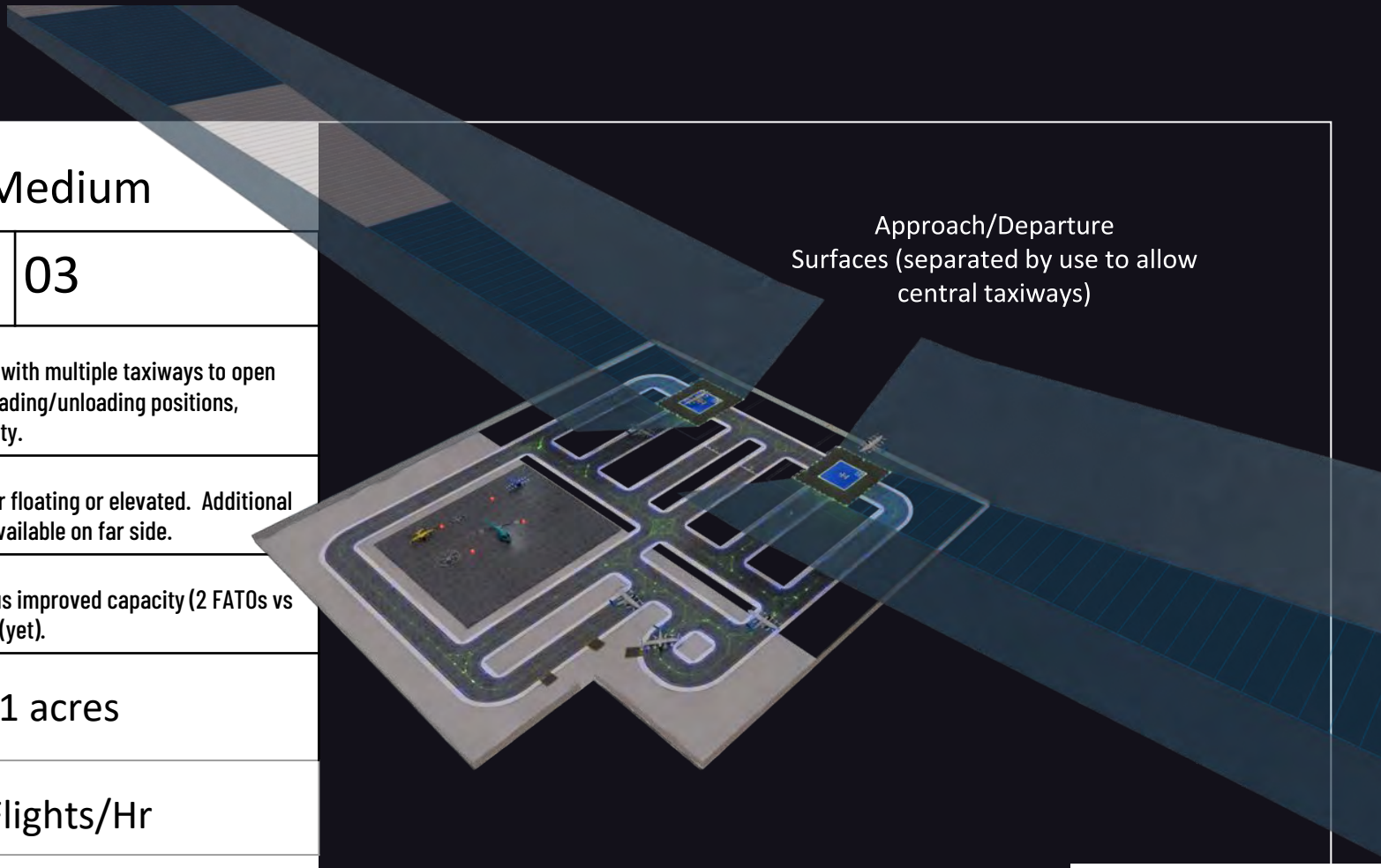
DESCRIPTION:
Dual FATOs (1 arr, 1 dep) with multiple taxiways to open ramp AND designated loading/unloading positions, increased safety, security.

OPTIONS:
Placement: Too large for floating or elevated. Additional development (cargo?) available on far side.

FEATURES:
All previous features plus improved capacity (2 FATOs vs 1). No terminal building (yet).

SIZE:
Moderate: 11 acres

FATO CAPACITY:
Low: 23-38 Flights/Hr



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Vertiport: Eventport

REFERENCE NUMBER:	04A

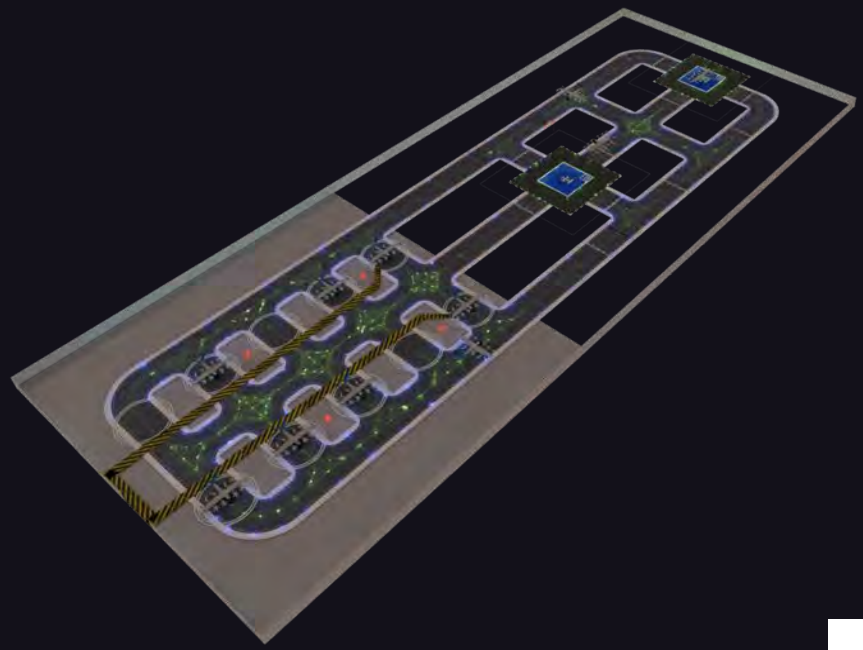
DESCRIPTION:
Special-Use Vertiport designed for high-profile event parking with 10 vehicle parking capacity and recharging services. 2 dual-use FATOs for increased arrival or departure capacity with multiple taxiways to ramp & terminal building for loading/unloading passengers. Transient parking emphasized over long-term storage hangars.

OPTIONS:
2 Loading and Unloading Positions and 8 Parking Positions. Mobile charging truck.

FEATURES:
Parking only with optimal FATO layout

SIZE:
Medium: 9 acres

FATO CAPACITY:
High: 46-76 Flights/Hr



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REFERENCE NUMBER:	04A

DESCRIPTION:
Special-Use Vertiport designed for high-profile event parking with 10 vehicle parking capacity and recharging services. 2 dual-use FATOs for increased arrival or departure capacity with multiple taxiways to ramp & terminal building for loading/unloading passengers. Transient parking emphasized over long-term storage hangars.

OPTIONS:
2 Loading and Unloading Positions and 8 Parking Positions. Mobile charging truck.

FEATURES:
All previous features plus .

SIZE:
Medium: 9 acres

FATO CAPACITY:
High: 46-76 Flights/Hr

skyway

Vertiport: Large

REFERENCE NUMBER:	04

DESCRIPTION:
QUAD FATOs (2 arr, 2 dep) with multiple taxiways to open ramp AND terminal building for loading/unloading passengers, increased safety, security.

OPTIONS:
Placement: Too large for floating or elevated. Additional development (cargo?) available on far side.

FEATURES:
All previous features plus improved capacity (4 FATOs vs 2), and dedicated terminal building.

SIZE:
Large: 16 acres

FATO CAPACITY:
Low: 30-80 Flights/Hr

skyway

Vertiport: Large

REFERENCE NUMBER:	04

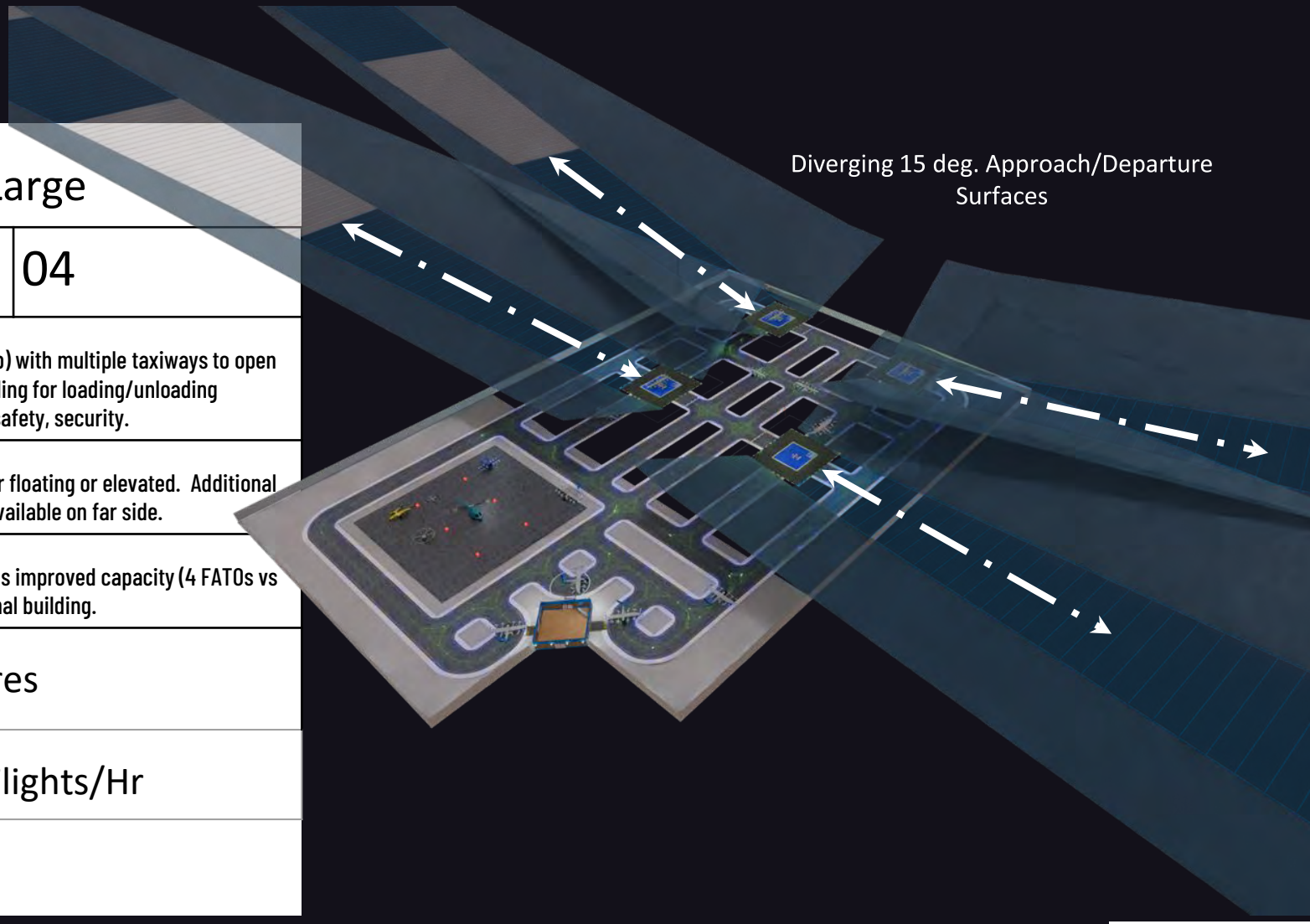
DESCRIPTION:
QUAD FATOs (2 arr, 2 dep) with multiple taxiways to open ramp AND terminal building for loading/unloading passengers, increased safety, security.

OPTIONS:
Placement: Too large for floating or elevated. Additional development (cargo?) available on far side.

FEATURES:
All previous features plus improved capacity (4 FATOs vs 2), and dedicated terminal building.

SIZE:
Large: 16 acres

FATO CAPACITY:
Low: 30-80 Flights/Hr



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Vertiport: Fleet Service

REFERENCE NUMBER:	05

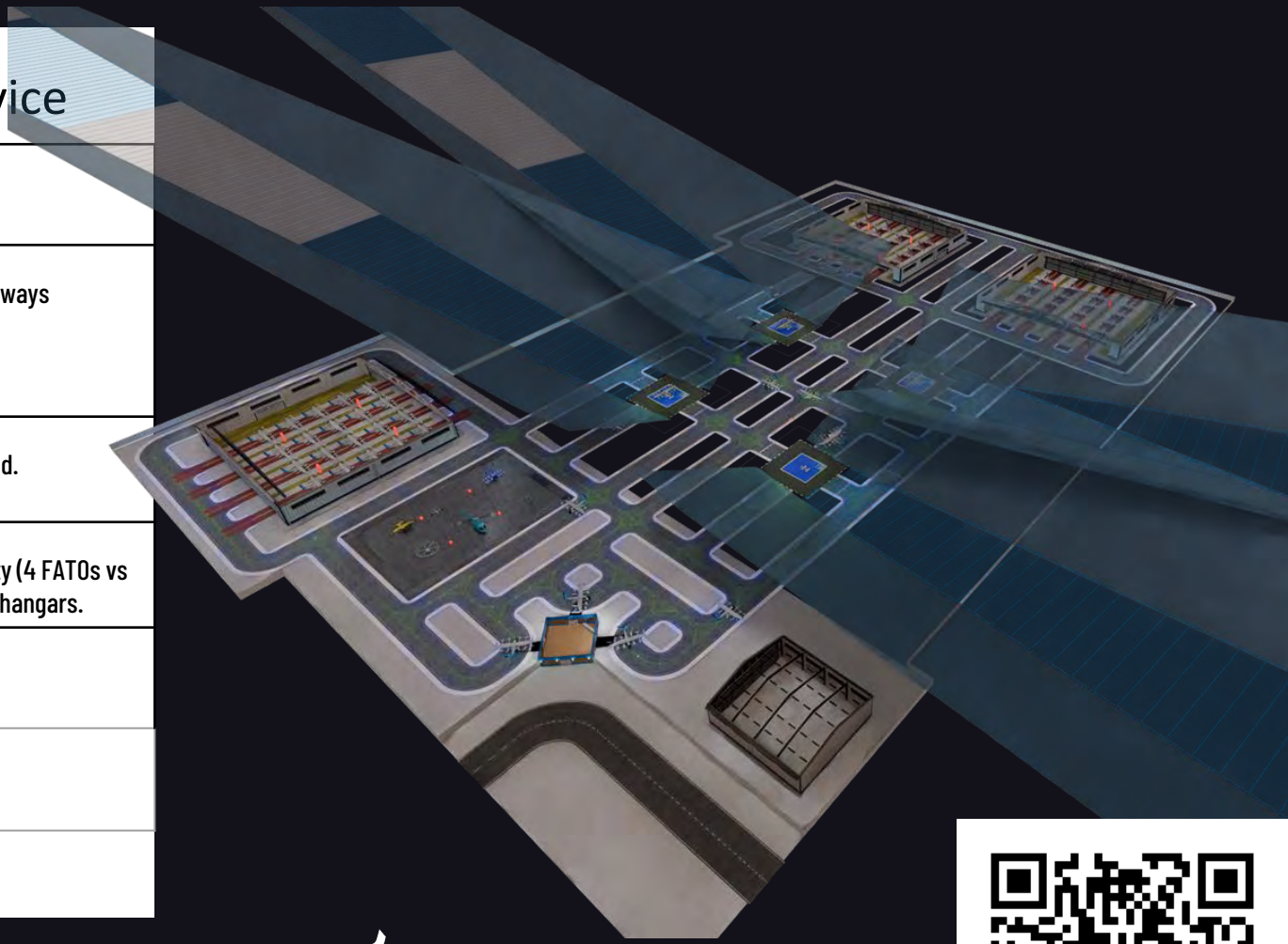
DESCRIPTION:
QUAD FATOs (2 arr, 2 dep) with multiple taxiways to ramp & terminal building for loading/ Unloading passengers. Storage hangars & maintenance hangar.

OPTIONS:
Placement: Too large for floating or elevated.
Cargo may replace any hangar.

FEATURES:
All previous features plus improved capacity (4 FATOs vs 2), terminal building, roadway and parking, hangars.

SIZE:
Very Large: 40 acres

FATO CAPACITY:
High: 46-76 Flights/Hr
276-456 Pax/Hr



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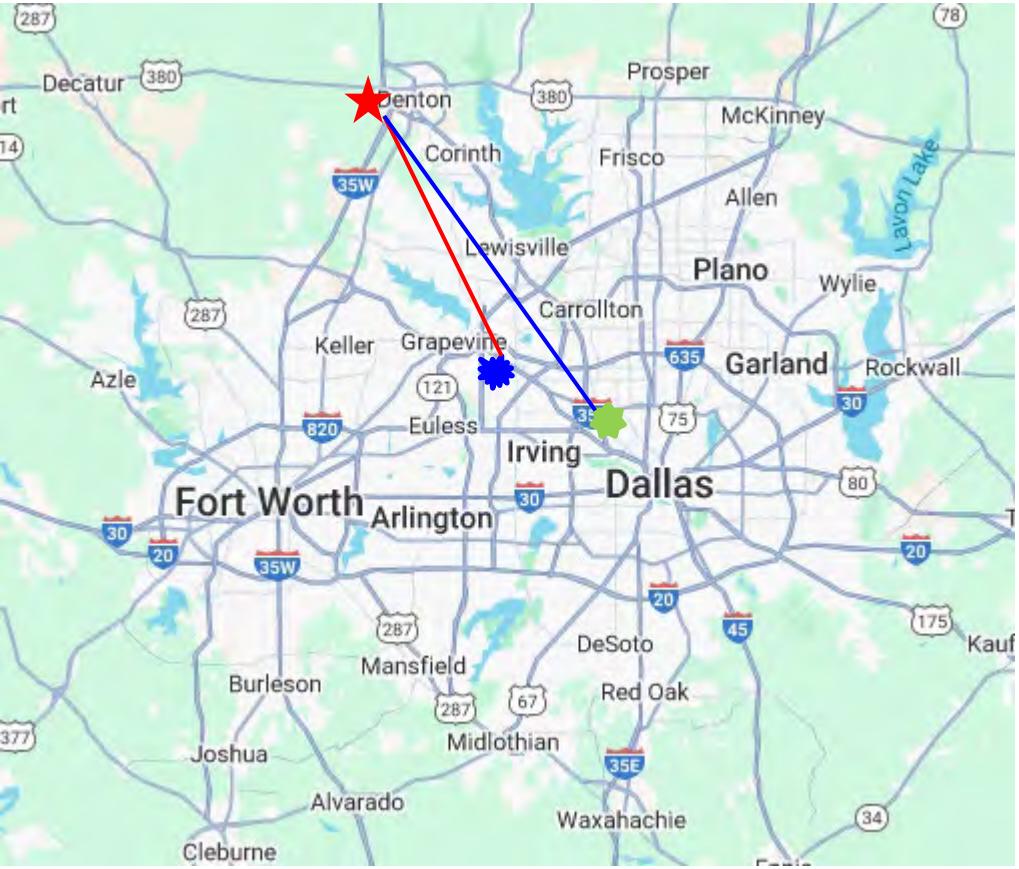
Forecasting Demand



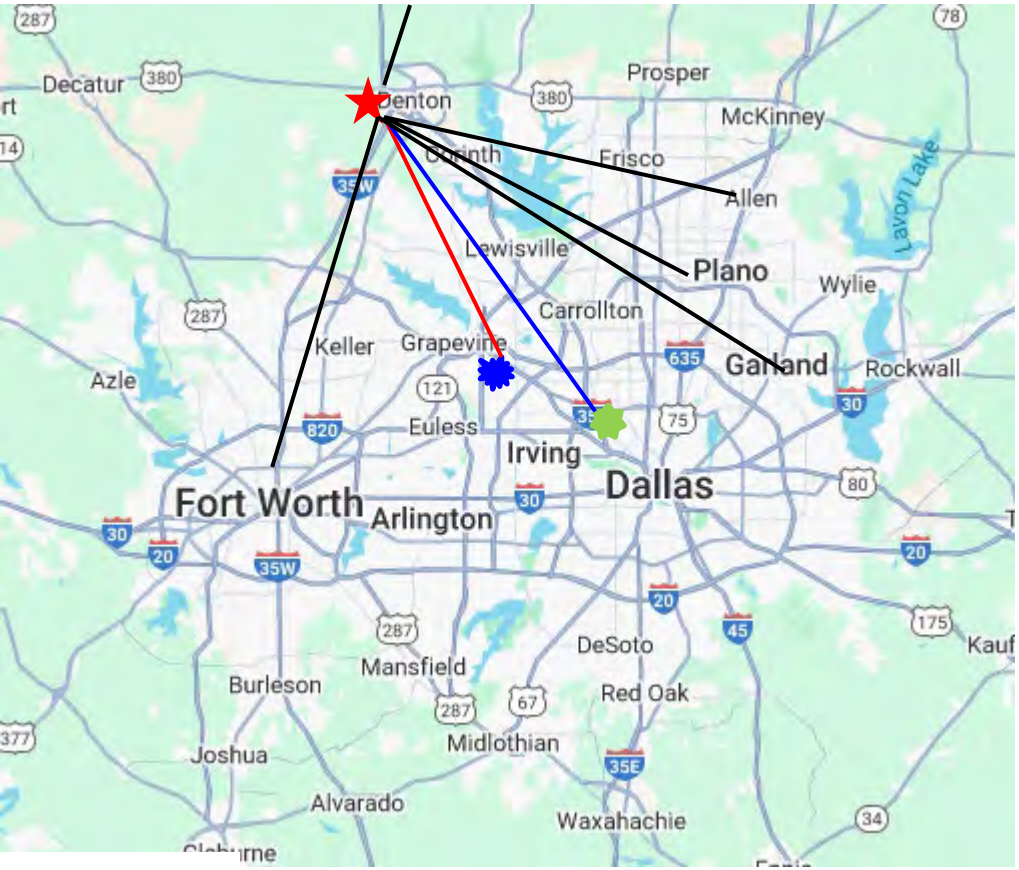
- $A \times I_H\ (I_P) \times U \times (T_a/T_v) \times (P_a/P_v)$
  - A: Propensity to leave car (0-1, low in Texas, High in NY)
  - $I_H\ (I_P)$: Income household
  - U: Intention to utilize eVTOL
  - T_a/T_v: Travel time for alternative and eVTOL
  - P_a/P_v: Price for alternative and eVTOL

North Eastern Corridor (WAS-NYK-BOS) Transportation Demand Model:

- Population, Aircraft type, Transport mode, Income, Time, Service, Cost, Frequency

$$T_{ijk} = \alpha_0 P_i^{\alpha_1} P_j^{\alpha_2} R_i^{\alpha_3} R_j^{\alpha_4} I_i^{\alpha_5} I_j^{\alpha_6} N_{ij}^{\alpha_7} \theta_{ijo}^{\beta_1} \theta_{ijk}^{\beta_2} C_{ijo}^{\gamma_1} C_{ijk}^{\gamma_2} f_{ijo}^{\delta_1} f_{ijk}^{\delta_2}$$

Forecasting Network Density



- Law of Gravity

$$T_{ij} = k \frac{P_i^{\alpha_i} P_j^{\beta_j}}{d_{ij}^{\beta}}$$

- Passenger demand
  - Population / population per square mile
  - Travel time to work
  - Accommodation and food services sales
  - Household income / per capita income
- Cargo demand
  - Population / population per square mile
  - Transportation and warehousing revenue
  - Retail sales / per capita

Forecasting Network Density for Cargo

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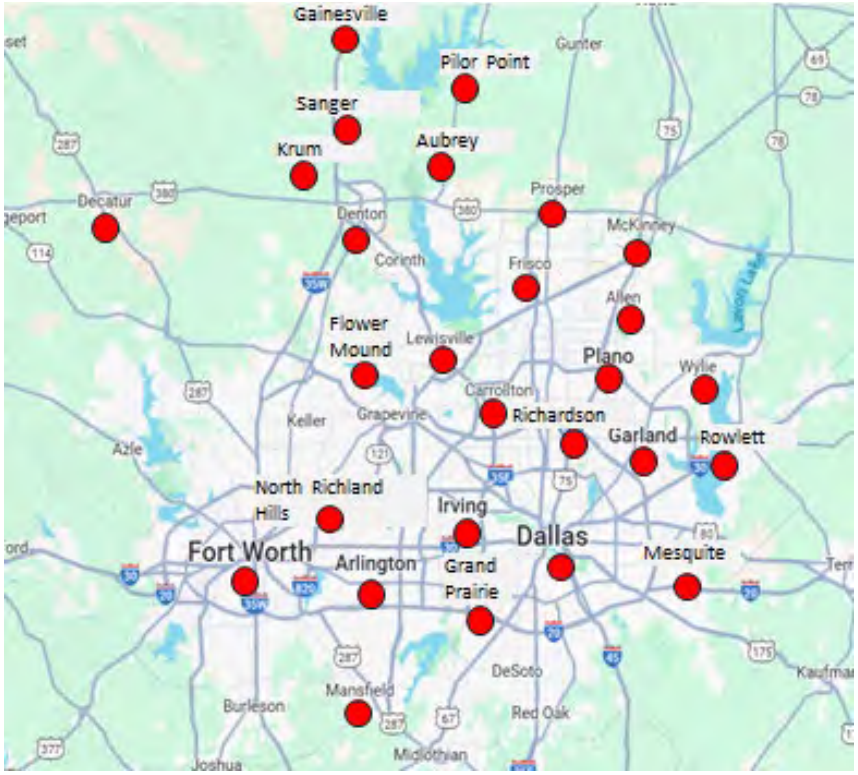
	Pq	Tw	Tr
Garland	2.966	0.329	1.013
Irving	2.640	1.903	2.035
Plano	2.744	0.341	3.051
Arlington	2.833	0.656	2.267
Fort Worth	1.823	3.458	4.500
Dallas	2.646	10.712	8.883
Lewisville	2.082	0.305	0.929
Denton	1.000	1.000	1.000
Mesquite	2.133	0.449	0.772
Grand Prairie	1.862	1.175	1.039
McKinney	2.009	0.259	1.395
Frisco	2.012	0.317	1.558
North Richland Hills	2.652	0.079	0.603
Flower Mound town	1.247	0.167	0.305
Mansfield	1.366	0.157	0.399
Allen	2.730	0.053	0.526
Richardson	2.881	0.084	0.817
Carrollton	2.508	0.359	1.215
Wylie	1.797	0.020	0.190
Rowlett	2.077	0.017	0.193
Prosper town	0.825		0.300
Decatur	0.513	0.020	0.157
Aubrey	1.145	0.002	0.009
Krum	1.466		0.007
Gainesville	0.621	0.073	0.195
Sanger	0.518	0.032	0.051
Pilot Point	0.694		0.025

Cargo demand

- Population / population per square mile (Pq)
- Transportation and warehousing revenue (Tw)
- Retail sales (Tr)



Forecasting Demand and Network

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- The **probabilistic choice model** developed by McFadden (1981) based on the random utility theory.
  - The utility concept is a measure of one's relative satisfaction or pleasure resulting from a particular action (Ben-Akiva et al., 2018), such as **choosing a transport mode to travel**.
- The **random utility model** is $U_{in} = V_{in} + \epsilon_{in}$ (1) where *n* individuals choose transport mode *i* with unobserved attributes (ϵ).
  - Based on formula (1), we take three attributes, such as travel time (in-vehicle time and access time); $V_{in} = \beta_{i1} time_{i1} + \beta_{i2} price_{i2}$ (2).

Design of survey scenario for passenger

Transport mode choice (C_n)		Attributes		Utility
		Ticket price	Time	
1	eVTOL (C_1)	p_1	t_1	U_1
2	Uber/Lyft (C_2)	p_2	t_2	U_2

Note: t_1 = {20 min, 40 min}, t_2 = {45 min, 75 min}; and p_1 = {\$75, \$125}, p_2 = {\$50, \$100}

Design of survey scenario for cargo

Transport mode choice (C_n)		Attributes		Utility
		Ticket price	Time	
1	eVTOL (C_1)	p_1	t_1	U_1
2	Truck/Van (C_2)	p_2	t_2	U_2

Note: t_1 = {20 min, 30 min}, t_2 = {12 hours, 1 day}; and p_1 = {\$75, \$125}, p_2 = {\$45, \$60}

Forecasting Demand and Network: Other variable

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Demographic Information: Age, Gender, Education, Income

- Other Variables: Familiarity of AAM and eVTOL, Intention to use

Travel quality: Safety/Security, Comfort, Punctuality, Accessibility, Connection

- Case: UAM vs. Taxi in South Korea (Choi & Park, 2022)

Variables		Coeff.	p-value
Attributes	Travel time	-0.0827	0.000***
	Ticket price	-0.0722	0.000***
	Comfort	0.7102	0.001***

*** Significant at α = 0.001

Maximum fare increase that can secure passengers compared to taxi services.

Reduced time (min)	20	30	40	50
maximum fare increase (USD)	22.905	34.363	45.817	57.271

The comparison for the cost of fare (UAM services).

Institution	MNL model	Uber Elevate (2016)	Booz Allen Hamilton (Goyal et al., 2018)	MOLIT (2021)
Cost of fare (USD)	96–108	36–109	111–171	103–116

Route (Airport-downtown)	ORD (Chicago)	JFK (New York)	LHR (London)	CDG (Paris)	NRT (Tokyo)
Travel time (without congestion, min[1])	24	30	24	34	62
Travel distance (mile[1])	18	19	17	19	46
Fare range[2] (USD)	37.5–57.7	45.2–68.6	37.0–56.7	50.1–75.1	96.6–148.6
Fare range[3] (USD)	61.7–90.5	69.4–101.4	61.2–89.5	74.3–107.9	120.8–181.4

Note: 1. We derived the distance and travel time from January 24 to January 25, 2022 using the Google Maps service.
2. Estimated fare for Uber X service assuming that there is no congestion.
3. Estimated fare for Uber X service assuming 20 min of congestion.

Feasibility analysis of UAM

- A fare range of $96 to 108 USD from Seoul to ICN could attract users, but economic viability requires more than just **reduced travel time**.
- Simulations indicate that a fare of **$57.35** yields a 0% internal rate of return (IRR), while **$63.85** results in a 5% IRR.
- To enhance economic feasibility, involving multiple operators and implementing **dynamic pricing strategies** is crucial.
  (Choi & Park, 2022)

Time Savings: UAM airport shuttle service offers significant time savings over traditional transportation, especially taxis.

Convenience: Quick and efficient airport procedures, including dedicated CIQ channels, enhance the user experience.

Fare Pricing: Competitive pricing will attract passengers, especially if travel times are notably faster than conventional options.

Economic Impact Analysis for a proposed vertiport at Geico Garage, Orlando (vhb, 2021)

Capital Cost: Estimated at $30M for retrofitting.

Economic Benefits:

- 202 jobs created, $35.9M GDP impact over 20 years.
- Tax revenue: $4.4M for Orlando, $14.8M for Orange County.
- CapEx: eVTOL vehicles, Ground infra., ATM system integration, Staffing, etc.
- OpEx: eVTOL , Ground lease, Staffing, Utilities, Income tax, Ground infra. Maint.
- Revenue: Passenger user charge

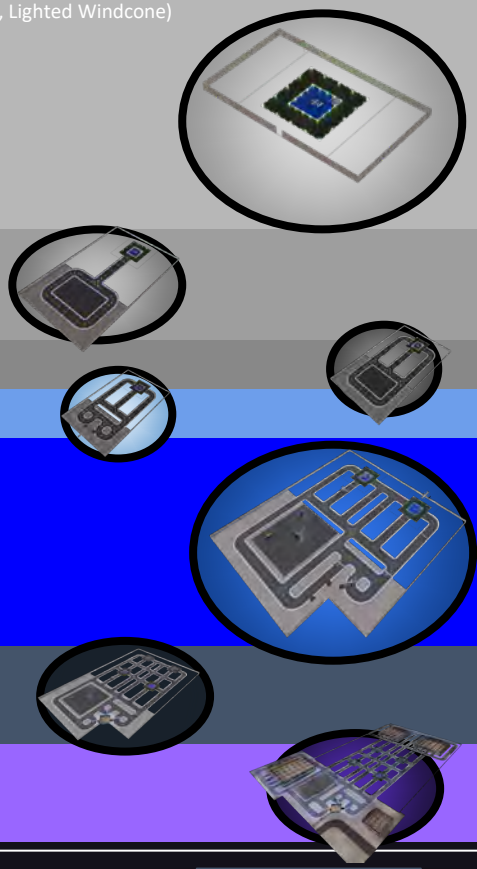
- Recommendation: City should **partner with an AAM operator** to share costs and mitigate parking revenue losses.
  - Vertiport Industry Trends
    - Publicly built and leased?
    - Single or multitenant?
    - Privately built and operated?

Future Considerations: Explore alternative sites for lower costs and reduced Impacts.

Infrastructure Features

The natural progression of off-airport vertiport infrastructure.

Reference Number	Qty	Features
1	1	FATO (incl. TLOF, FATO, Safety Area, Lighted Windcone)
	1	Security Fence/Gate
	1	Surveillance (video)
	1	Communications
	1	Weather Sensors
1A	1	Taxiway to Open Ramp
	1	Open Ramp
1B	3	Parallel Taxiways
2	2	Passenger Loading/Unloading Positions
3	4	Aircraft Chargers
	2	FATOs
	3	Passenger Loading/Unloading Positions
	1	Open Ramp
4	4	FATOs
	1	Terminal Building, 3 Gates
5	3	Aircraft Storage/Charging Hangars
	1	Aircraft Maintenance Hangar



skyway

Vertiport Design

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- **Capital Cost**: Estimated at $30M for retrofitting.
- **Economic Benefits**:
  - 202 jobs created, $35.9M GDP impact over 20 years.
  - Tax revenue: $4.4M for Orlando, $14.8M for Orange County.
  - CapEx: eVTOL vehicles, Ground infra., ATM system integration, Staffing, etc.
  - OpEx: eVTOL , Ground lease, Staffing, Utilities, Income tax, Ground infra. MRO
  - Revenue: Passenger user charge
- Recommendation: City should **partner with an AAM operator** to share costs and mitigate parking revenue losses.
  - Vertiport Industry Trends
    - Publicly built and leased?
    - Single or multitenant?
    - Privately built and operated?
- Future Considerations: Explore alternative sites for lower costs and reduced Impacts.

Many Thanks for your attention!!!

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Survey link:
https://unt.az1.qualtrics.com/jfe/form/SV_a2BIrg15l4xMkKO
OR https://tinyurl.com/mjn3tjz3

Survey for Economic Feasibility Study of Denton Vertiport

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