Enabling Autonomous Flight & Operations in the NAS

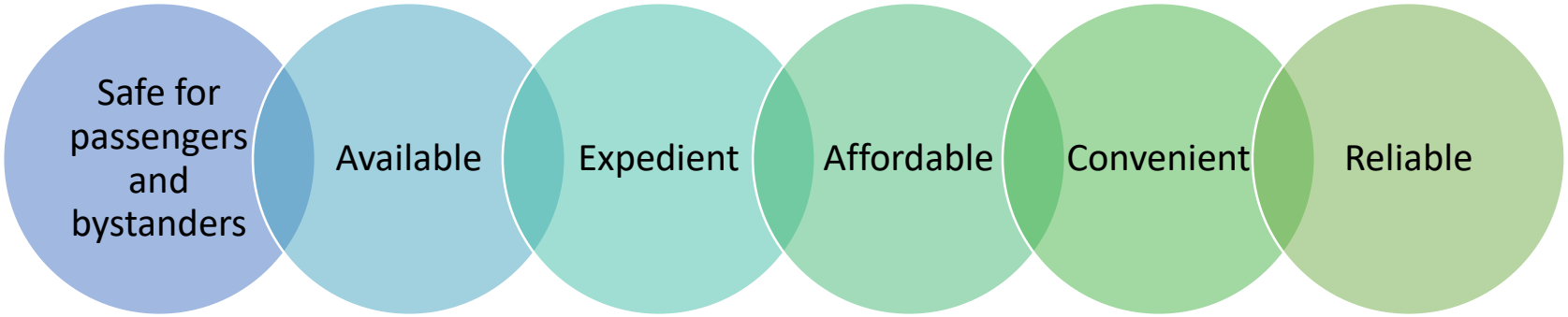
Urban air mobility

Overview

NEEDS FOR URBAN AIR MOBILITY

Personal Mobility

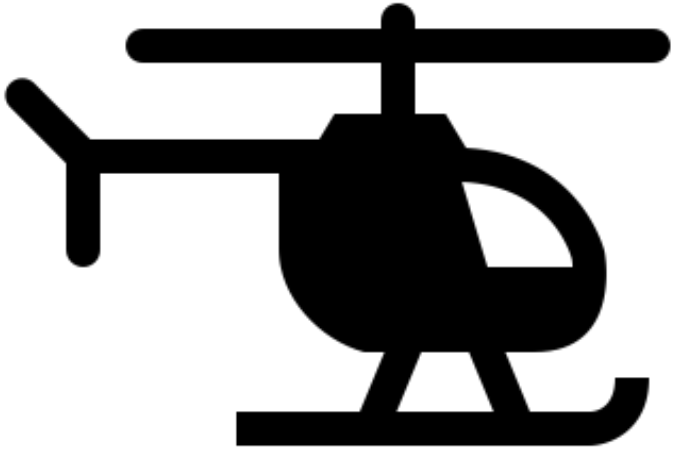
Cargo Delivery



CHARACTERISTICS OF AN MVP

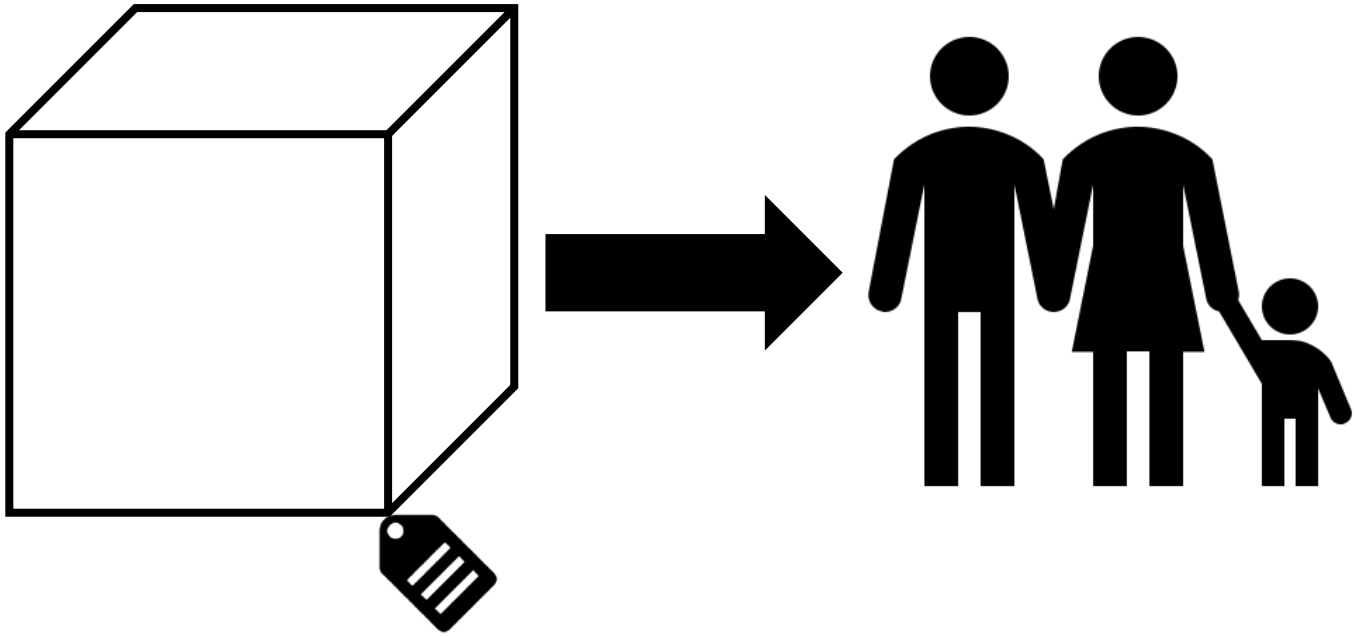
- “Routine Operations”
- Shared airspace with other UAM operations
- Certifiable in current regulations
- “Quiet”
- ”More evolution than revolution”
- “Recoverable”
- “Minimum equipage to interact with positively controlled airspace”
- Simple trajectories to begin- with increasing complexity
- High frequency (quick turn around)
- Has a market – eventually
- “Nearly” All Weather Ops
  - For the market to be used- it needs to have high availability

MVP – STARTING FROM HELICOPTER



- Piloted helicopter operations
- next steps as increasing levels of autonomy – reducing training needs and therefore cost
- Differences: noise, efficiency of flight, density, simplified ops
- Likely eVTOL or Hybrid
- Resilience

ENABLING AUTONOMOUS FLIGHT & OPERATIONS IN THE NAS



Initially Airports?

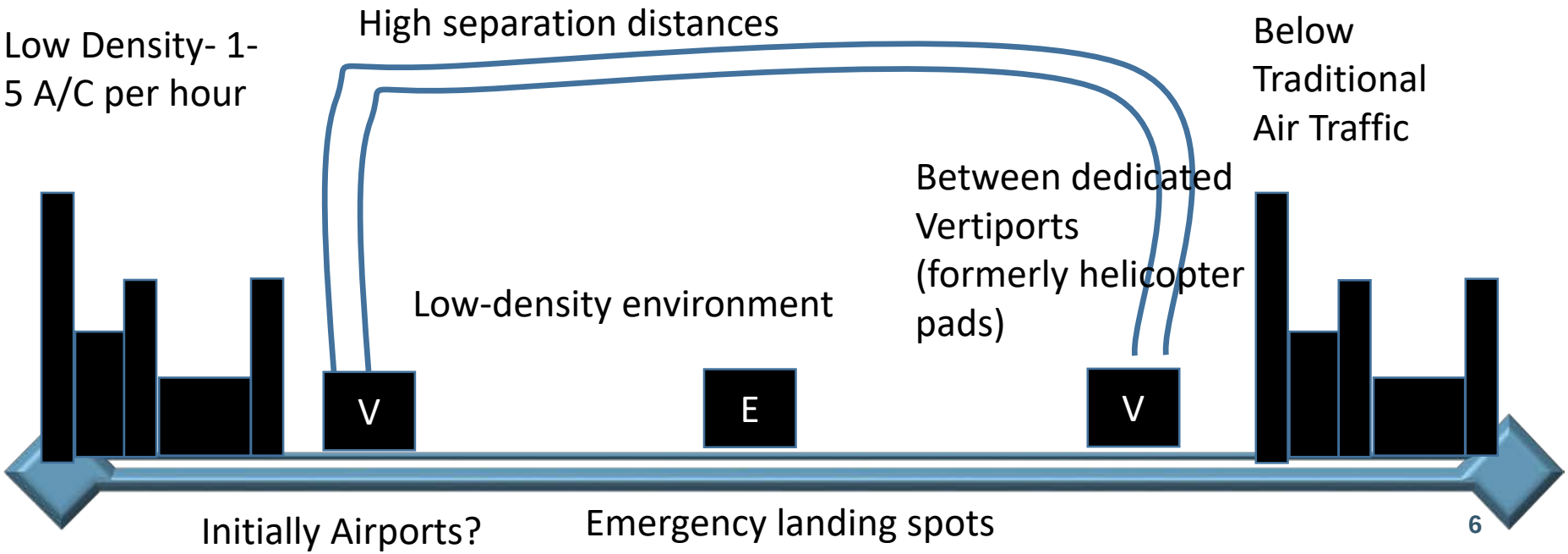
Emergency landing spots

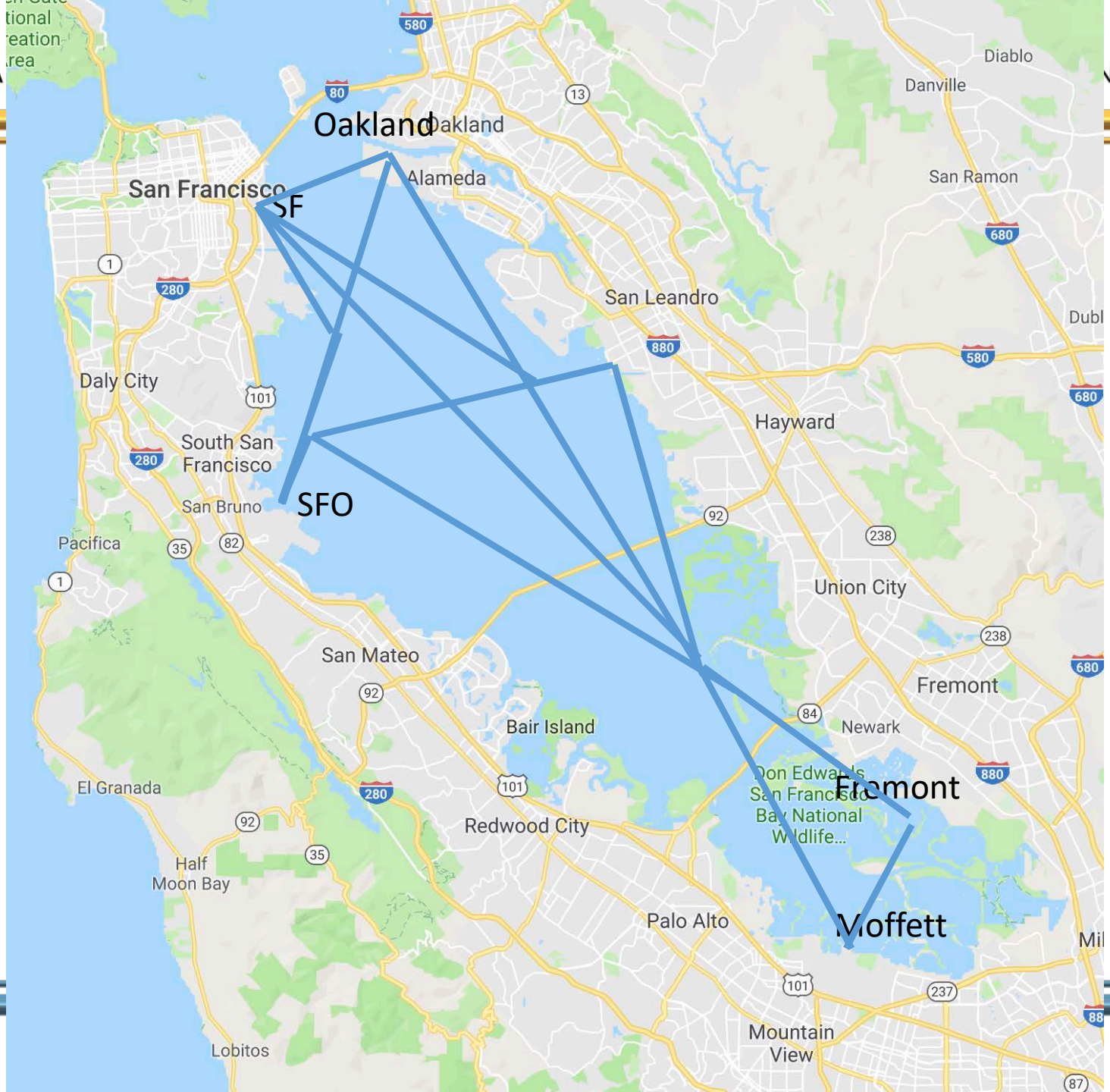
MINIMUM VIABLE PRODUCT – CONOPS 1

PRE-URBAN – CONCERN: LIMITED MARKET

LOWER RISK & NOISE

Traditional Air Traffic




Oakland
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Fremont
Moffett
San Francisco
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Alameda
Diablo
Danville
San Ramon
San Leandro
Daly City
South San Francisco
San Bruno
Pacifica
Hayward
Union City
San Mateo
Fremont
Newark
Bair Island
El Granada
Redwood City
Half Moon Bay
Palo Alto
Mountain View
Lobitos

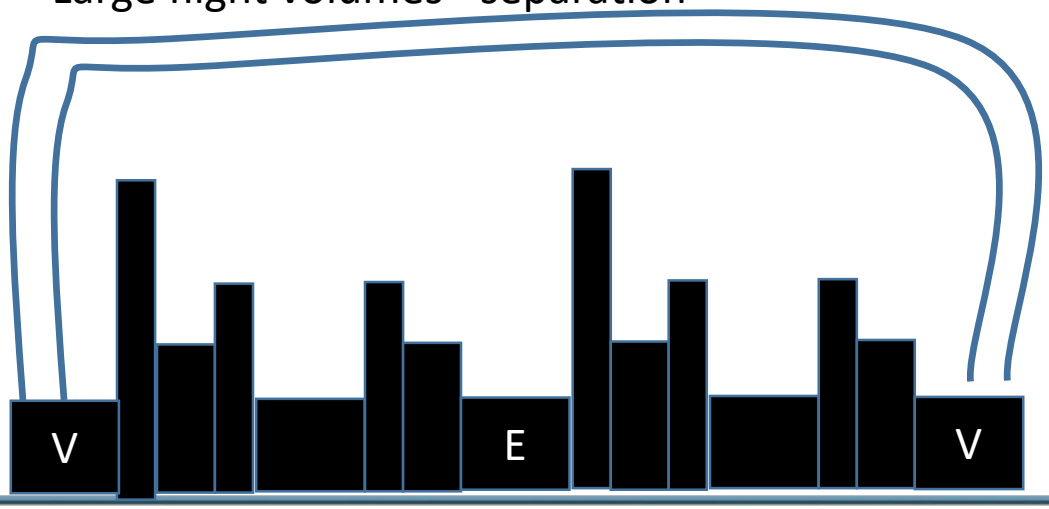
MINIMUM VIABLE PRODUCT – CONOPS 2

Traditional Air Traffic

Large flight volumes - separation

Below Traditional Air Traffic

Above skyline



Between dedicated Vertiports (formerly helicopter pads)

Initially Airports?

Emergency landing spots

TYPES OF MISSIONS

1. Firefighting
2. Emergency Medical Transport
3. Commercial Cargo Transport
4. On Demand personal mobility

FUNCTIONS OF AN MVP

1. UAM airspace/aviation services management system
2. Increasingly autonomous vehicle and traffic operations management
3. One or more aviation service products that operators can sign up for

DISCUSSION: AIRSPACE

Controlled- additional complexity and have to deal with ATC, but common equipage, less likely to have non-avian uncooperative traffic

UTM SUA corridors – separate from all other traffic

- VFR corridor

VFR, IFR, or *UFR?*

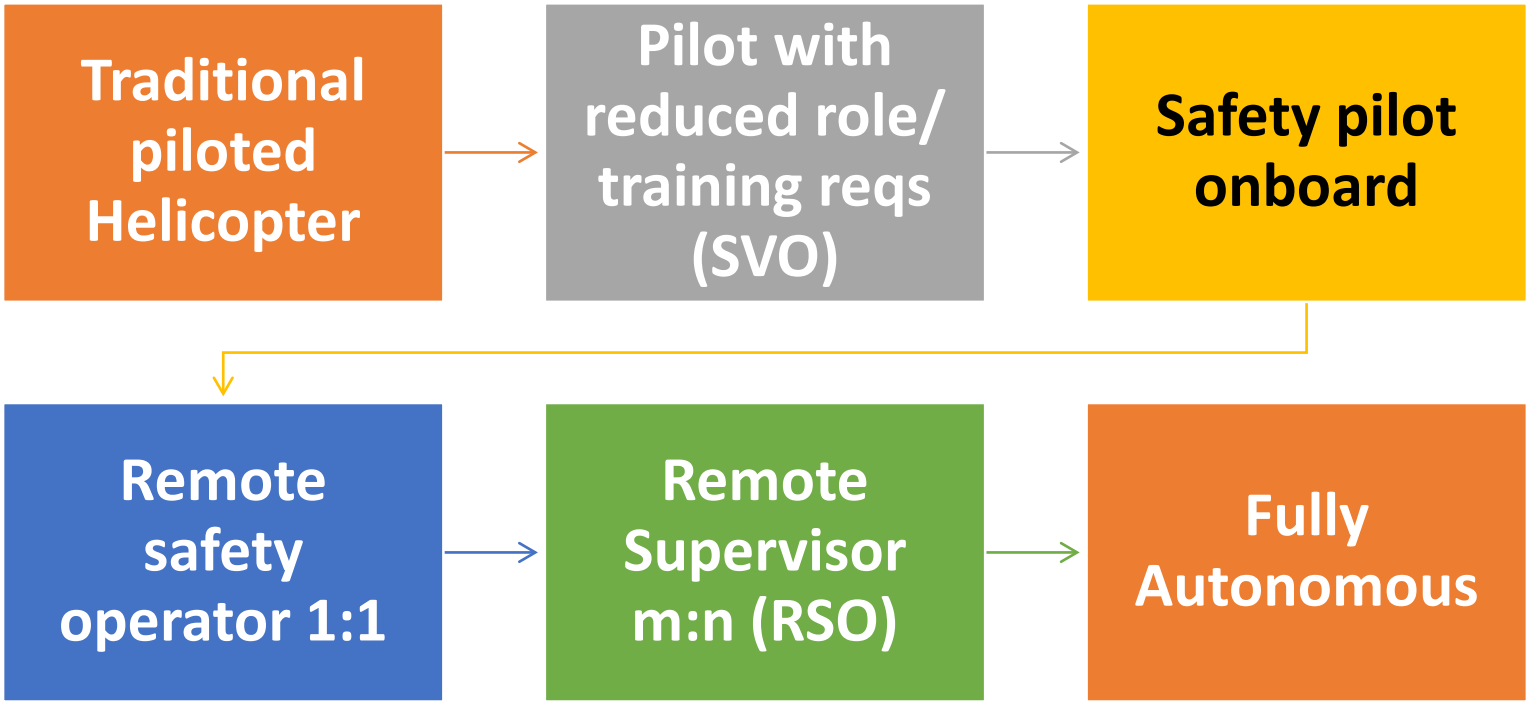
- Starting with VFR might be a lower bar

DISCUSSION: HOW FAR CAN AUTONOMY GO WITHOUT HUMANS?

- Rule 91.3 says that Human is responsible for automation
- Human and pilot work in parallel until we get to full autonomy
- Task oriented automation- because functions are certified and not the automation.
- Societal Issues:
  - Full autonomous- may still require human communication about overall mission. This will give that warm and fuzzy.
  - Passenger control: Pax should not be expected to make decisions like “land now”, who may not be the right person.
  - Fully autonomous could be for the vehicle, and not the entire eco system. This needs to be clarified and defined. It should not have a human as a backup.
  - Who is responsible for liabilities? The legal issues? Today we blame the driver of truck or pilot or manufacturer.

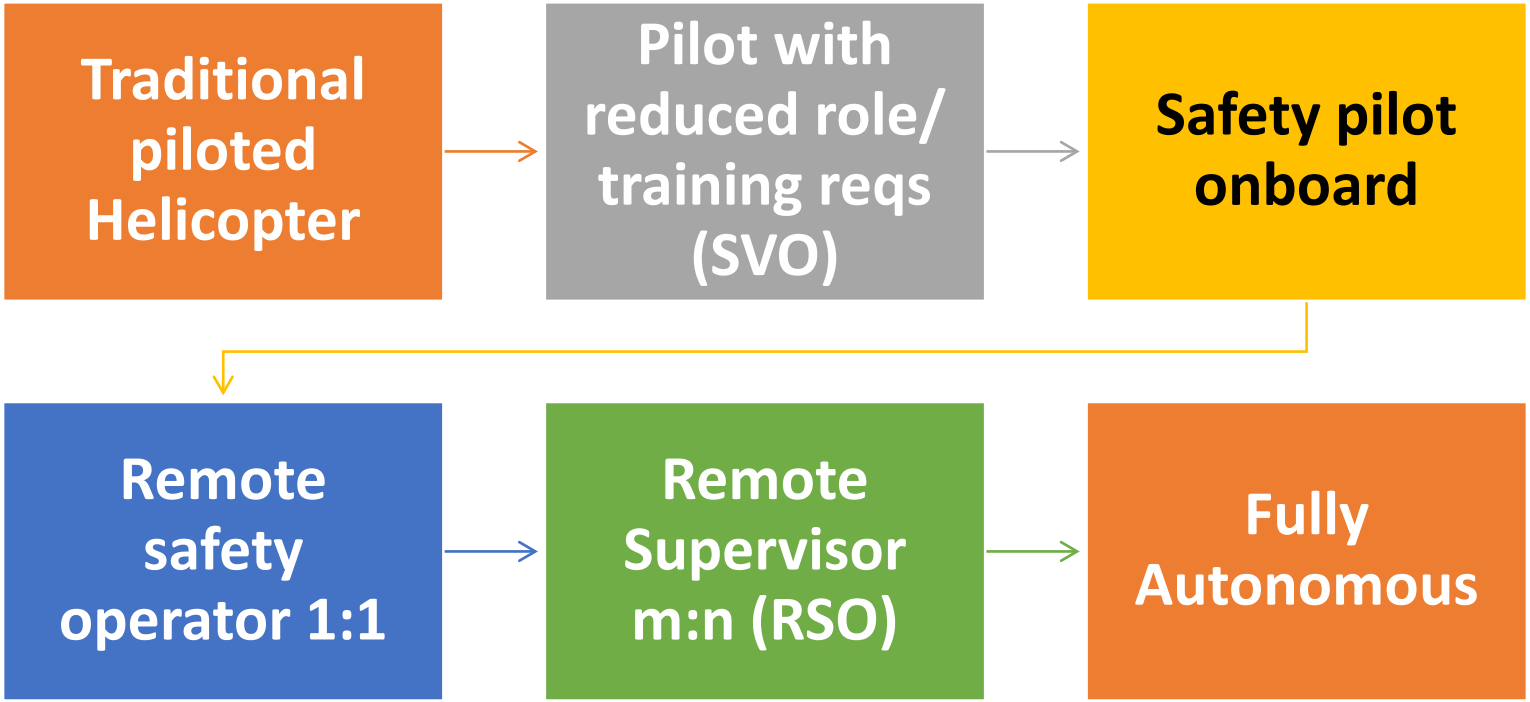
General Discussion – Where is MVP?

"…as easy as driving an Uber"
"train on a simulator"



General Discussion – Where is MVP?

Start here to build trust in autonomy
(the Autonomous Car Approach)



MINIMUM VIABLE PRODUCT

- Discussion – Regulatory needs
  - Does it need to be done under current regulations, or can it be done under future Part-21 regs under development?

INFRASTRUCTURE GAPS OF MEDIUM-SIZE URBAN AIR MOBILITY

reliability and security

Information- Common state awareness, intent

Communications

1.Technology for assisting take off and landing

1.Vertiports

Charging Stations

Airspace structure, conflict management, UAM Surveillance integration SERVICES

UTM infrastructure for UAM ATM

Spectrum Management infrastructure

Allocate appropriate spectrum (RTCA SC-228)

TECHNOLOGICAL GAPS OF MEDIUM-SIZE URBAN AIR MOBILITY

1.Resilient automation architecture design

VFR operational technology

1.Certified lower SWAP-C technology (e.g., radio, computers, sensors)

Collision Avoidance Sensors, DAA for UAM

Maturity, standards, interoperability with other collision avoidance functions

Contingency Management

”Resilient CNS” without GPS - Common

TECHNOLOGICAL GAPS OF MEDIUM-SIZE URBAN AIR MOBILITY

1.Autonomous Landing

Accurate, Detailed, and Robust Perception of Environment

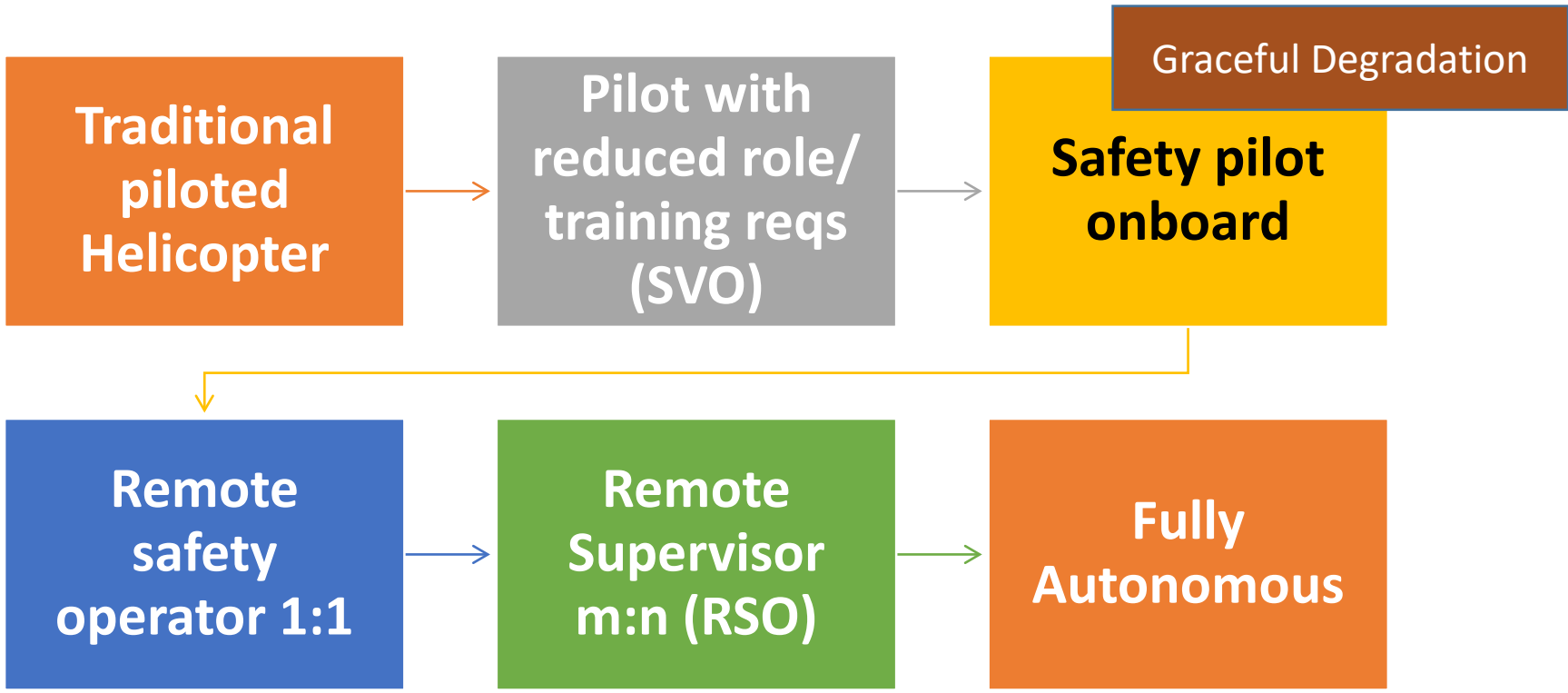
Especially in "adverse weather"

1.IVHM

Cybersecurity

MVP Gaps

Standards, tools, certification technologies, regulation, and best practices



OTHER GAPS OF MEDIUM-SIZE URBAN AIR MOBILITY

1.TRUST!!

Regulatory "Clarity"

Address policy and data gaps regarding integrated risk analysis: Incorporate new areas of concern (societal benefits, intermodal …)

1.Legal Challenges

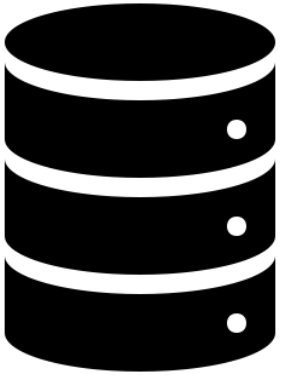
Procedures and technology to handle non-cooperative

i. interoperability e.g. Data exchange, DAA definitions
ii. operating env conditions – winds, weather
iii. interface
iv. A/C and flight standards collectively
v. gaps in certification for UAM

Standards

a.Roadmap for evolution from VFR to IFR ops.

Tightly coupled w/ manned v/s unmanned. IFR is easier to implement but the IFR routes will not be great with UAM ops. Need for a third set of rules?



Real World Operational and Support Data

MEDIUM-SIZE URBAN AIR MOBILITY

POSSIBLE COLLABORATIVE DEMONSTRATIONS

Collaboration demonstrations considerations:

Scenario-1:

- Using an existing helipad operation, add improved safety and efficiencies through UAM enablement and demonstrate a flight with route defined
- Keep UAM vehicle beneath 1500 feet, with human on board
- Fly from point A to point B under control of UAM solution
- Outcome would be operational requirements and procedures as well as inputs for next demonstration

Scenario-2: Higher density route that demonstrates transfer from urban to rural setting (UTM and ATM interoperability)

- Emergency situation with EMS / medical personnel or doctor-patient onboard
- Non-standard situations with vehicle and airspace management (including interaction with UTM and ATM) and non-participating aircraft

Scenario-3: Team competition in a airport with a “last-drone-standing” prize

Scenario-4: Participate in Grand Challenge

NOTE: Consider how to Demonstrate verifiable AI

MEDIUM-SIZE URBAN AIR MOBILITY

POSSIBLE COLLABORATIVE DEMONSTRATIONS

Collaboration Demonstration - Airspace Management focus (Scenario-2)

Demonstrate increasing density of routes – for example transfer from rural and/or suburban (non-vertiport, medical facility?) to urban setting (UTM and ATM interoperability).

- Emergency situation with EMS / medical personnel to scene or medical personnel to patient
- Non-standard situations with vehicle and airspace management (including interaction with UTM and ATM) and non-participating aircraft
- Integration with GA Pathways/broad area networks without encroaching (emphasis regarding avoiding conflict, creating safe well defined UAM corridor)
- Spectrum / C&C battle (protocol, spectrum grading, …) and discussion including FCC and FAA re safe operation in the NAS (dedicated spectrum required)
- Incorporate vehicle, operators and airspace autonomy elements
- Include aspects of vertiport management (urban setting) leveraging UAM airspace structure
- Remain as vehicle agnostic as possible

MEDIUM-SIZE URBAN AIR MOBILITY

RESEARCH GAPS AND NEEDS

Breakout Session 2 (Aug 7, 10:30-12:00)
Re Collaboration Demonstration - Airspace Management focus (Scenario-2)

1. How do we integrate UAM traffic with existing traffic (e.g. sUAS, GA airliners)
   - Airspace structure (e.g. 500-1500 feet range)
   - Conflict management
   - UAM surveillance integration (cooperative and non-cooperative)
2. Address policy and data gaps regarding integrated risk analysis
   - Incorporate new areas of concern (societal benefits, intermodal …)
3. Spectrum management
   - Risk that Regulator will not allocate appropriate spectrum (RTCA SC-228)
   - Communications infrastructure reliability and security
4. Standards for UAM flight model and characteristics – and a dynamic Well Clear

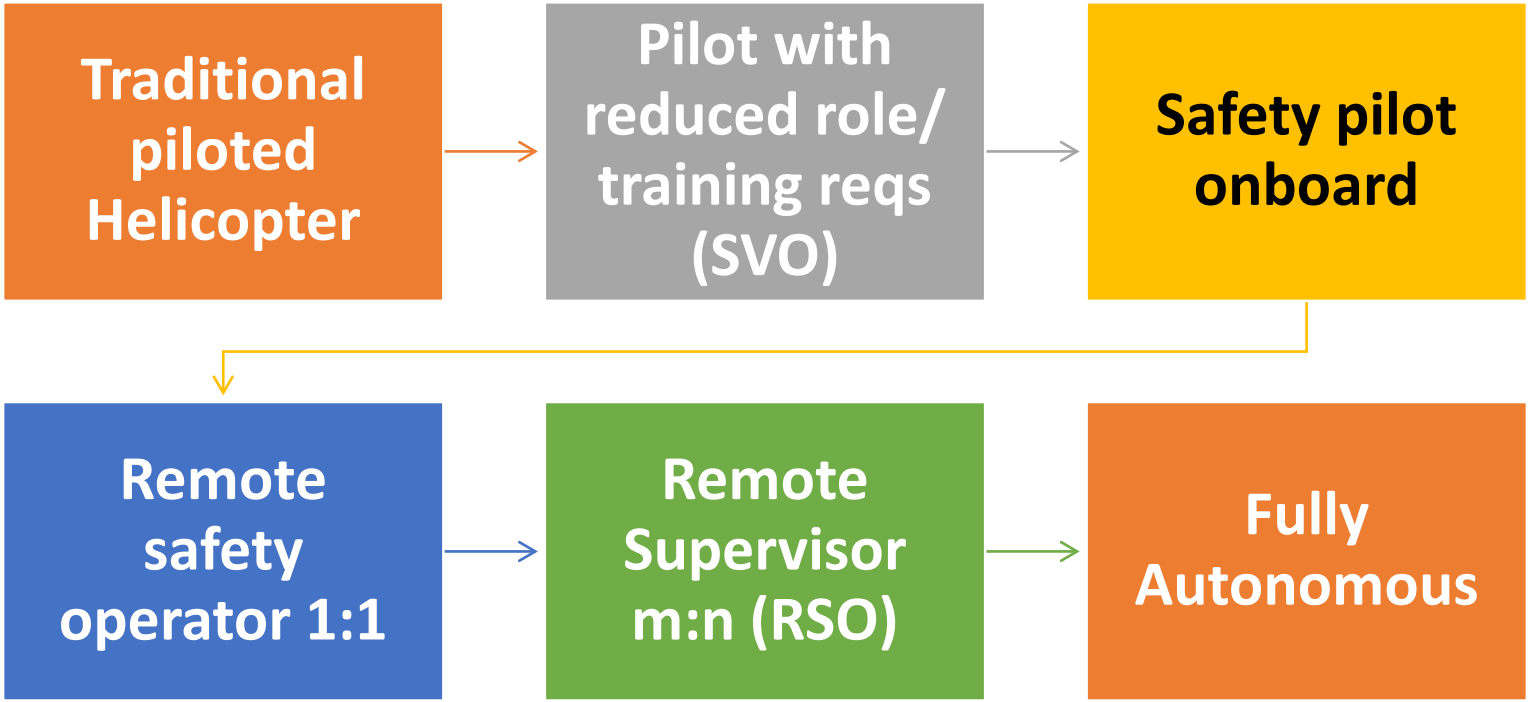
MEDIUM-SIZE URBAN AIR MOBILITY

STEPS TOWARD OPERATIONALIZATION OF INCREASINGLY AUTONOMOUS SYSTEMS.

Scenario-2 Operationalization Steps (how):

1. Get FAA buy-in extending to their ecosystem of influence (and budgets)
2. Share data with standards orgs to help develop appropriate UAM-relevant standards
3. Develop a public engagement strategy (leverage public – private partnerships)
4. Develop an industry partnership strategy (e.g. vertiport owners, vehicle mfgs)
5. Engage with current state and local organization on lessons learned
6. Work with an existing autonomous system (e.g. DoD-NASA and other collaborations)
   - Take tactical steps to improve system operation (in UAM context)
7. Cover airspace to ground operations (e.g. with management tools)
8. Explore allocation / responsibility for flights from 500'-1500'
   - Take an incremental approach
9. Gather data on UAM (e.g. passenger experience, performance, DAA…) to inform and help define Well Clear and other operational and air worthiness standards
10. Develop strategic UAM - UTM avoidance system

General Discussion – Where is MVP?



WHERE INDUSTRY NEEDS HELP

- Operational Rules – from FAA/NASA
- Procedures and tools for V&V/certification of AI/Autonomy – FAA/NASA
- Standards – coordination with standards agencies
- Creation of government/industry working groups
- Cybersecurity
- Resilient Automation
- Contingency Management – technologies and procedures
- Human Autonomy Teaming- Standards and tools for SVO/RSO – especially training
- Define pre-competitive technology
- Infrastructure
  - Communication – Reduction of voice clearances
    - Additional information (e.g., intent)
  - Spectrum Management
  - Mature, Scalable UTM for UAM
- Operational data
- Test/demonstration opportunities

MEDIUM-SIZE URBAN AIR MOBILITY

WHERE WILL COLLABORATION BE MOST PRODUCTIVE

Collaboration will be most productive if it includes:

1. Public acceptance (noise, privacy, safety, trust)
2. Public policy (that supports Public acceptance, works with DOT)
3. Technology providers (air framers, avionics, platform, apps, sensors, airspace management, communications (esp. re spectrum), geofence providers)
4. Security (physical port and transport, DHS)
5. Cyber security (e.g. DHS)
6. Intermodal operations (e.g. DOT)
7. Infrastructure (airport and vertiport standards, communications)
8. Standards (e.g. ASTM, SAE, RTCA, ICAO, etc..)
9. Certification (e.g. FAA)
10. Spectrum allocation (FCC)
11. Current Operations (e.g. DHS)

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Urban air mobility

Thank you

Irene Gregory, William Chan, Savvy Verma, Ryan Hendricks, Bryan Barmore, Jay Shively, Kim Shish, Wes Ryan, Jessica Nowiski

An everyone who participated

Enabling Autonomous Flight & Operations in the NAS

Urban air mobility

MINIMUM VIABLE PRODUCT

- Discussion – Challenge of MVP for Aerospace
  - Comes from Software Engineering where you create an initial product, then you improve with a quick product cycle.
  - Difficult to achieve with Aerospace product lifecycle timeperiod
  - MVP means something a little different