Urban Air Mobility
Operations and Business Aspects

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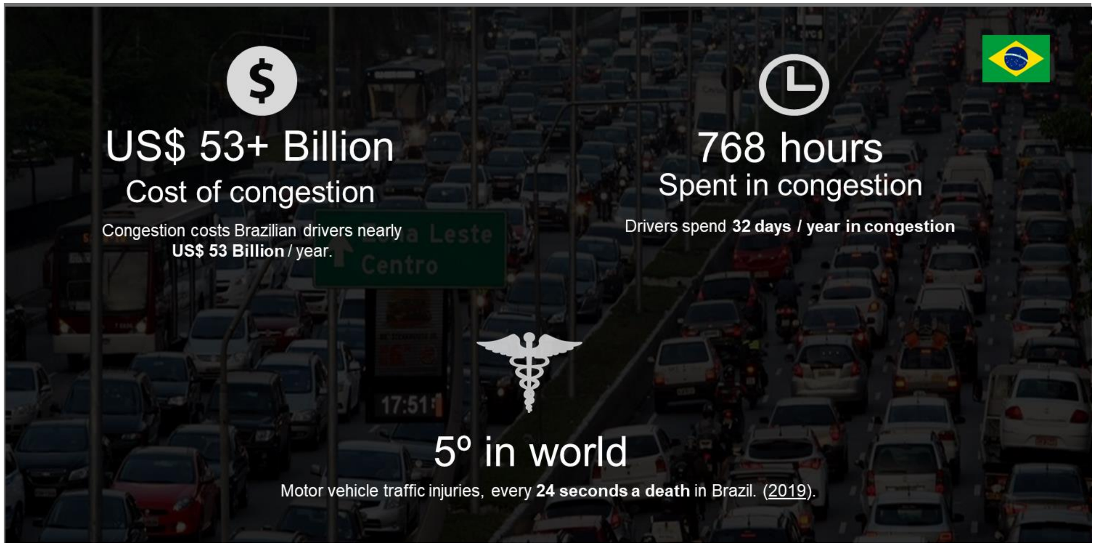
Roadmap

- *Introduction*
- *Technical Challenges*
- *Concept of Operations*
- *Autonomy*
- *The Ecosystem*
- *Operational Implementation*
- *Business Challenges*
- *Final Thoughts*

Motivation

- **Urbanization is increasing**
  - ✓ By 2050 the absolute urban population will double.
  - ✓ 70% of global population will live in urban areas (*).
  - ✓ Number of cars continues to grow, commuters are traveling more every year, ridesharing services are increasing traffic.



(*) Source: Barr Foundation, Boston Metropolitan Planning Organization and World Economic Forum

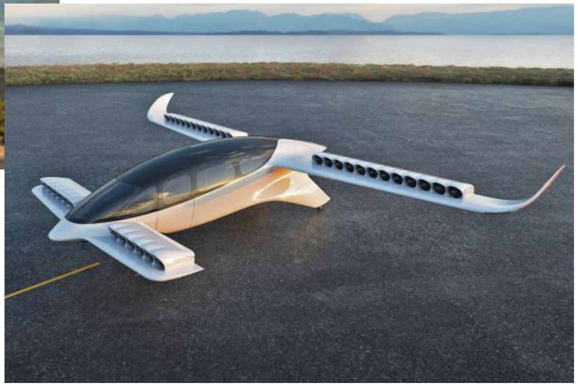
Motivation

- ✓ When entrepreneur JoeBen Bevirt launched Joby Aviation 12 years ago, it was just one of a slew of offbeat tech projects at his Sproutwerx ranch in the Santa Cruz mountains.

- ✓ **Today, Joby has more than 1,000 employees and it's backed by close to US $2 billion in investments,** including $400 million from Toyota Motor Corporation along with big infusions from Uber and JetBlue.

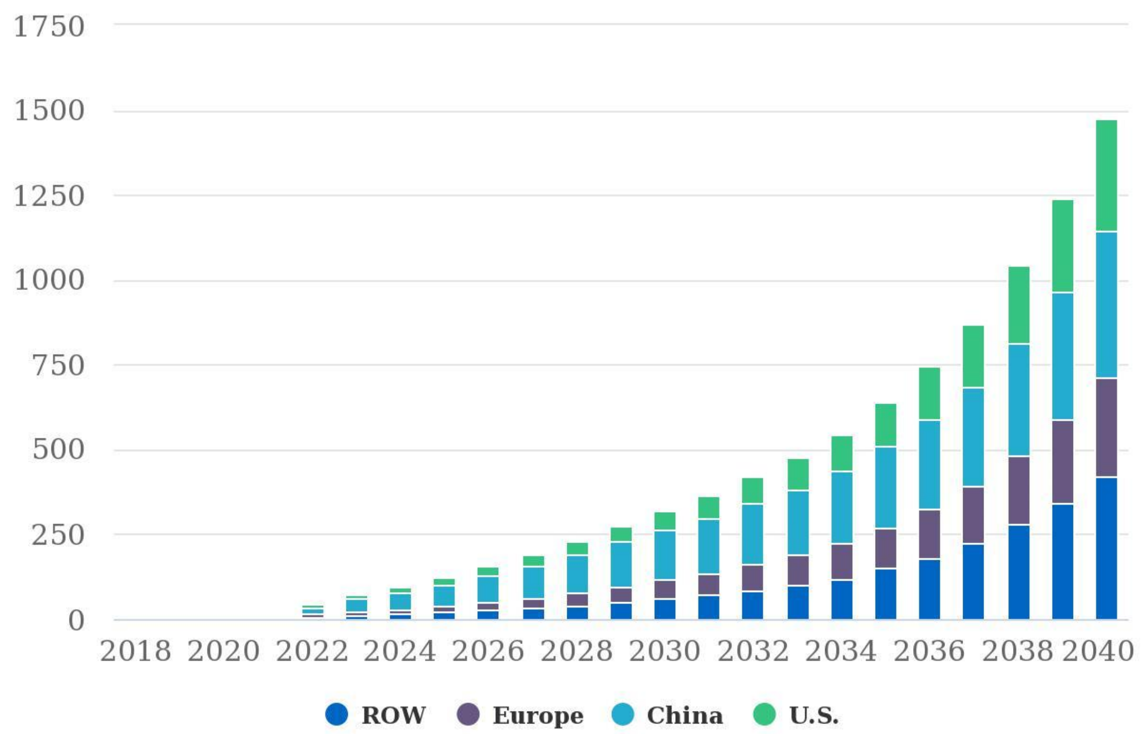
- ✓ **At least 250 companies worldwide** are angling to revolutionize transportation in and around cities with a new category of aviation, called **urban air mobility or advanced air mobility.**

- ✓ The category's **top seven companies together have hauled in more than $5 billion in funding.** Even by the standards of big-money tech investment, the UAM vision is giddily audacious.



Introduction

- **UAM Opportunity**
  - ✓ $1.5 trillion market for Urban Air Mobility by 2040 (Morgan Stanley).



Source: Morgan Stanley

Introduction

- **Urban Air Mobility (UAM)** means urban transportation systems that **move people by air in response to traffic congestions**, mainly related to **intracity** transport.
- Represents a disruptive breakthrough in the aerospace industry, promising **lower and competitive costs when compared with other terrestrial and aerial modals**.
- Use vehicles capable of executing **vertical take-off and landing maneuvers** and, using **electrical propulsion** (eVTOLs), bringing an appealing solution towards the **zero-emissions and lower operational costs.**

"UAM is a new safe, secure and more sustainable air transportation system for passengers and cargo in urban environments, enabled by new technologies and integrated into multimodal transportation systems. The transportation is performed by electric aircraft taking off and landing vertically, remotely piloted or with a pilot on board" (EASA)

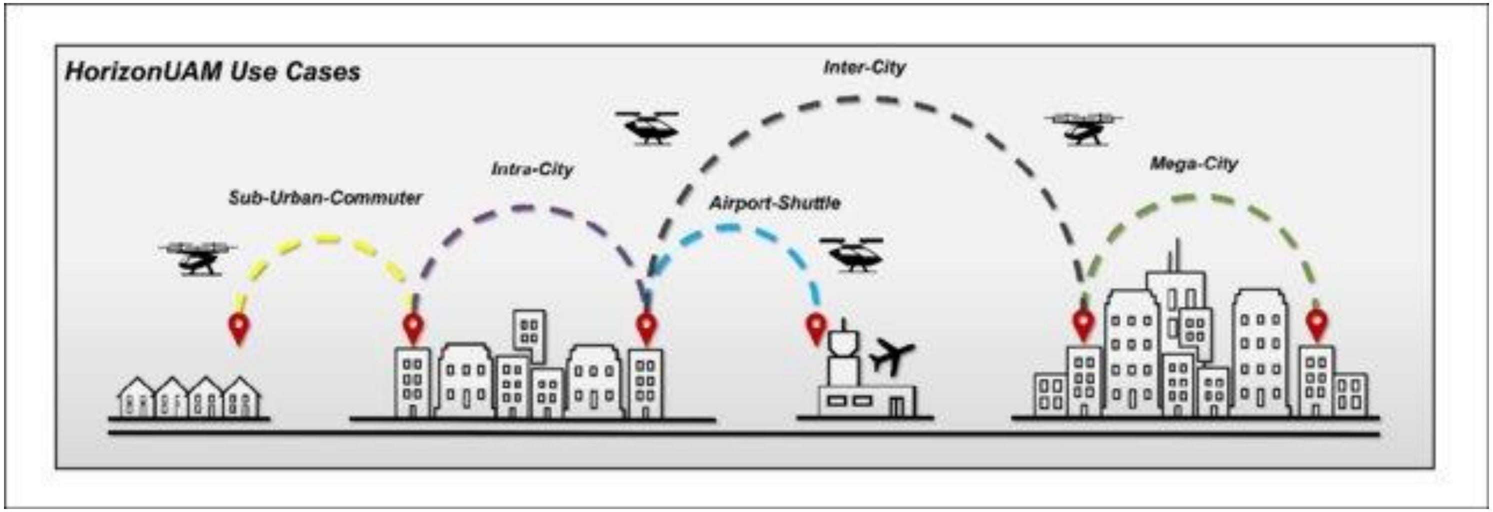
Introduction

- **Expected Benefits (OEMs perspective)**
  - ✓ **New transport modal** for urban areas (70% of world population by 2050).
  - ✓ **Traffic congestion alleviation**.
  - ✓ **Faster mobility:** 15 to 40 minutes saved on average on a standard city travel time and more than 70%-time savings for emergency / medical delivery.
  - ✓ **Reduction of carbon footprint**, by using electrical vehicles (?)
  - ✓ Enhancement and development of **urban infrastructure**.
  - ✓ Positive economic impact with **creation of new jobs**.
  - ✓ **Lower operational costs**, when compared with helicopters.
  - ✓ **Accessible air travel**, at lower fares, offered to a wider range of population.
  - ✓ **Safer mobility:** lower risk to be involved in a fatal accident in road transport.

https://www.easa.europa.eu/what-is-uam

Introduction

- **Use Cases**

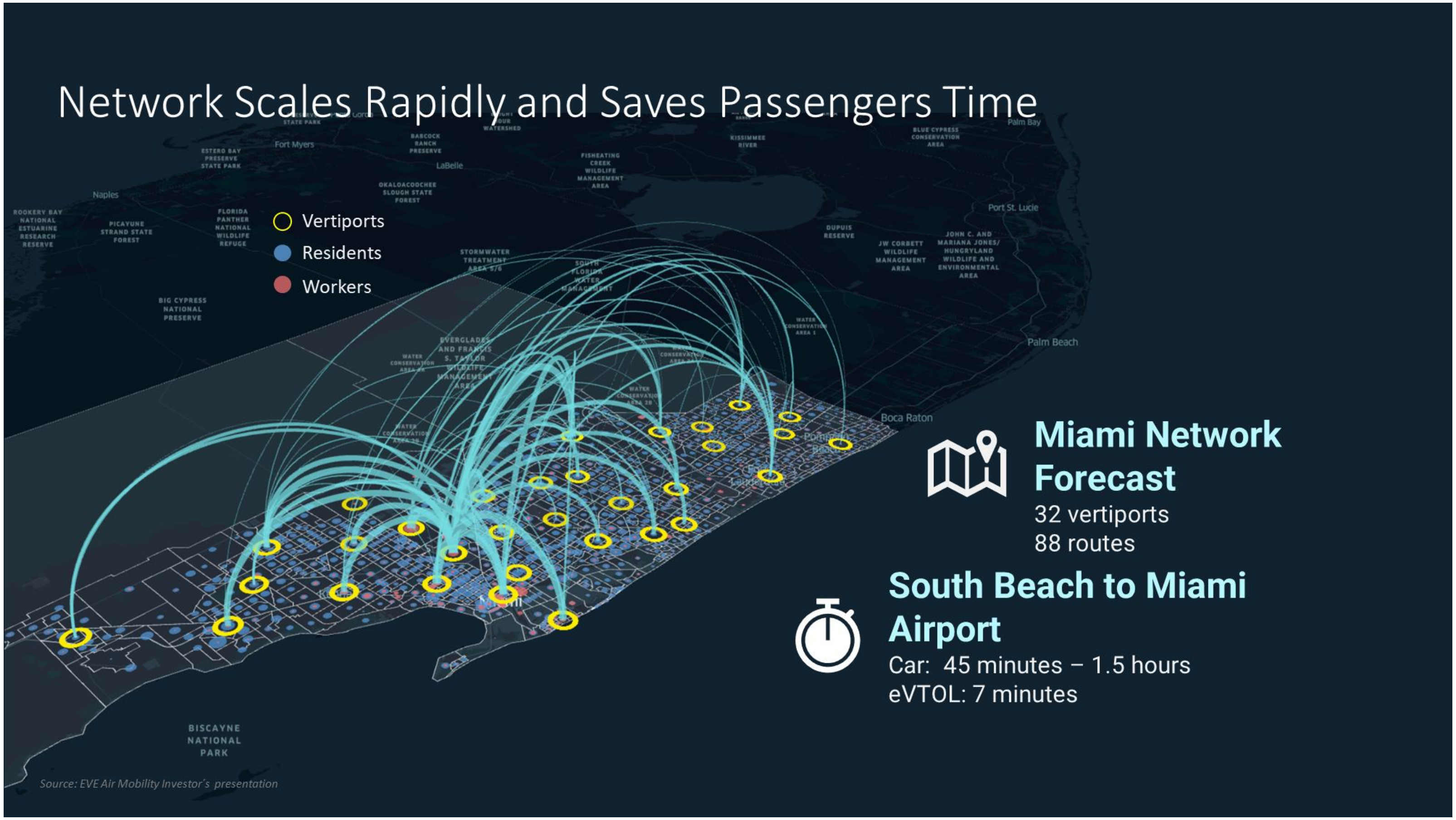


Asmer, Lukas, et al. "Urban air mobility use cases, missions and technology scenarios for the HorizonUAM project." AIAA Aviation 2021 Forum. 2021.

- Types of operations:
  - ✓ **Airport shuttles:** connecting city locations to main airports.
  - ✓ **Commuter**: connecting two city locations, on regular or on-demand basis.
  - ✓ **Sightseeing:** touristic flyby, origin is the same of destination.
  - ✓ **Utility**: aeromedical, fire-fighting, police, cargo transport and others.

Introduction

- **Example of time savings**

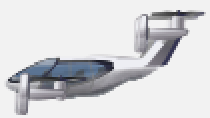


Source: EVE Air Mobility Investor´s presentation

Introduction

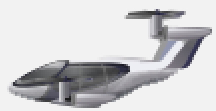
- **eVTOL Topologies**

Lift + Cruise



- Low/Medium Cruise Speed
- Short Range
- Transition from/to hover
- Simple design
- Lower noise in cruise
- Simple maintenance
- Easier to certify (?)

Tilt Rotor



- High cruise speed
- Medium/long Range
- Transition from/to hover
- Complex Design
- Medium noise in cruise
- Complex maintenance (?)
- Challenging certification

Vectored Fan

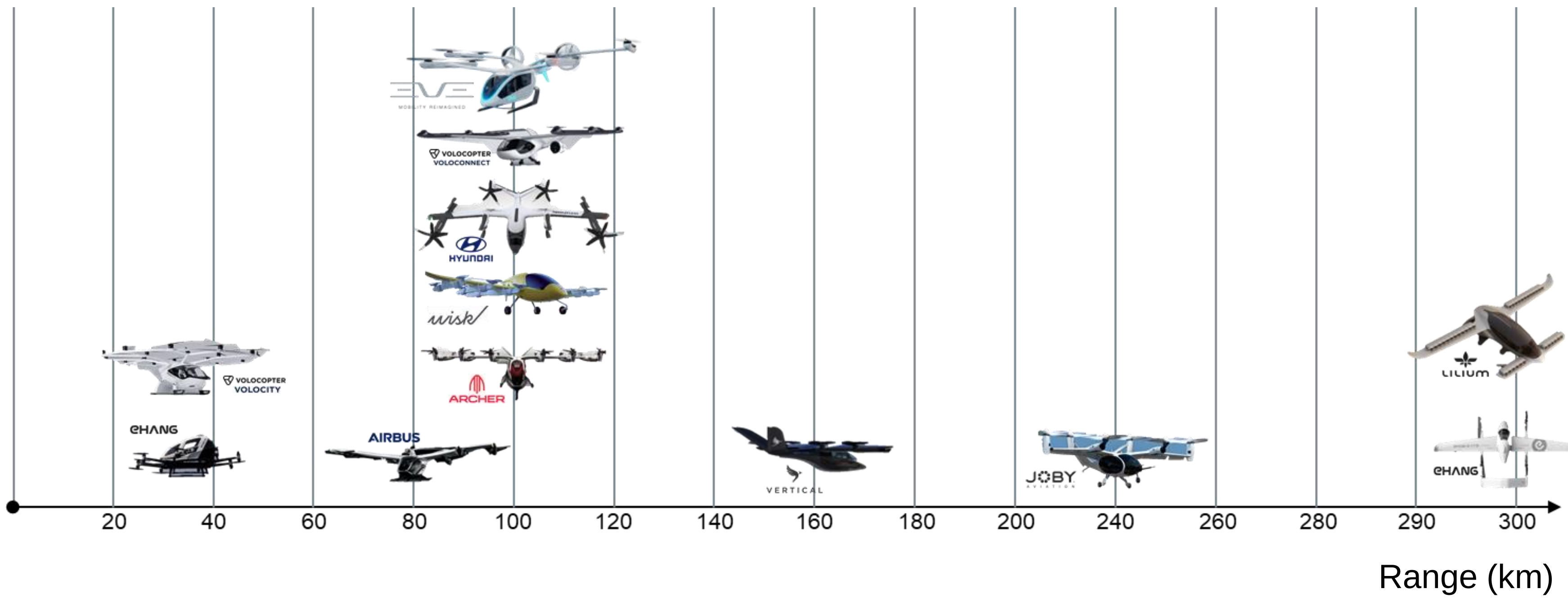
- High Cruise Speed
- Long Range
- Energy intensive hover
- Complex Design
- High Takeoff/Landing noise
- Complex Maintenance (?)
- Challenging certification

Wingless / Multirotor

- Low Cruise Speed
- Short Range
- Efficient hover
- Helicopter Design look-a-like
- Helicopters noise levels
- Helicopter Maintenance
- Easiest certification (?)

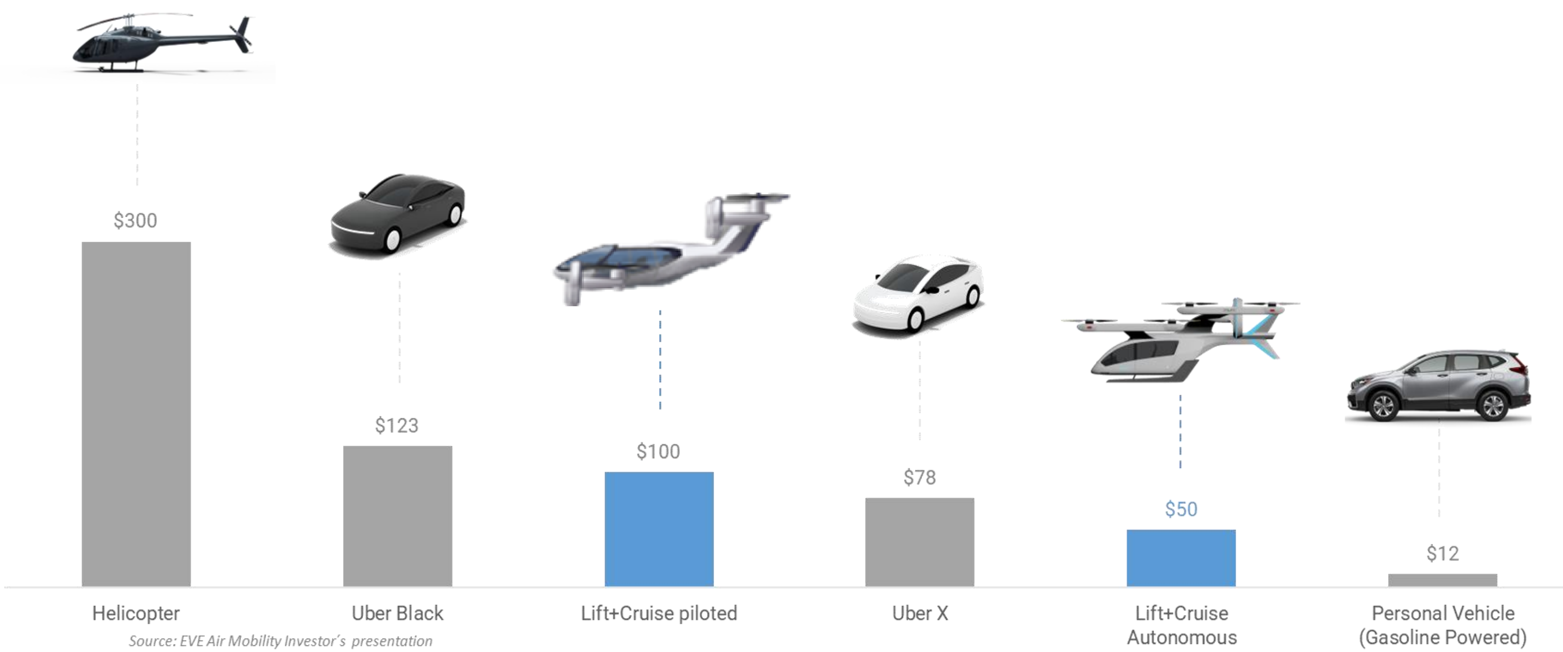
Introduction

- **Range Competition**



Introduction

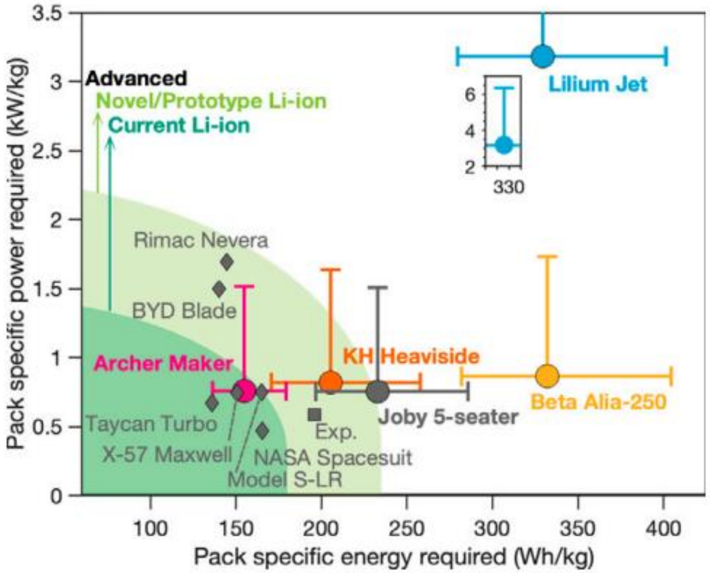
- **Estimated Fare Comparison (30 km trip)**

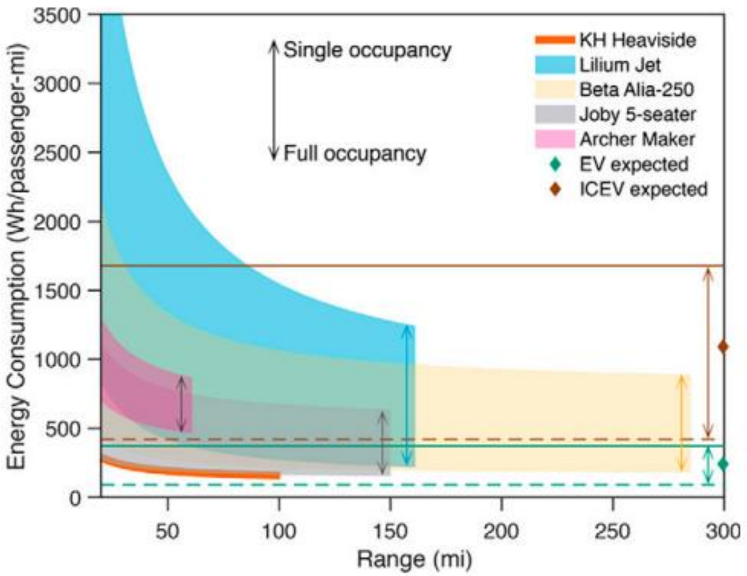


Source: EVE Air Mobility Investor´s presentation

Technical Challenges

- **Energy Density Dependency**



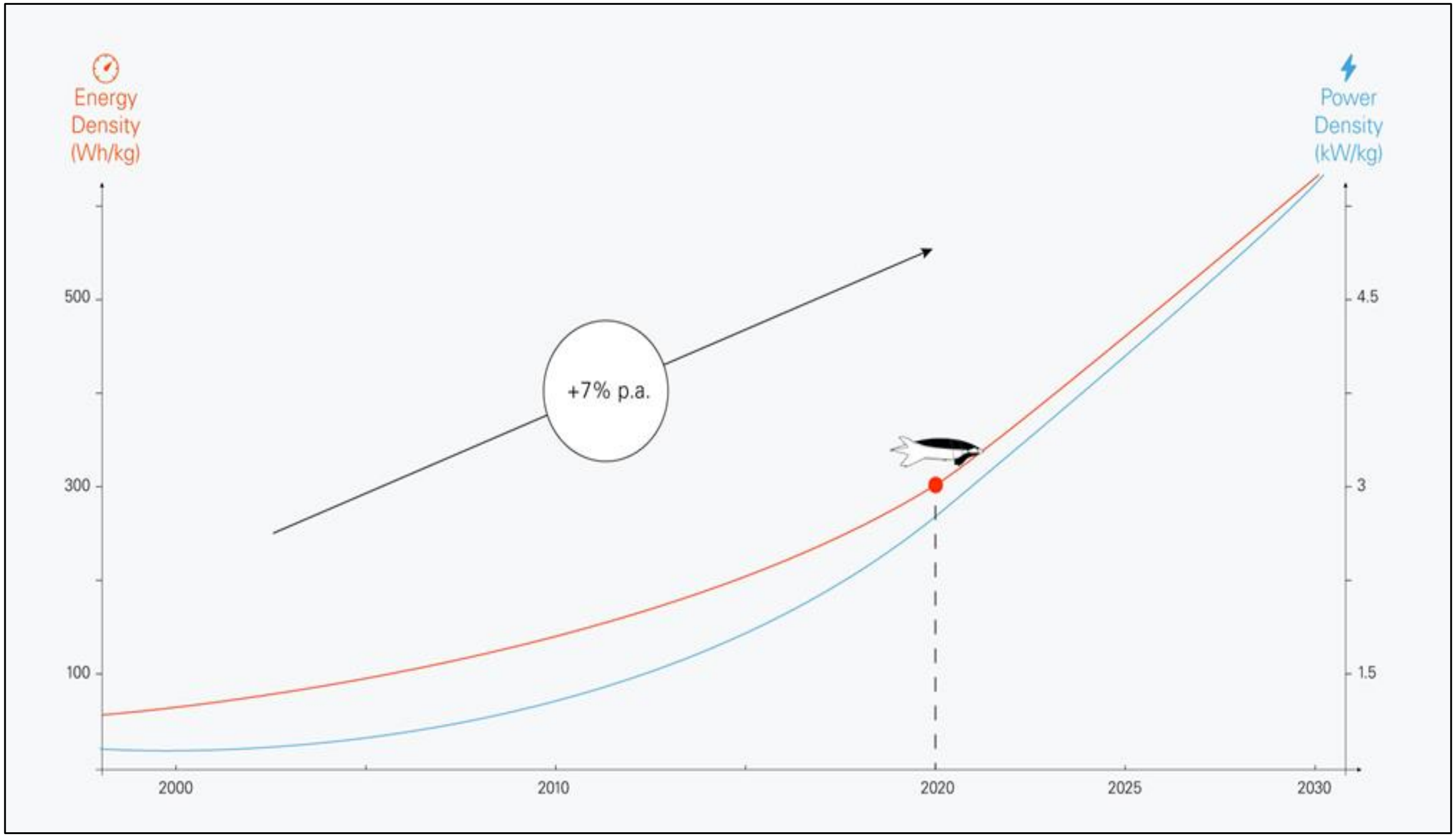


Sripad, S., & Viswanathan, V. (2021). The promise of energy-efficient battery-powered urban aircraft. Proceedings of the National Academy of Sciences, 118(45), e2111164118.

Source: Lilium

Technical Challenges

- Energy Density Dependency



Source: Lilium

Techncal Challenges

- Battery Weight Estimation

Typical UAM Mission:

- ✓ 4 PAX + 1 Pilot
- ✓ Cruise Speed: 100KIAS
- ✓ **Range : 100 km**
- ✓ Cruise Altitude: 1000ft AGL
- ✓ Maximum Take-off Weight : 2500kg
- ✓ Minimum Remaining Batt Energy: 40% Full
- ✓ **Energy Density: 300 W.h/kg**

Estimated Power Required:

$$\boxed{Preq = T.V = \frac{1}{\eta} TOW.g.\left(\frac{CD}{CL}\right).V}$$

Preq = (1/0.7)*2500*9.81*(1/10)*(51.95)
= 182.0 kW

Estimated Energy Required:

$$\boxed{Ereq = Preq\ .\ T}$$

T = D/TAS = 100/(100*1.852)= 0.53h (32.3 min)
Ereq= 182.0*0.53 = **94.5 KW.h + 4 KW.h (hover in&out)**

TOTAL BATTERY CAPACITY= 98.5/0.4 = **246.3 kW.h**

BATTERY PACK WEIGHT = 246.3 / 300 *1000 = **820.8 kg**

Current Technology:

30% to 35% of vehicle’s weight is related to batteries !

4 PAX+ Pilot Payload = 425kg (@85 kg)
Estimated DOW= 1254 kg (???)

Technical Challenges

- According to recent studies (NASA and FAA), **hundreds of eVTOLs will be sharing the airspace simultaneously over metropolitan area within the next ten years.**

- New technologies should enable a substantial increase in the **number of route frequencies throughout the low-altitude airspace, thus significantly increasing the complexity of operations.**

- This development/trend/tendency should be assisted by a **high level of system integration and automation, which could eventually enable pilotless operations in the long term.**

- New infrastructures and associated services must be developed to support such kinds of intensive operations: **vertiports and dedicated airspace design.**

✓ *eVTOLs are expected to be certified by 2024*

✓ *Commercial operations in cities are expected to start around 2025*

✓ *with delivery of goods by drones or transport of passengers by piloted aircraft*

Source; NASA (2020)

Technical Challenges

Operational Aspects to Consider

- ✓ Flights conducted at low level airspace in the urban environment
- ✓ **Short flight duration** (10-15 min)
- ✓ **High frequency** (20-30 flights per day)
- ✓ **Short turn-around time** (10-15 min)
- ✓ Dedicated departure and landing facilities (vertiports)
- ✓ Mixed on-demand and scheduled flights.
- ✓ Short autonomy and range - limited batteries energy (holdings/hovers highly undesirable).

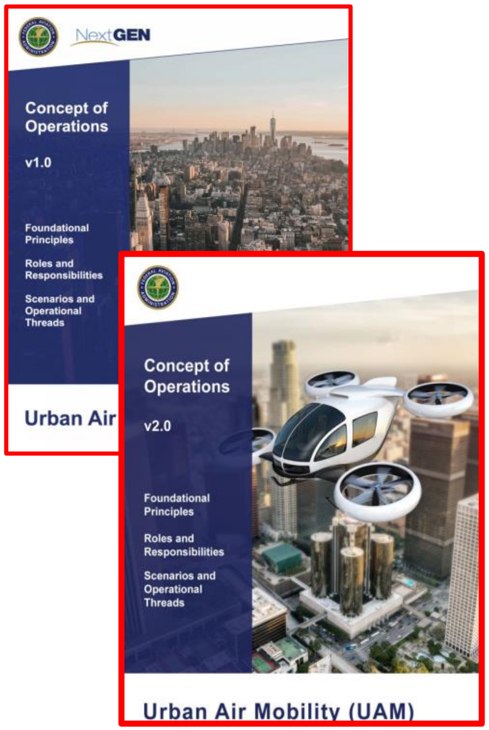
- ✓ *Bottlenecks will soon arise with current airspace environment.*
- ✓ *Need for new systems, automation and autonomy in aircraft and ground systems.*

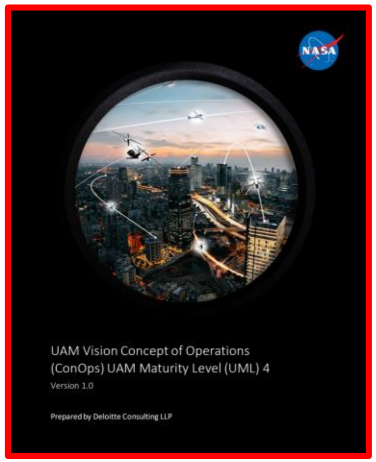
Source; NASA (2020)

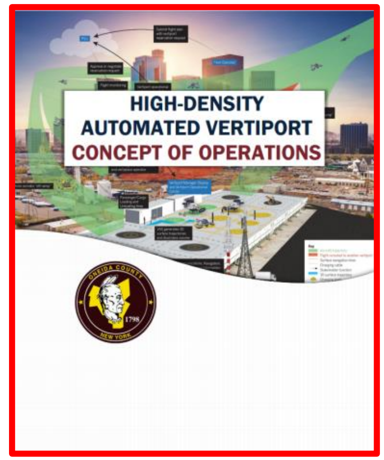
Concept of Operations

- **Useful Documents**

  - ✓ NASA UAM Vision Conops UML 4
  - ✓ FAA Conops 1.0 and 2.0
  - ✓ NASA High Density Automated Vertiport
  - ✓ Concept of operations for European UTM systems

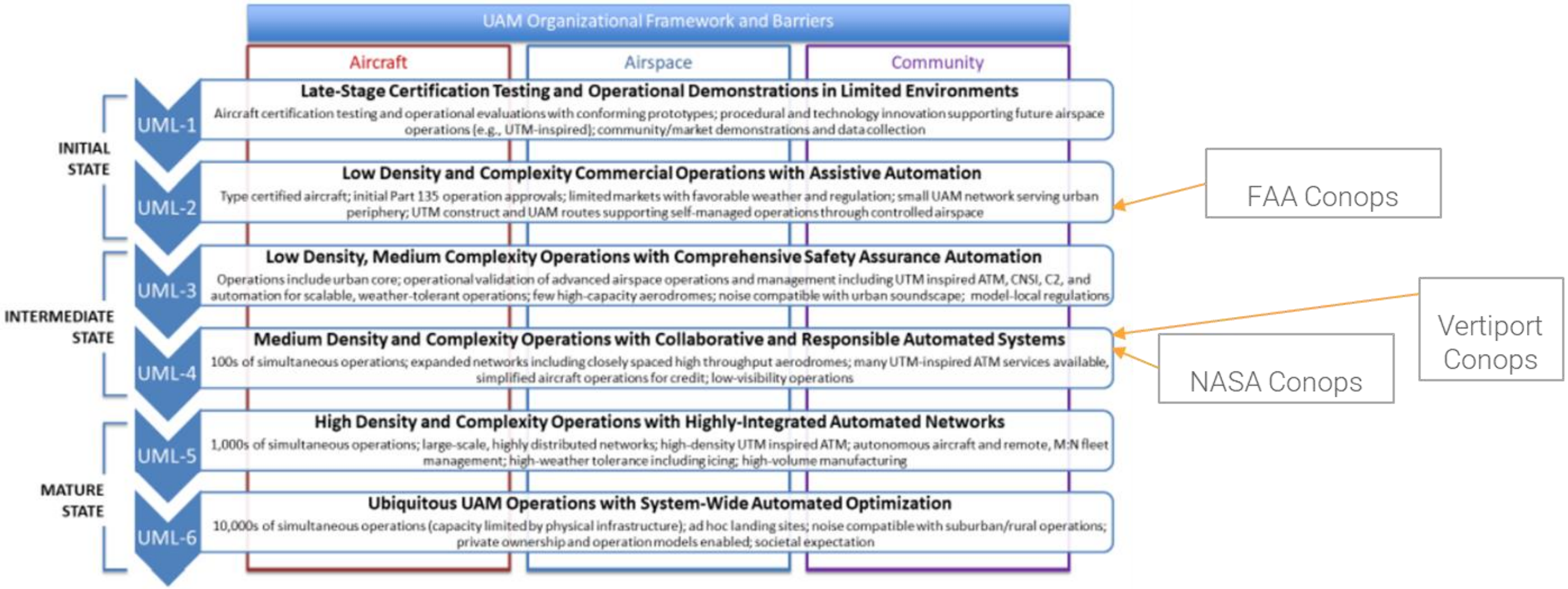






Concept of Operations

- NASA Maturity Levels



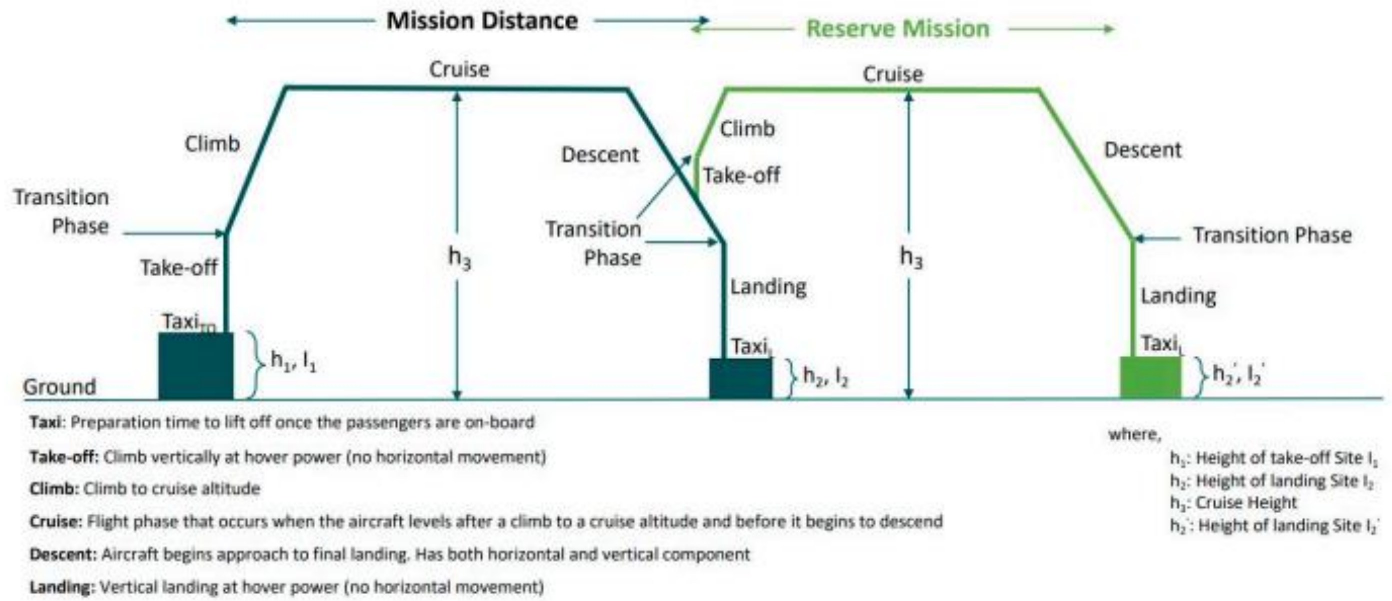
Concept of Operations

- **FAA ConOps**

Key Indicator	**Horizon 1**	**Horizon 2**
Operational Characteristics	✓ Conducted by certified UAM aircraft and conventional helicopters consistent with current rules and regulations.	✓ With increasing operations, UAM operations will need to evolve through changes to the governing regulations augmented by UAM structure and automation.
Operational TEMPO	✓ Low	✓ Medium
UAM structure (airspace and procedural)	✓ Implementation of existing helicopter infrastructure (e.g., routes, helipads, rules and regulations, ATC services). ✓ No UAM unique structures or procedures exist.	✓ Operations occur within defined UAM Corridors from specific aerodromes based on UAM performance requirements. ✓ There is minimal UAM Corridor structure or intersections. ✓ ATC tactical separation services are not provided for operations within the UAM Corridors. ✓ Tactical separation is allocated to the UAM operators, PICs, and PSUs.
Regulatory	✓ Conducted consistent with the current rules, regulations, and local agreements.	✓ Changes to ATM regulations and new UAM regulations that enable operations within UAM Corridors.
Automation level	✓ Consistent with current, manned helicopter technologies.	✓ PICs actively control the aircraft with UAM-specific capabilities.
Pilot location	✓ Onboard	✓ Onboard

Concept of Operations

- **Operational Profile**



Goyal, R., Reiche, C., Fernando, C., & Cohen, A. (2021). Advanced air mobility: Demand analysis and market potential of the airport shuttle and air taxi markets. Sustainability, 13(13), 7421.

Autonomy

- **Evolution**

  - ✓ Few OEMs are designing autonomous vehicles since day one
  - ✓ Envisioned to be achieved in a phased progression, ensuring flight safety
  - ✓ Public acceptance is key
  - ✓ What is the fastest path to certification ?

Phase 4
- Fully Autonomous

Phase 3
- No Pilot
- Less Structured Operations

RPA?

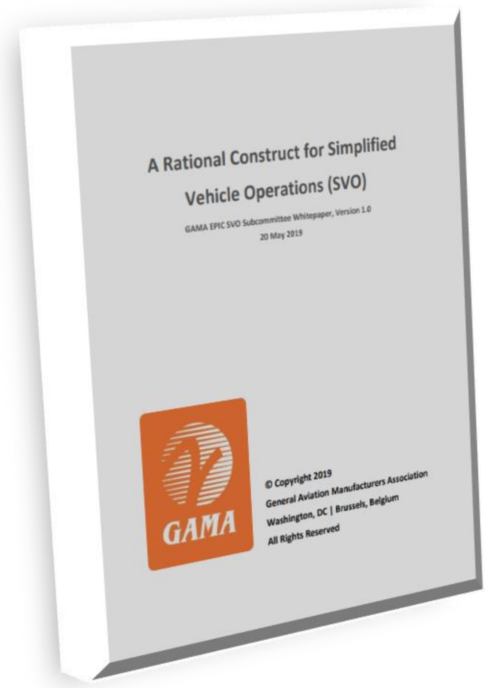
Phase 2
- No Pilot
- Structured Operations

FAA ConOps H1 and H2

Phase 1
- Pilot on-board
- Structured Operations

Autonomy

- **Simplified Vehicle Operations (SVO)**
  - ✓ Means the use of automation coupled with human factors best practices aiming to reduce the quantity of trained skills and knowledge that the pilot must acquire to operate an aircraft at a required level of operational safety.
  - ✓ Application of human and systems integration approach.
  - ✓ Ensures seamless coordination and execution of both independent and joint pilot and automation functions.
  - ✓ The high level of automation targets the increasing the level of safety.
  - ✓ GAMA working group was settled in 2015 to discuss long-term goal of enabling SVO is to facilitate the safe development and deployment of fully autonomous flight systems on manned aircraft.



Autonomy

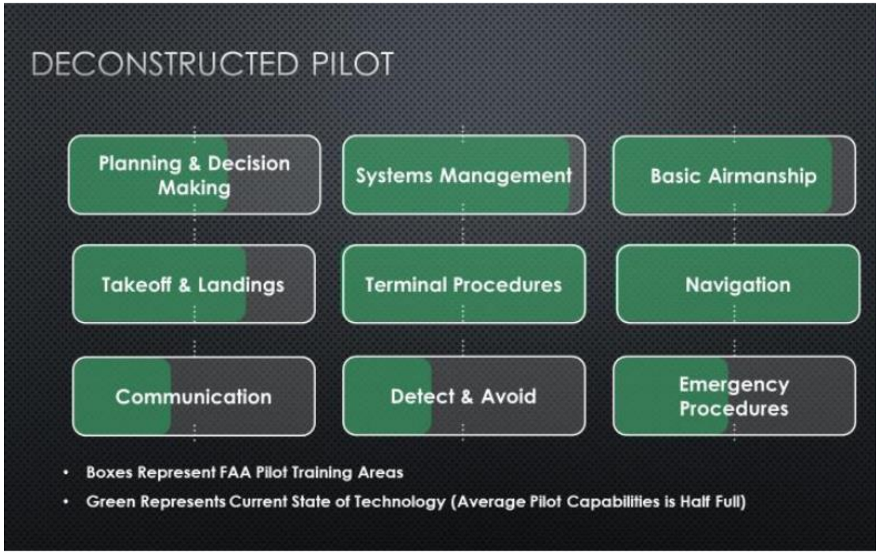
- **Simplified Vehicle Operations (SVO)**

  ✓ The basis of SVO is to “deconstruct” the functions that pilots are trained to accomplish today.

  ✓ Some functions may be more efficiently/reliably executed by an automated or autonomous system. (i.e. sys management and navigation)

  ✓ While others may be still difficult or impractical to automate in desired operating situations.

  ✓ (i.e. detect and avoid)



Source: Gama

Autonomy

- **Simplified Vehicle Operations (SVO)**

MARTOS, Borja. SFTE SVO Webinar December 2020. E-VTOL Flight Test Council.

SVO1

- *"Airplane like" in cruise*
- *Simplified hover controls*

Commercial Pilots (Helicopter/Fixed wings)

SVO2

- *Identical cruise and hover controls*
- *Auto takeoff/landing*
- *Auto failure protection*

UAM "Operator"

SVO3

- *Fully Autonomous Operations*
- *PAX designate destination.*

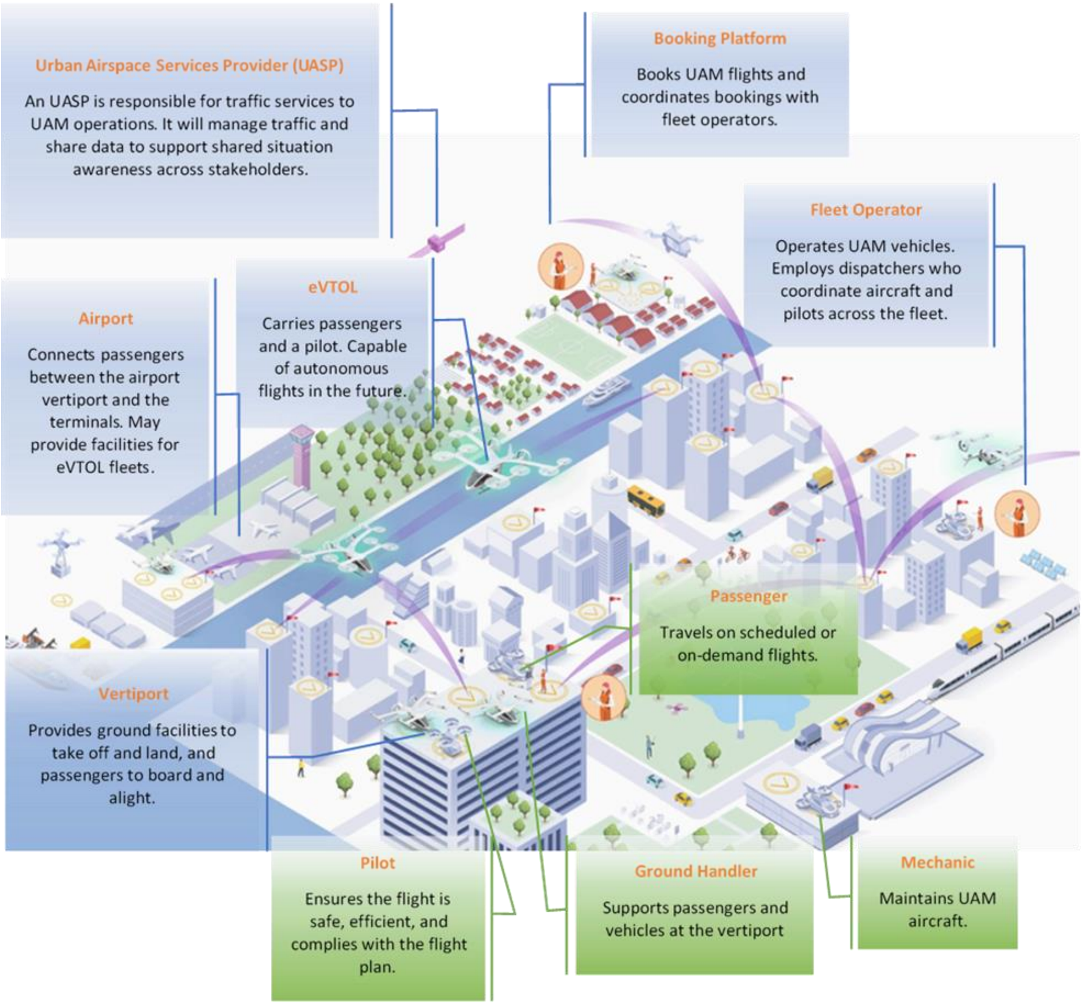
No Pilots

H1 H2 Hx

Increasing automation

The Ecosystem

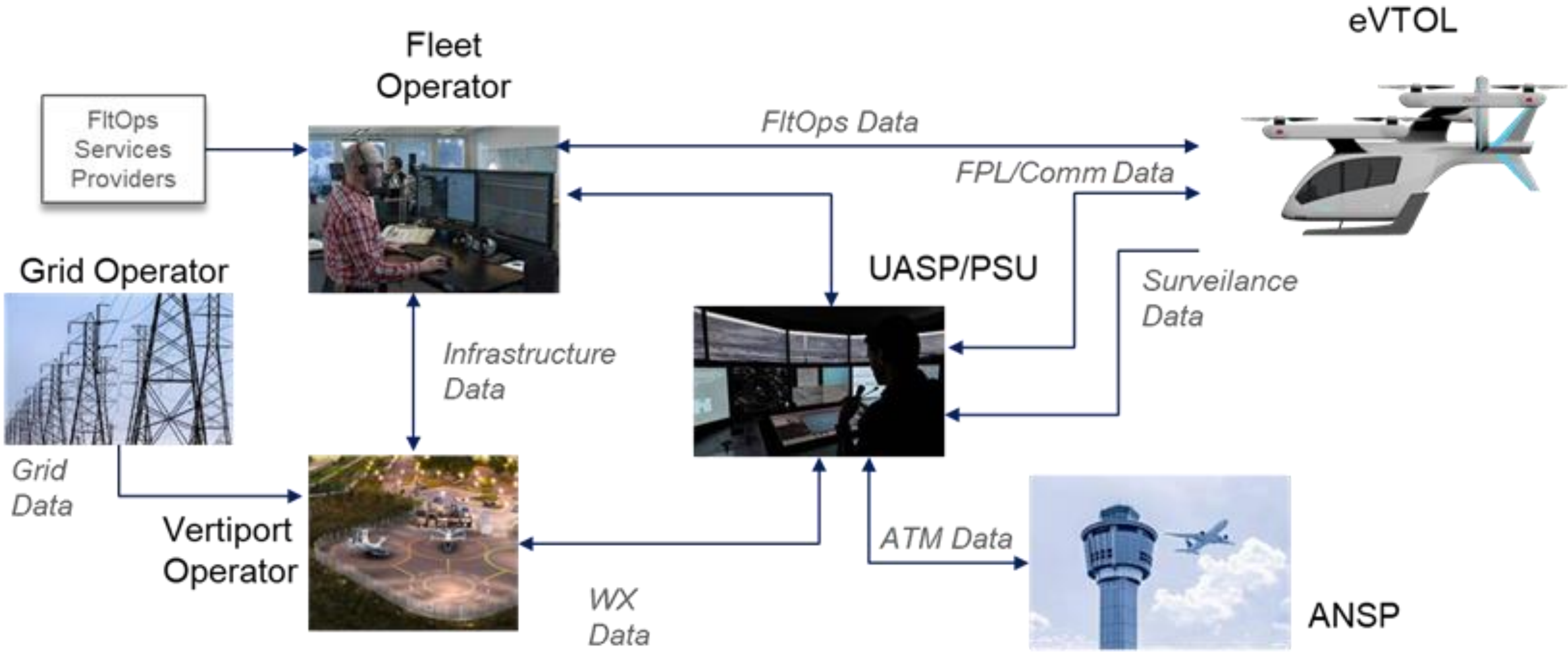
- **UAM Stakeholders**



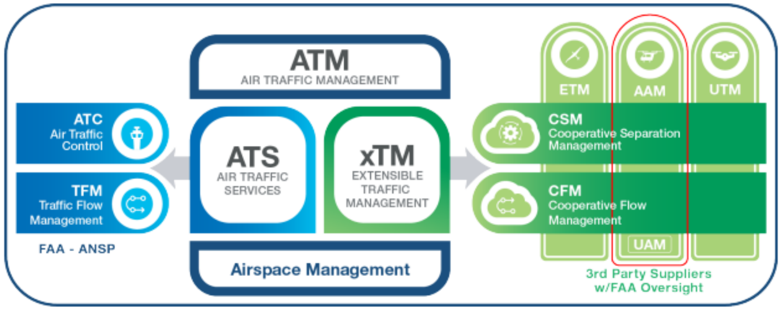
Source: Rio de Janeiro ConOps (EVE Air Mobility)

The Ecosystem

- UAM Systems Integration



Source: Rio de Janeiro ConOps (EVE Air Mobility)



Source: FAA ConOps 2.0

The Ecosystem

- **Fleet Operator**

- Manages their respective UAM vehicle fleet, schedule and maintenance
- Receive orders for flight through a booking platform operator for on-demand or timetabled bookings
- Selects the vehicle and pilot for incoming ride requests
- Exchanges information and coordinate airside and ground activities with Vertiports
- In coordination with the UAM vehicle pilot, the fleet operator will
  - ✓ Submit a flight intent notification and follow-up acceptance
  - ✓ Manage pre-flight data (weather, notices, others) and checks
  - ✓ Coordinate clearance requests
  - ✓ Follow-up the UAM flight operations until completion and coordinate ground activities

The Ecosystem

- **Vertiports**
  - Provide structured services to UAM flights
  - Support higher density of flights
  - Provide access to passenger and cargo, parking space
  - Might have multiples FATOs / TLOFs
  - Will have support for eVTOLs - eg. charging stations
  - Vertiports will have new technologies
    - ✓ Operations center
    - ✓ Integrated collaborative systems
    - ✓ Landing systems
    - ✓ Sensor systems - detection, airside

Source: Skyports

The Ecosystem

- **Vertiports**
  - Types:
    - ✓ Vertiport - normal operations
    - ✓ Vertistop - small location
    - ✓ Vertihub - fleet operator, maintenance

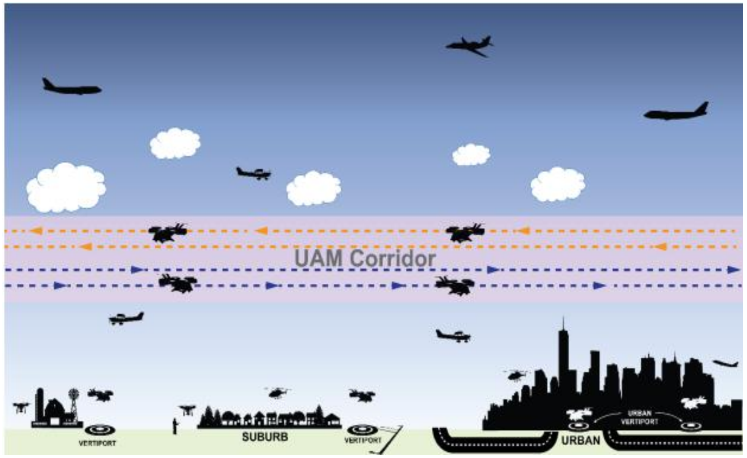
  - May have additional parking space
  - May have dedicated emergency TLOF
  - Must have navigation aids and visual lighting
  - Airspace capacity will depend deeply on vertiport capacity

Source: NASA Vertiport ConOps

The Ecosystem

- **Urban Airspace Services Provider (UASP)**

  - ✓ Supports UAM operators meeting operational requirements safe, efficient, use of the airspace.
  - ✓ Communication bridge fleet between operators, vertiport, ANSP and others.
  - ✓ Information source about planned UAM operations in a UAM Corridor for UAM operators and Vertiports.
  - ✓ Analyzes and confirms Operational Intent.
  - ✓ Distributes notifications (e.g., constraints, restrictions) for the intended area of operation.
  - ✓ Distributes operational data and advisories, weather, and supplemental data.
  - ✓ Supports cooperative separation management services (e.g., conformance/advisory services)
  - ✓ Determines UAM Corridors for ANSP.

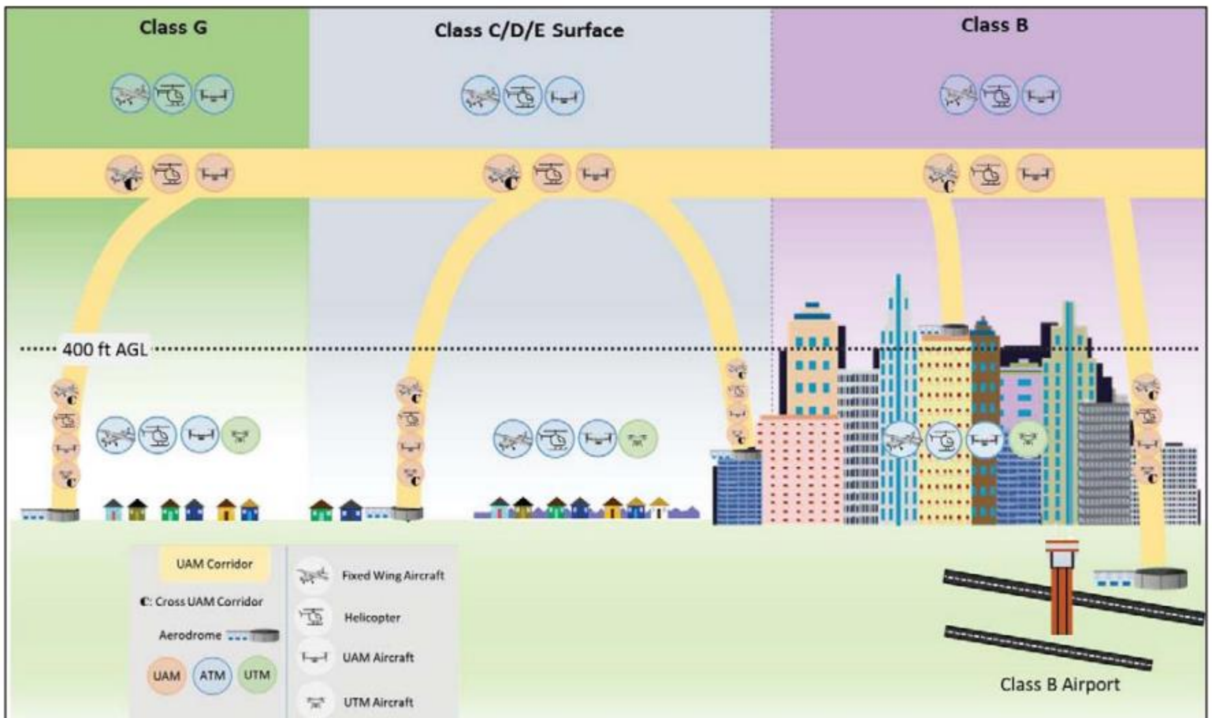


Source: FAA ConOps 1.0

The Ecosystem

- **UAM Airpsace**

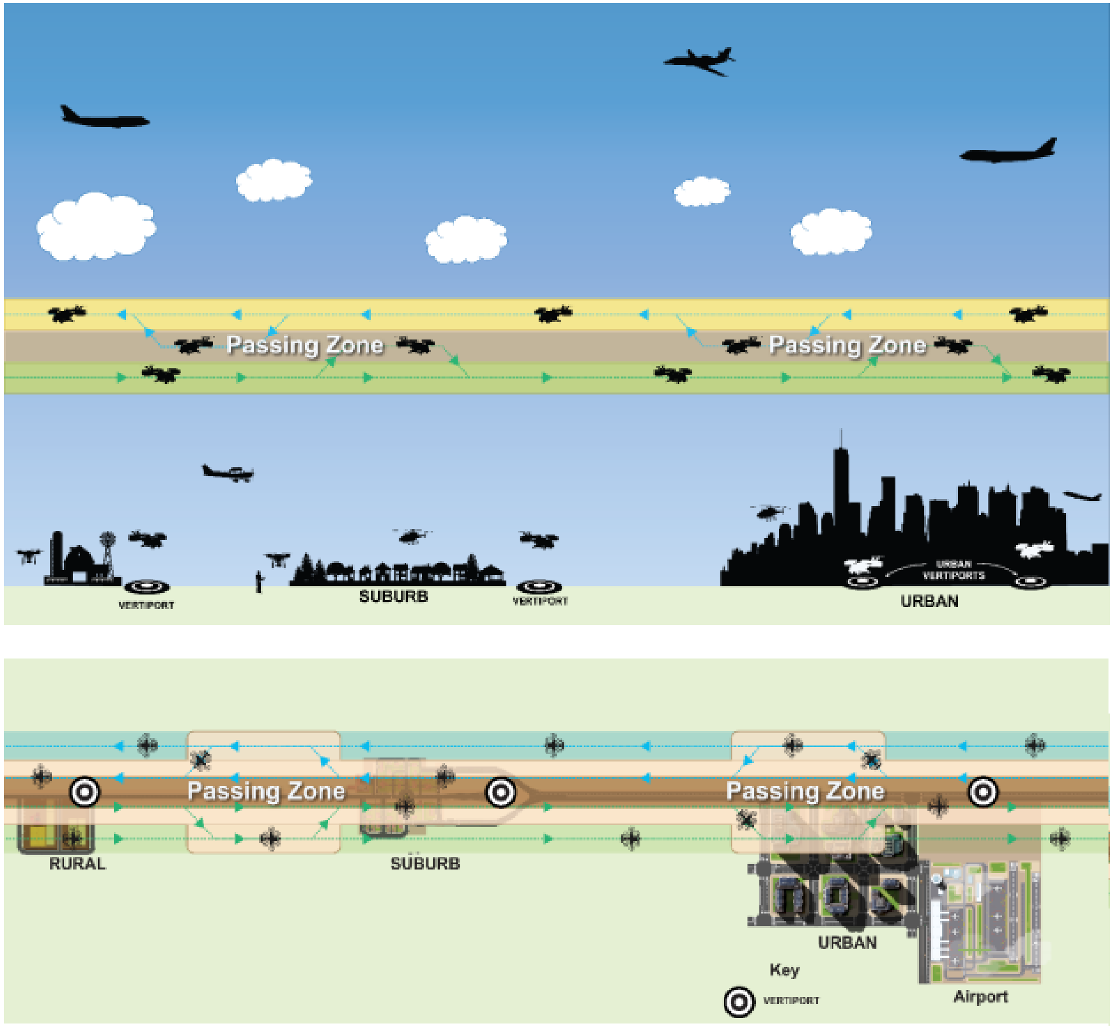
  - ✓ Evolution from Routes to Corridors to Reserved Volumes.
  - ✓ Inside corridors or volumes, all aircraft operate under UAM rules.
  - ✓ Crossed by UTM / fixed wing.
  - ✓ Operations independent of airspace class.
  - ✓ Operation may depend on performance.



Source: FAA ConOps 1.0

The Ecosystem

- UAM Corridors (FAA ConOps 2.0)



The Ecosystem

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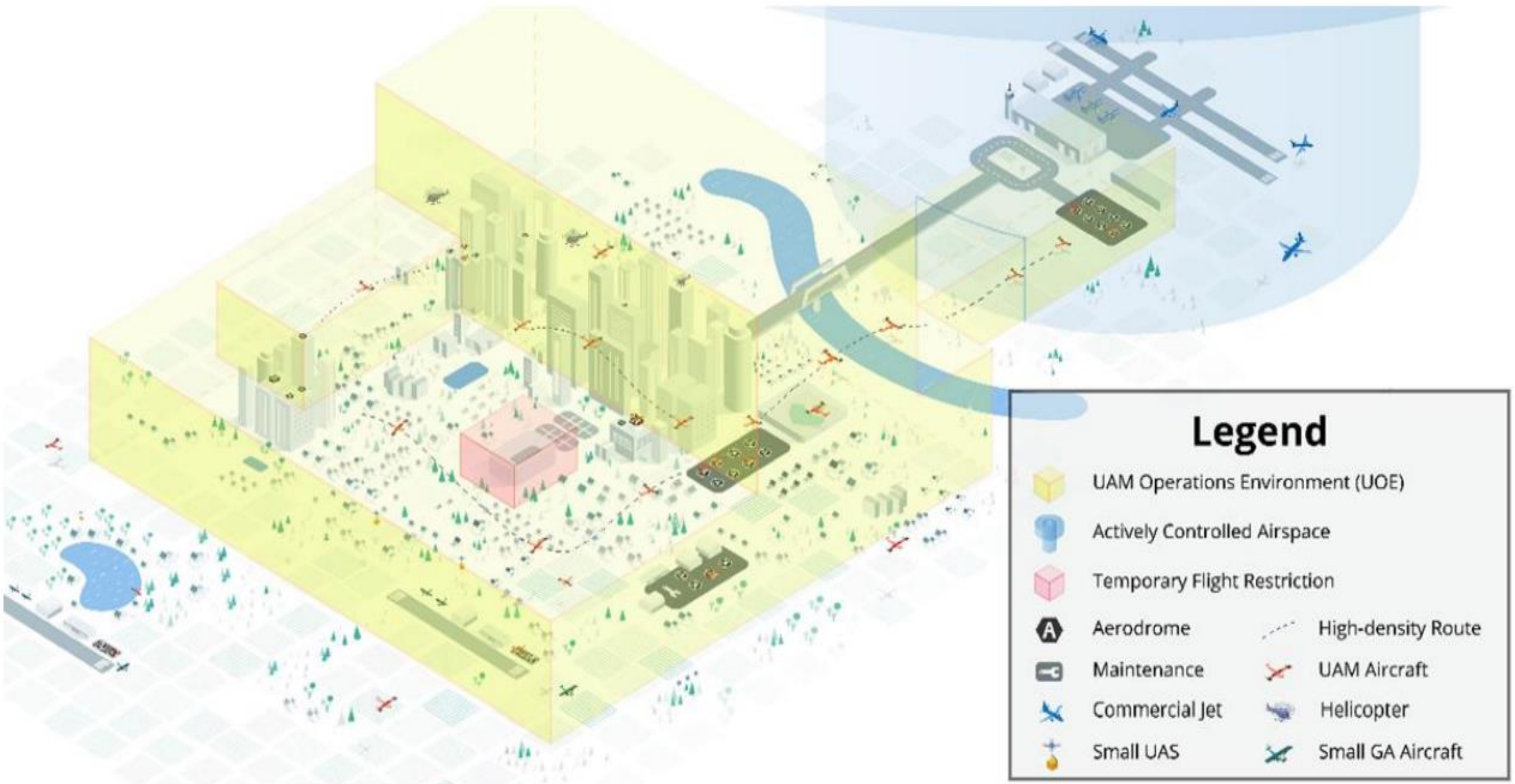

Source: FAA ConOps 1.0

The Ecosystem

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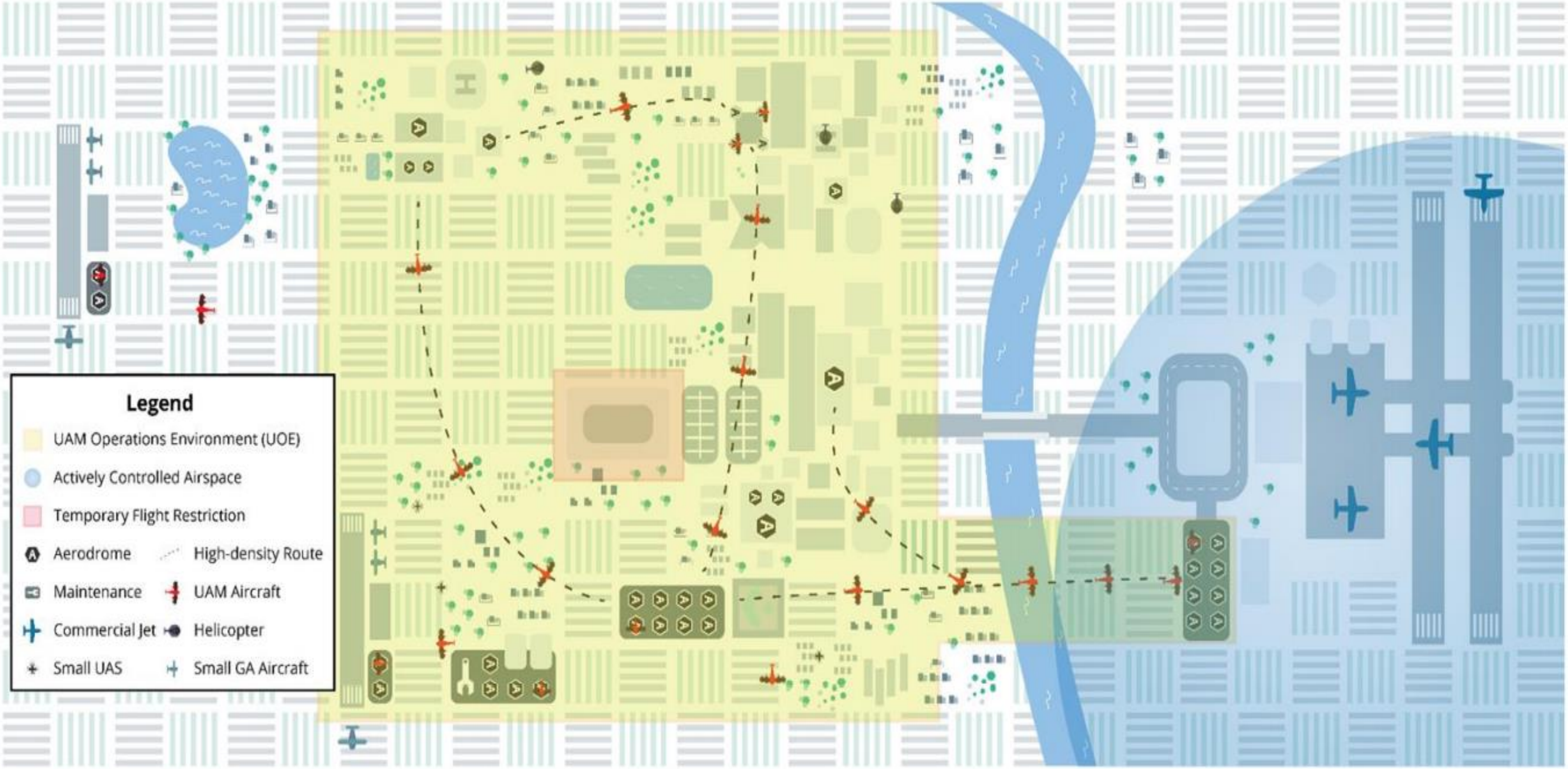

Source: FAA ConOps 1.0

The Ecosystem

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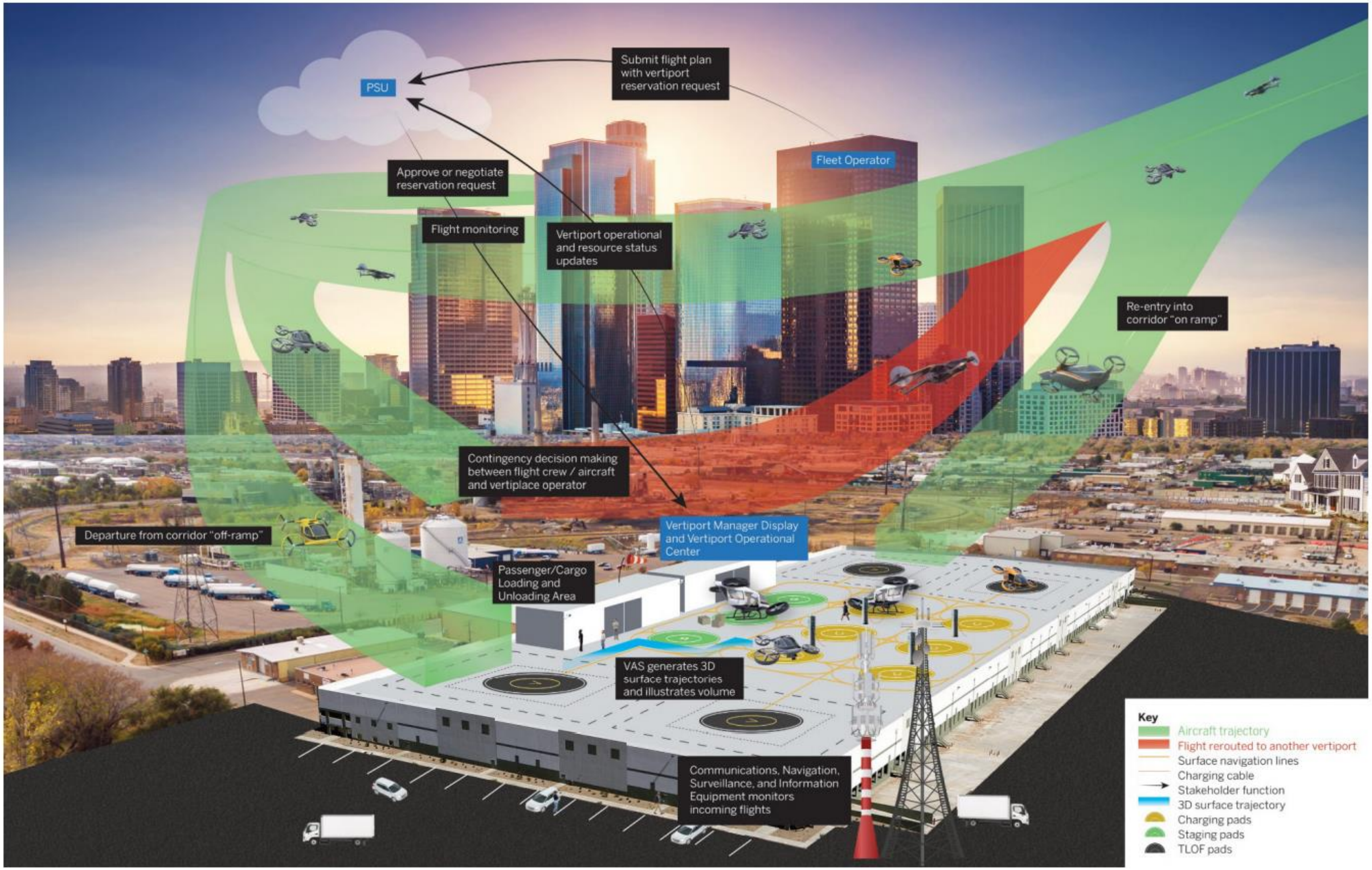
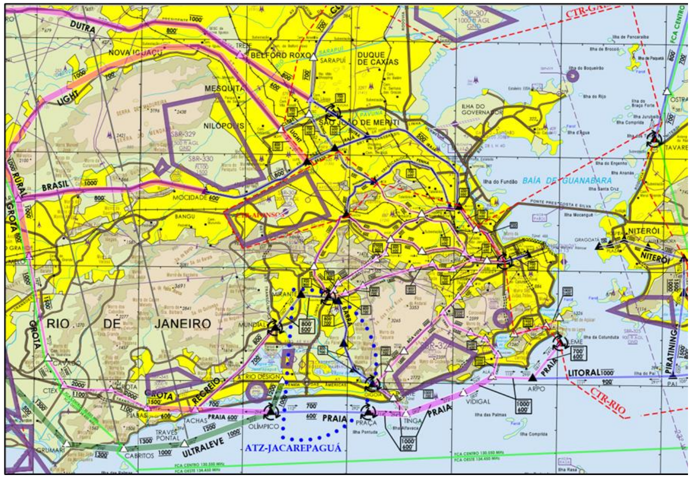


Operational Implementation

- ## Horizon 1

  - ✓ Use of current VFR corridors, considering the published vertical and lateral limits. This airspace is shared with general aviation (helicopters and fixed-wing operations).
  - ✓ An increase in traffic volume in these corridors, due to the presence of eVTOLs, is expected to have a magnitude of 5 to 10 times more flights than the regular helicopters flight demand.
  - ✓ The use of current heliports and airport networks might be necessary.
  - ✓ An increasing number of multiple fleet operators acting at the same time, with different vehicle types and networks.
  - ✓ The current CNS Infrastructure installed in TMA may be sufficient to support such a change at the very beginning.
  - ✓ ADS-B in/out and VHF Comm voice may be used.
  - ✓ However, as far as the volume of traffic increases, innovative solutions for Horizon 2 should be developed as soon as possible.

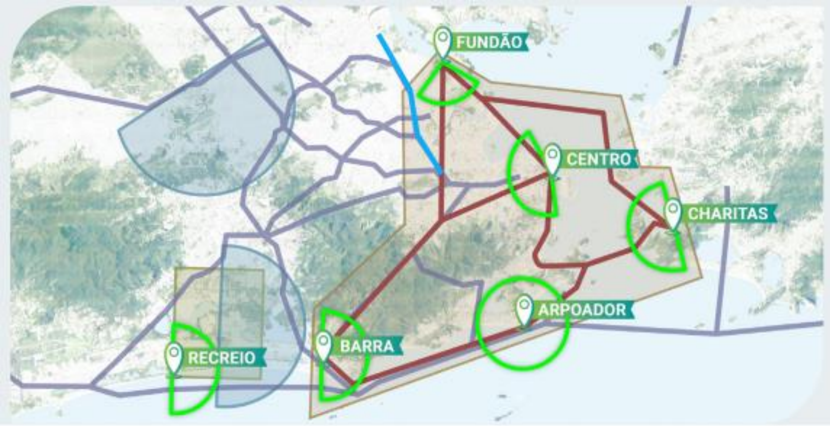


Source: DECEA

Operational Implementation

- **Horizon 2**

  - ✓ Establishment of new vertiports strategically located to attend passenger demand needs.
  - ✓ Strategic separation of UAM operations in 4D through the analysis and validation of flight intents submitted by the operators.
  - ✓ Reservation of airspace and vertiport resources through the validation of flight intents feasibility.
  - ✓ Design of corridors exclusive for eVTOL operations, for routes with a high volume of traffic, considering:
    - Optimum flight profiles.
    - Vertical and lateral limits interfacing with CTRs (Control Areas) and TMAs in Class A, C, and D airspaces.
    - 4D flow capacity constraints.
    - Avoid overflight of security concern areas.
    - Avoid overflight of noise constraint areas.
    - Design on Performance-Based Navigation (PBN) principles.



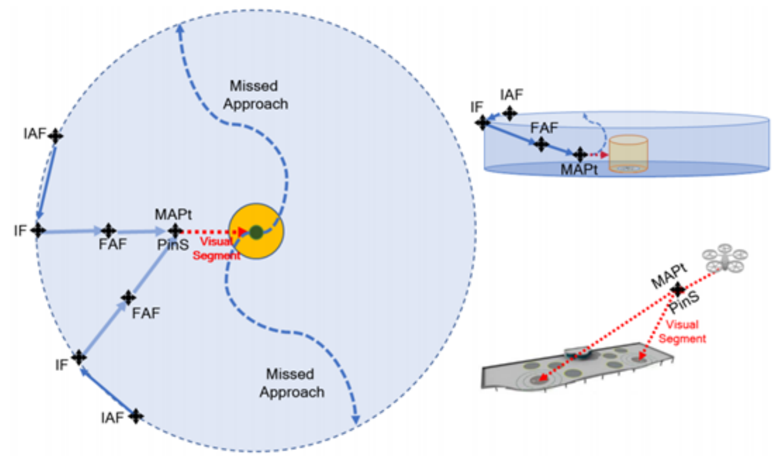
Source: Rio de Janeiro ConOps (EVE Air Mobility)

Operational Implementation

- **Horizon 2**

  ✓ Departure and approach procedures designed on PBN principles to support IFR operations under low visibility conditions, considering:
  ✓ Augmentation systems (ground or space-based) used to enable precision approaches.
  ✓ Approaches could be initially designed inspired by PinS (Point in Space) methodology.
  ✓ Accurate terrain and man-made obstacle mapping.
  ✓ New weather data sources or WX stations, for microclimate mapping (other than conventional METAR/TAF).
  ✓ Datalink technologies should be used for ATC/OCC comm to mitigate voice frequency congestions.

1. IAF – Initial Approach Fix – exit the high density corridor and start descend into vertiport
2. IF – Intermediate Fix - continue approach
3. FAF – Final Approach Fix
4. PinS/MAPt – Point in Space - Decision point for visual approach or missed approach
5. Vertiport has comms and nav with aircraft for landing
6. Aircraft follows landing procedure



Source: ICAO Doc.9168 Vol 2

Operational Implementation

- **Technology Aspects**

  - ✓ **UAM vehicles will operate in low-level airspace.** UAM vehicles are expected to operate primarily between 500 ft – 1,000 ft AGL, but they will also operate above this level. Low-level airspace includes airspace within and outside of the urban environment.

  - ✓ **Blend of Human and Machine Detect-and-Avoid Capabilities**. eVTOL operations will conduct detect-and-avoid through some combination of human (pilot-in-command) and technical systems, which may also incorporate off-board systems (i.e. ground-based detect-and-avoid).

  - ✓ **Initial operations will use voice communications but will evolve into an integrated system**. Initial eVTOL operations are expected to be piloted aircraft that will require voice-based communication capabilities and later will evolve to a highly integrated system interconnecting fleet operators, vertiports, aircraft and crew and service providers.

  - ✓ **Need for High-Precision Surveillance.** Starting from initial operations, eVTOL aircraft are expected to carry the required equipment for day and night operations. For initial operations, eVTOL aircraft will be equipped with ADS-B, but will have additional position broadcasting and other datalink technologies (eg. 5G, WiMax, etc) and will be equipped with technology to support high-precision cooperative surveillance.

  - ✓ **UAM vehicles will integrate with other airspace users**. Other airspace users, including helicopters, UASs, fixed-wing aircraft and hot air balloons will also use low-level airspace. No single category of operators will have exclusive use of airspace, and all operations will need to be integrated.

Operational Implementation

- **Regulatory Aspects**
  - **Horizon 1**
    - ✓ Operational regulations (FAR 91,119, and 135) would not change drastically, but slightly adapted from helicopter rules to enable the introduction of eVTOLs.
    - ✓ The focus on the reduction of paperwork, taking advantage of system automation.
    - ✓ Adaptation of Vertiport Design regulations.
  - **Horizon 2**
    - ✓ New UATM regulatory framework to support higher density airspaces.
    - ✓ New Labor regulations for intensive operations (journey limits).
    - ✓ New regulations for PSU Certification, Operations, and Safety Management.
    - ✓ New Ground Ops Crew training programs (PSU and Vertiports).
    - ✓ New Pilot training program specific for UAM operations (i.e., Simplified Vehicle Operations - SVO).
    - ✓ New capacitation programs for Pilots, Dispatchers, and PSU Operators.
    - ✓ Adaptation of current regulations for BATT charging and firefighting procedures.

Business Challenges

- **The Infrastructure**

"Experts foresee eVTOLs largely replacing helicopters for niche applications. There's less agreement on whether middle-class people will ever be routinely whisked around cities for pennies a mile. Some advocates think that's more than 10 years away, if it happens at all." - Delloit

- ✓ How could municipal and aviation authorities can solve the challenges of **integrating large numbers of eVTOLs into the airspace over major cities?** Some of these challenges are, like the aircraft themselves, totally new – Airspace and Ground Infrastructure are key.
- ✓ Most viable scenarios require the construction of **"vertiports" in and around cities**. These would be like mini airports where the eVTOLs would take off and land, be recharged, and take on and discharge passengers. **Right now, it's not clear who would pay for these.**
- ✓ At urban facilities, **vertiports space** will likely be limited to accommodating **several aircraft .** And yet at such a facility, **room will be needed during rush hours to accommodate dozens of aircraft needing to land, be charged, take on passengers, and take off.**
- ✓ Vertiport scheduling and capacity may become bottlenecks that limit the value of UAM.

IEEE (2022). *Following the Money in the Air-Taxi Craze - Are eVTOLs the "mother of all aerospace bubbles"? Spectrum-IEEE. AI Newsletter. February 2022.* https://spectrum-ieee-org.cdn.ampproject.org/c/s/spectrum.ieee.org/amp/evtol-aircraft-2656559231

Business Challenges

- Scaling Operations with Autonomy

"We're going to have to get the consumer used to thinking about flying in a small aircraft without a pilot on board. I have reservations about the general public's willingness to accept that vision." — Laurie Garrow, Georgia Tech

✓ Limited commercial flights will begin with **eVTOL aircraft flown by human pilots**, a phase that is **expected to last six to eight years at least.**

✓ Costs will be like those of **helicopter trips, which tend to be in the range of US$3.75 to US$6.26 per km**
Would you pay 120 US$ for a São Paulo Downtown-Guarulhos Airport Trip?

✓ Of the **250+ startups in the field**, **only three**—Kittyhawk, Wisk and Ehang—**plan to go straight to full autonomy** without a preliminary phase involving pilots.

✓ **The autonomy issue is the heart of whether this entire enterprise can succeed economically**. "When you figure in autonomy, **you go from US$1.8 to US$0.31 cents per km**" says Chris Anderson (Kittyhawk CEO), citing studies done by his company. "You can't do that with a pilot in the seat."

✓ For the **large-scale vision**, **autonomy will be critical.**

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Business Challenges

- **Regulations and Laws**

"The technical problems are, if not solved, then solvable. The main limiters are laws and regulations." — Chris Anderson, COO, Kittyhawk

- ✓ **OEMs are counting on mass-manufacturing techniques** to reduce the costs of these exotic aircraft, but such techniques have **never been applied to producing aircraft** on the scale specified in the projections.
- ✓ eVTOLs will require surmounting entire categories of **challenges**, including **regulations and certification, technology development, and the operational considerations of safely flying large numbers of aircraft in a small airspace**.
- ✓ FAA has chosen to **adapt its existing certification rules**. The EASA, on the other hand, has **created an entirely new set of regulations** tailored for eVTOL aircraft and related technology.
- ✓ **Regulators do not actually have a body of knowledge** and experience for certifying aircraft that fly by means of battery systems and electric motors.
- ✓ FAA **requires three certifications**: one for the aircraft itself, one for its operations, and one for its manufacturing.

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Business Challenges

- **Certification**

“If very high levels of automation are critical to scaling, that will be very difficult to certify. How do you certify all the algorithms?” —Matt Metcalfe, Deloitte Consulting

- ✓ This certification phase of **piloted aircraft is fraught with unknowns because of the novelty** of the eVTOL craft themselves. But experts say a greater **challenge lies ahead**, when manufacturers seek to certify the vehicles **for autonomous flight.**

- ✓ **How to certify that the systems will always going to be able to do what it is supposed to do with true autonomous technology ?** The system itself can make an undetermined number of decisions, within its programming….

- ✓ Current certification regulations assume the knowledge of the inputs and outcomes of every decision that the aircraft system makes. Does it work with autonomous systems ?

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Final Thoughts...

- Within a decade, during rush hour the skies over a large city, such as São Paulo, New York or Los Angeles, would swarm with hundreds, and eventually thousands, of eVTOL “air taxis.”

- Each would seat between one and perhaps half a dozen passengers, and would, eventually, be autonomous. Hailing a ride would be no more complicated than scheduling a trip on a ride-sharing app.

- But with some of these companies pledging to start commercial operations in 2024, there is no clear answer yet to a fundamental question:

Are we on the verge of a stunning revolution in urban transportation, or are we witnessing the “mother of all aerospace bubbles”?

Video – Autonomous Flights

https://www.youtube.com/watch?v=gZIM-OzzKpw&list=PPSV

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Thank You!