Air Mobility Network Design for DFW

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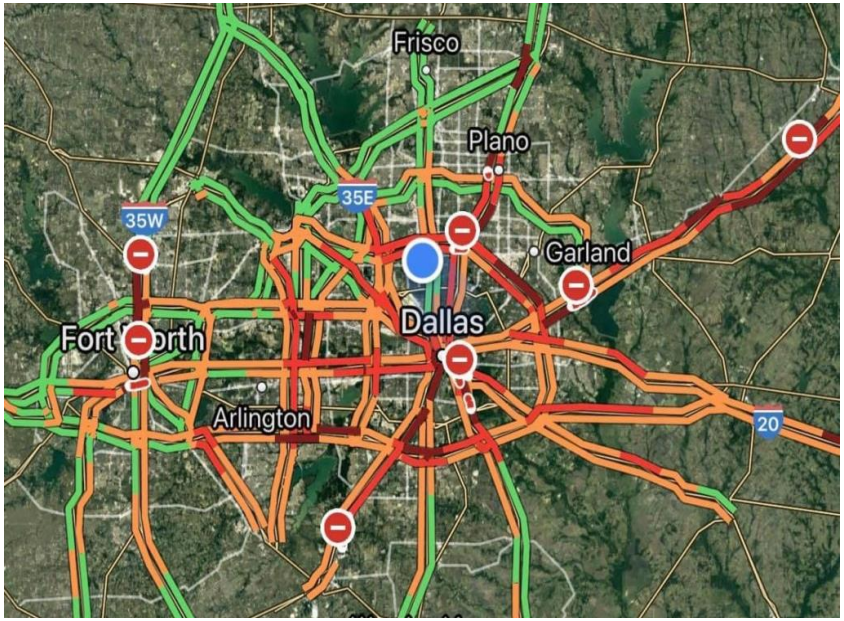
Source: EmbraerX

Agenda

- Urban Air Mobility
- UAM Network Design
- Results and Analyses
- Opportunities for Further Study

Urban Air Mobility

- DFW freeway traffic



Source: Audacy and Paper City

Urban Air Mobility

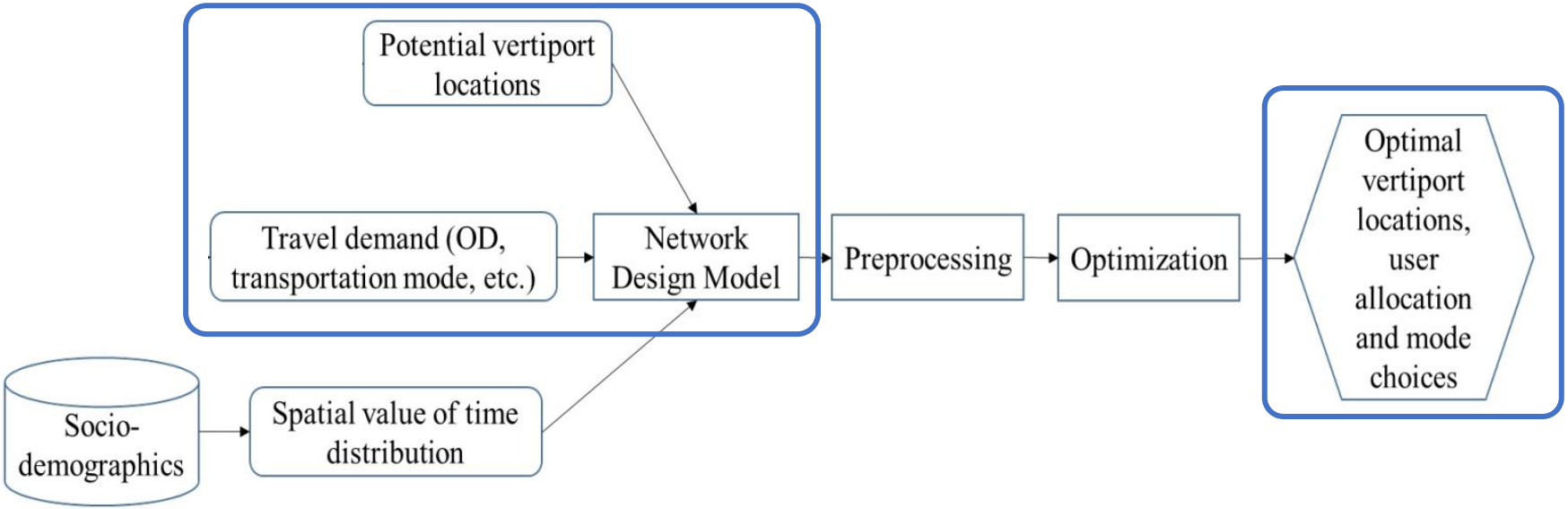
Air mobility trip as an individual

- Integrate with other transportation modes during access and egress

Source: Community Air Mobility Initiative 2021

UAM Network Design

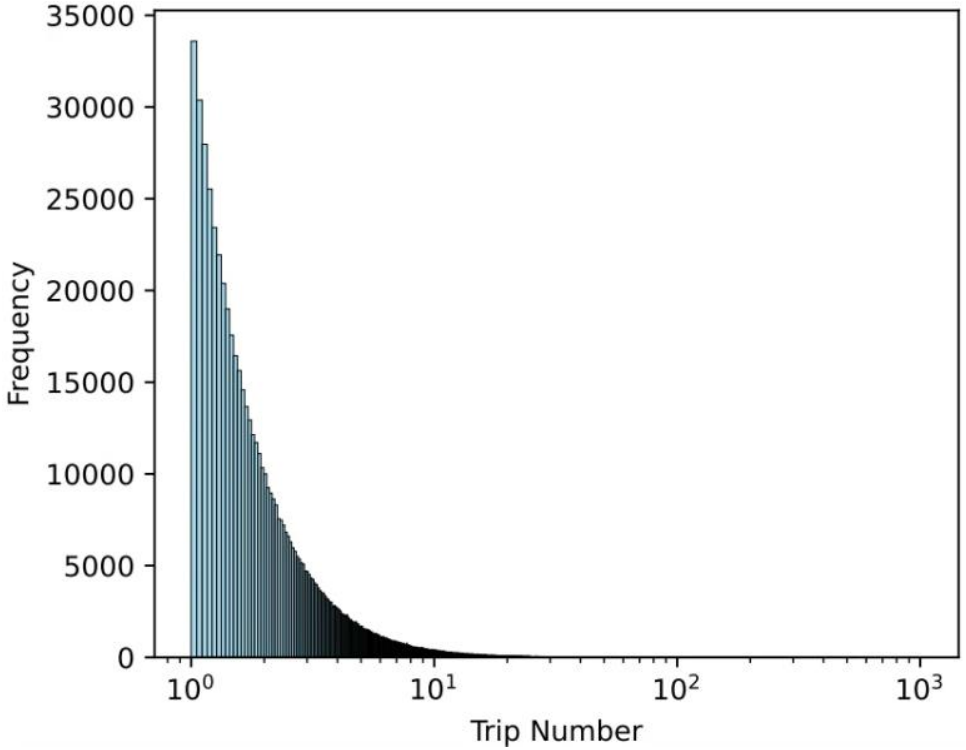
Methodology: how to design the UAM network?



Source: Wu and Zhang 2021

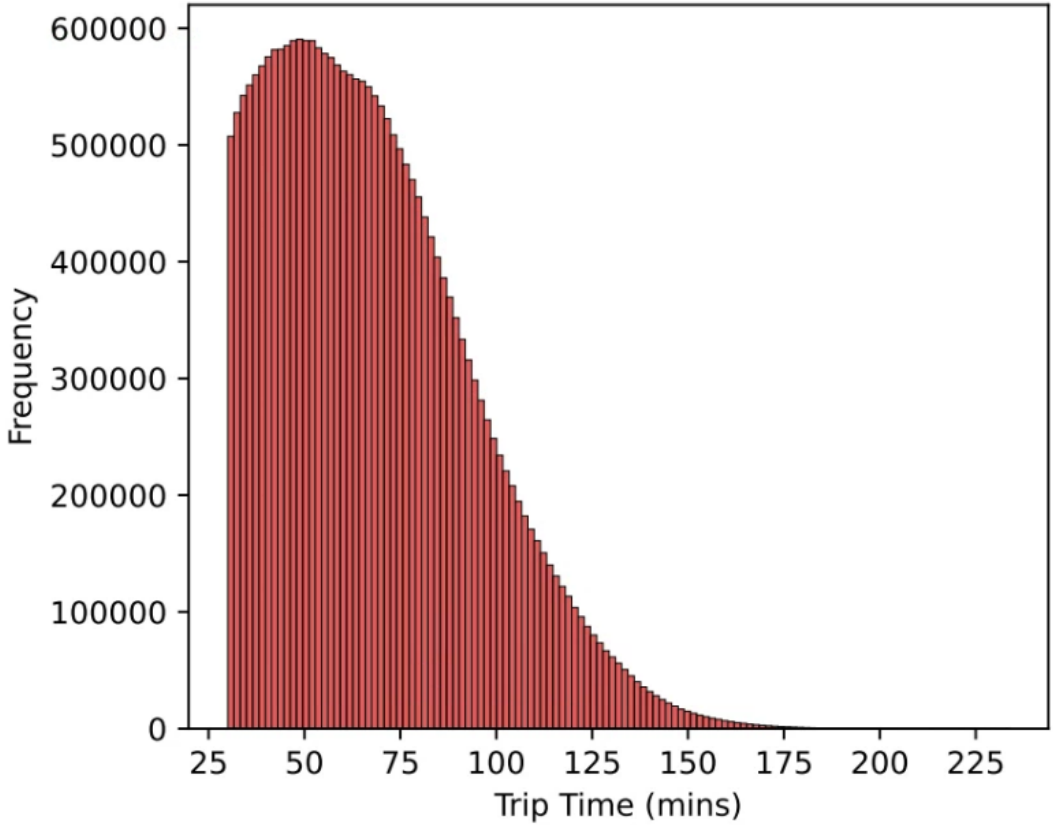
Number of Trips Between Zones

- Histogram
- Very few trips between most zones
- Cutoff at 5



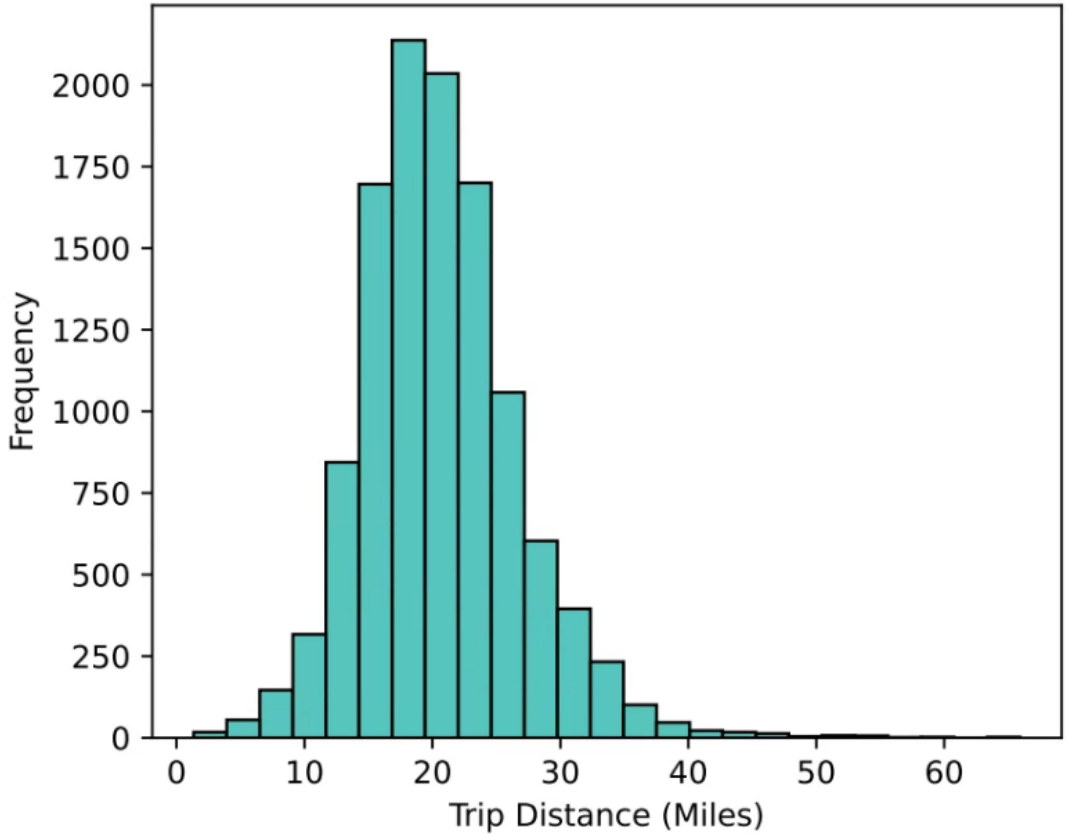
Travel Time Between Zones

- Histogram
- Cutoff: 30 mins
- Mean: ~ 50 mins



Travel Distance

- Histogram
  - Mostly 15-25 miles
  - Cutoff at 15 miles



Vertiport Candidates

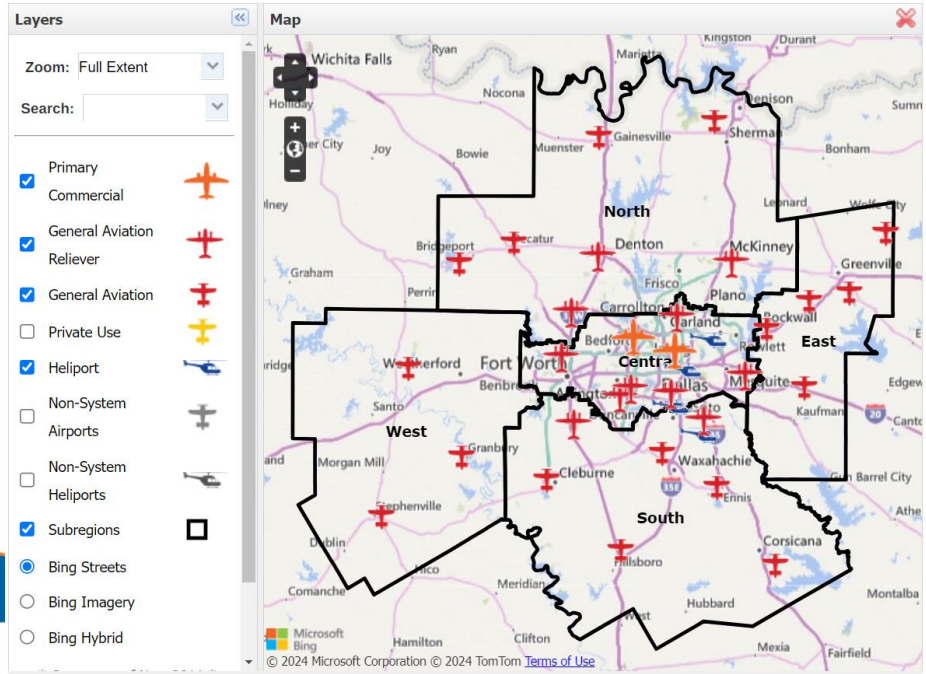
Vertiport can be: vertihub, vertiport, and vertistop

- At street level or on top of buildings.
- Have good connection services to roads, railway stations, buses, etc.

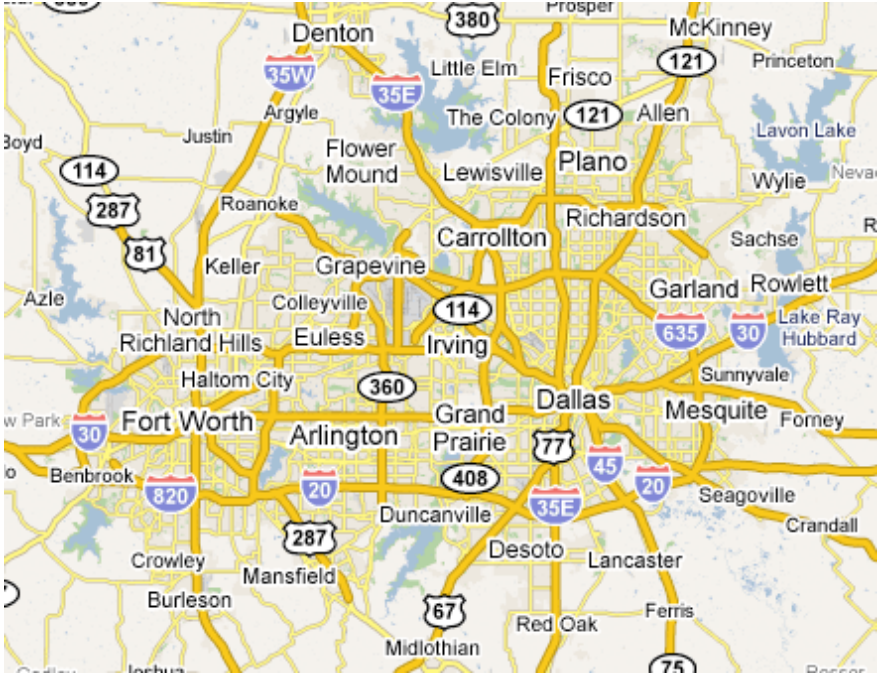
Vertiport Candidates

Potential vertiport locations

Existing public airports (30)

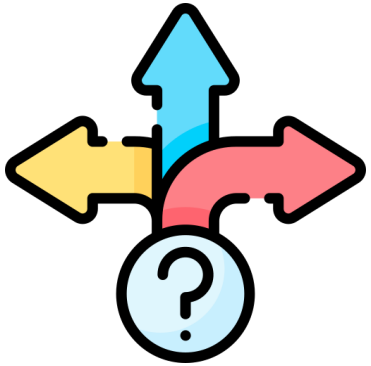


Major city centers (17)



Air Mobility Network Design

- Mathematical formulation
  - Decisions
    - Optimal locations of vertiports among the candidates
  - Objective: Minimal total cost (time is monetized)



$$\min \sum_{p \in P} \Bigg\{ (t^p \cdot \gamma^p + c^p) \cdot z^p + \sum_k \sum_{d \neq k} [c_{kd} + (t_{kd} + t_{tw} + t_{tl}) \cdot \gamma^p)] \cdot x^p_{kd}$$

$$+ \sum_a \sum_k g^p_{ak} (t^p_{ak} \cdot \gamma^p + c^p_{ak}) + \sum_e \sum_d h^p_{ed} (t^p_{ed} \cdot \gamma^p + c^p_{ed}) \Bigg\}$$

Air Mobility Network Design

- Mathematical formulation
  - Tons of constraints

s.t.

$$\sum_k y_k = u, \ \forall k \in M$$

$$z^p + \sum_k \sum_{d \neq k} x_{kd}^p = 1, \ \forall p \in P$$

$$\sum_{d \in M, d \neq k} x_{kd}^p + \sum_{d \in M, d \neq k} x_{dk}^p \leq y_k, \ \forall k \in M, \ \forall p \in P$$

$$\sum_k \sum_{d \neq k} x_{kd}^p = \sum_a \sum_k g_{ak}^p, \ \forall p \in P$$

$$\sum_k \sum_{d \neq k} x_{kd}^p = \sum_e \sum_d h_{ed}^p, \ \forall p \in P$$

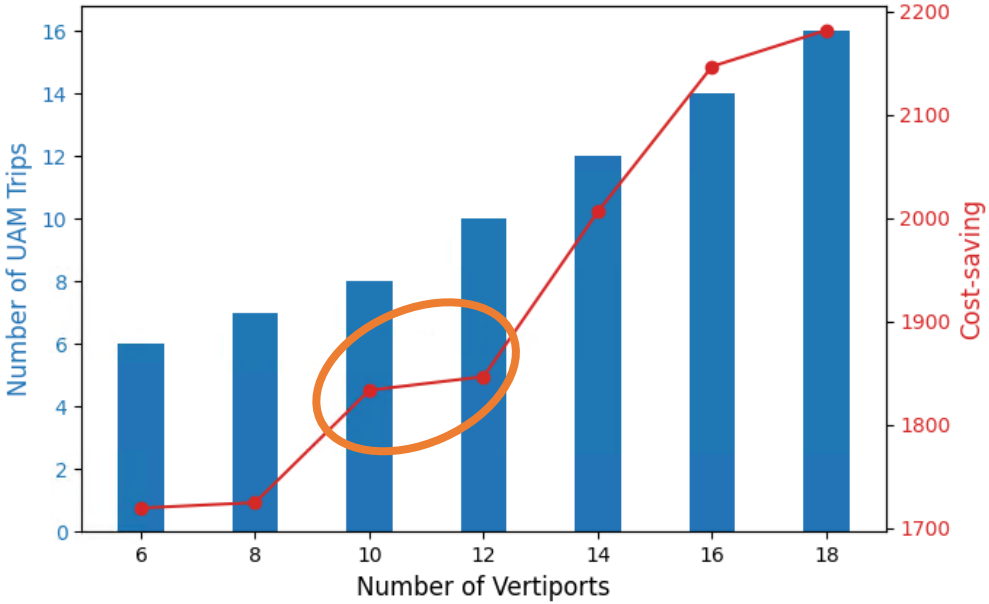
$$2x_{kd}^p \leq \sum_a g_{ak}^p + \sum_e g_{ed}^p, \ \forall k, d \neq k \in M, \ \forall p \in P$$

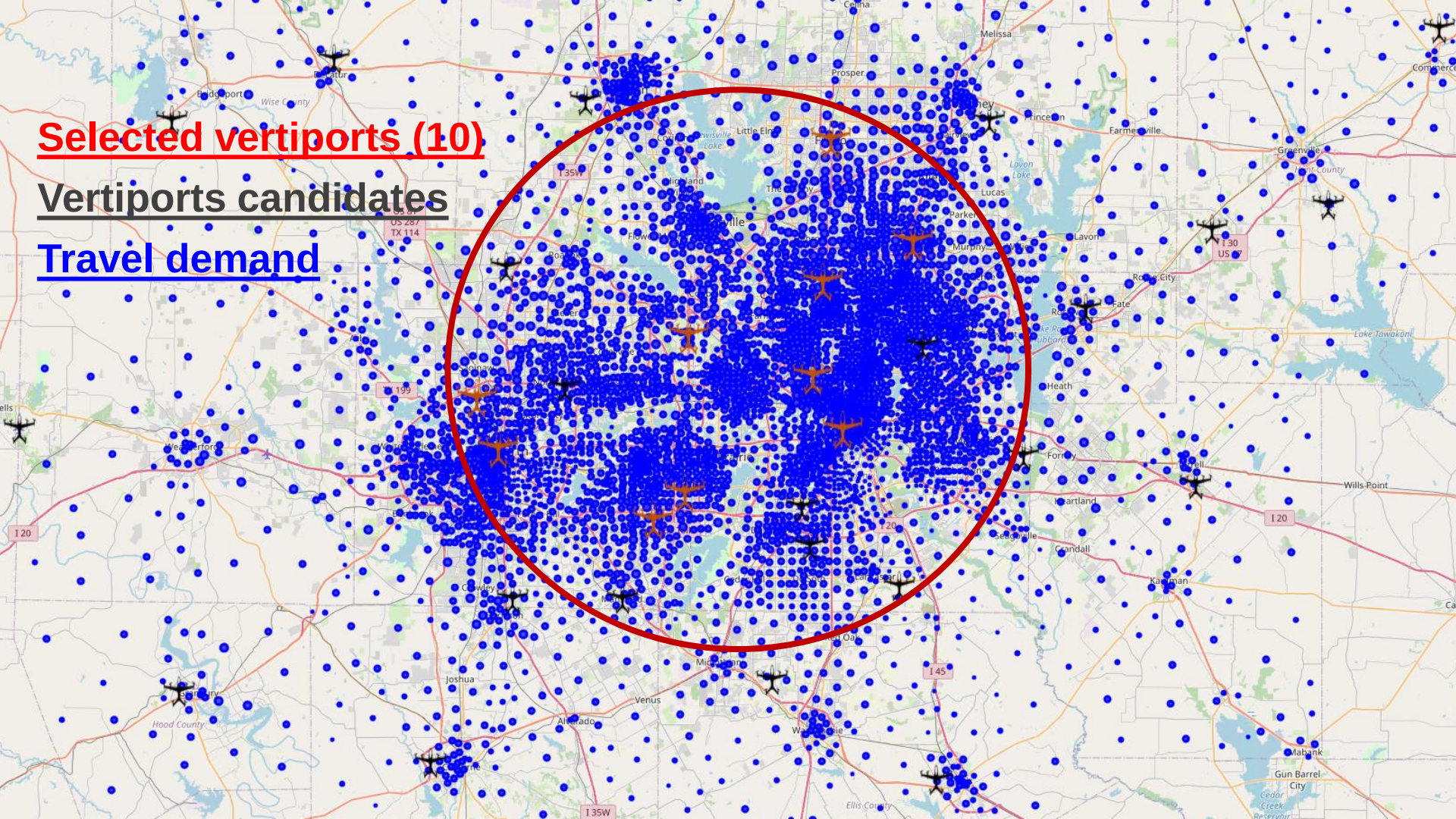
$$\left[t^p - \sum_k \sum_{d \neq k} (t_{kd} + t_{\text{tw}} + t_{\text{tl}}) \cdot x_{kd}^p - \sum_a \sum_k g_{ak}^p t_{ak}^p - \sum_e \sum_d h_{ed}^p t_{ed}^p \right] \cdot \gamma^p \geq \sum_k \sum_d c_{kd}^p \cdot x_{kd}^p + \sum_a \sum_k g_{ak}^p c_{ak}^p + \sum_e \sum_d h_{ed}^p c_{ed}^p - c^p, \ \forall p \in P$$

$$z^p \in \{0,1\}, y_k \in \{0,1\}, x_{kd}^p \in \{0,1\}, g_{ak}^p \in \{0,1\}, h_{ed}^p \in \{0,1\}$$

Impact of Number of Vertiports

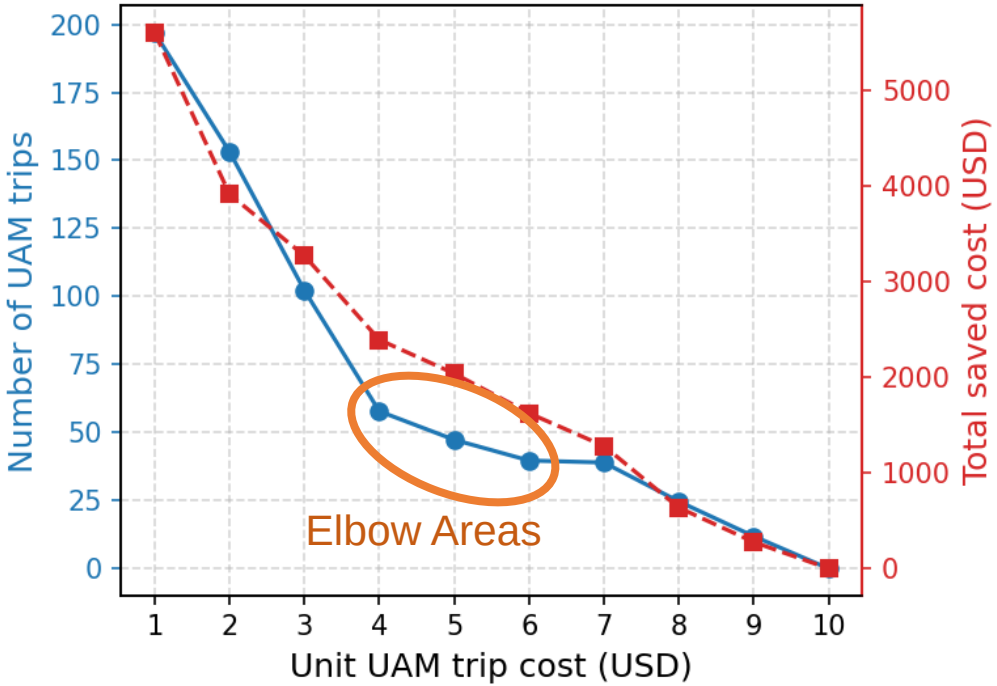
- Based on cost-saving reduction rate, the optimal number of vertiports is between 10 - 12 based on cost saving for travelers who will use UAM



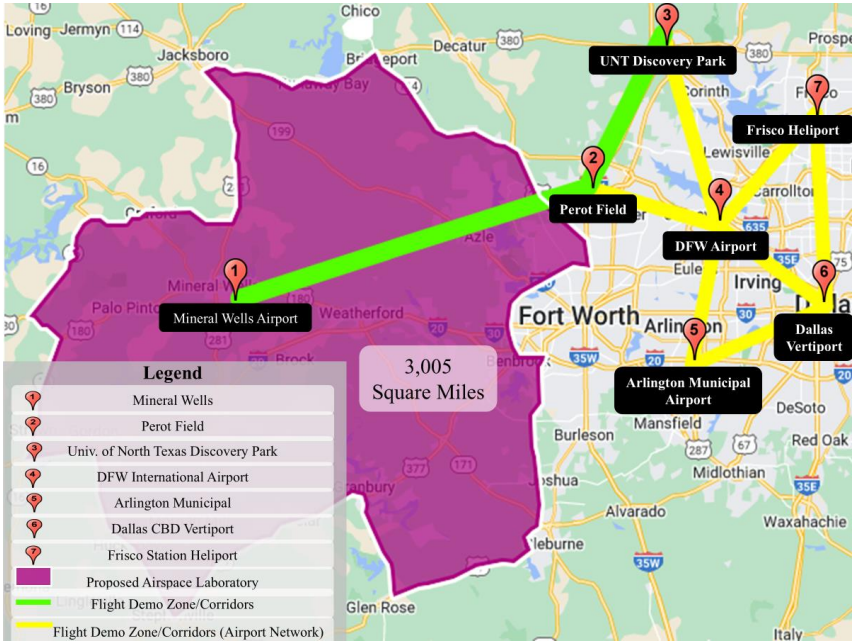

Selected vertiports (10)
Vertiports candidates
Travel demand

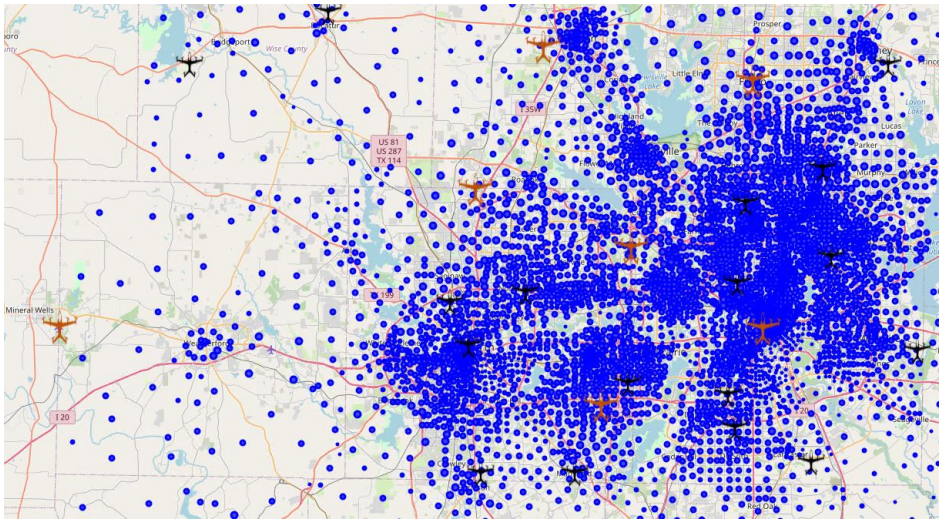
Impact of Unit UAM trip cost

- The unit UAM cost should not be greater than around $5 ($4-6) per passenger mile



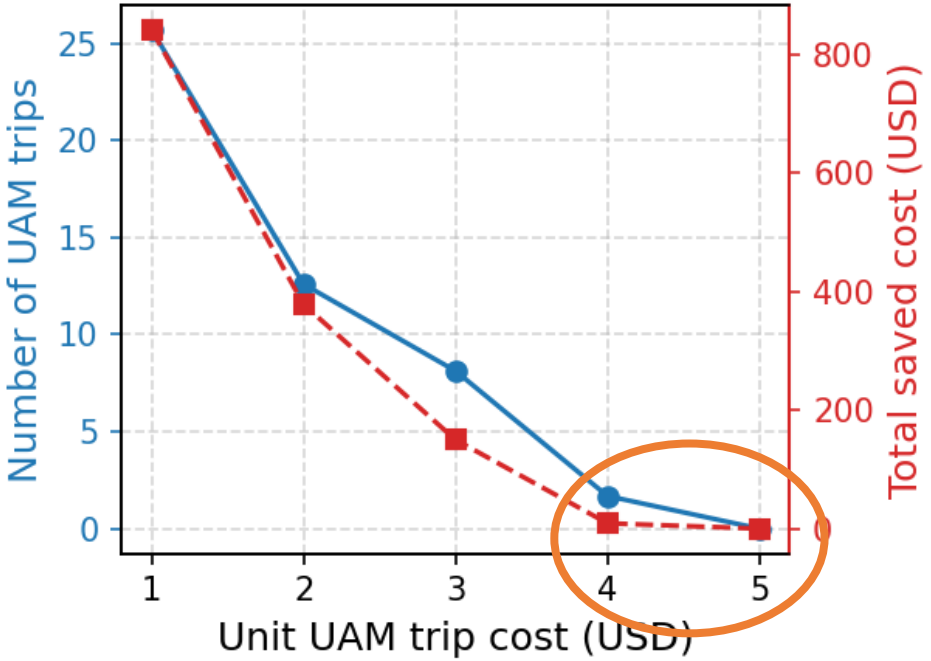
Current vertiports (7)





Impact of Unit UAM trip cost

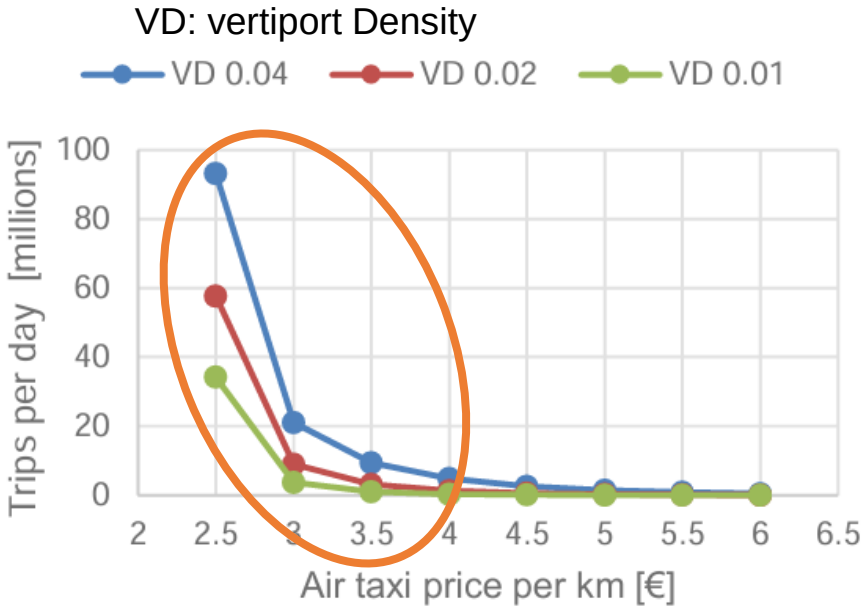
- The unit UAM cost should not be greater than around $4-5 per passenger mile



Impact of Unit UAM trip cost

- Current cost
  - NASA: $5-10
  - Uber: ~ $6
- Future cost
  - ~ $2 per passenger mile with $20 fixed cost
  - 4% market share

- Future trip count



Rinjha et. Al, 2021; Asmer et al., 2024

Assumptions

- Users’ comfort and convenience are not considered
- Universal UAM price scheme
- Universal value of time across travelers

Caveats

- Only data of travelers with annual household income greater than $50,000 is utilized
- Only home-to-work trips are considered
- Capacity of the vertiports is not considered

Opportunities for Further Study

- Refine demand estimation:
  - Incorporating a wider range of travel data e.g., diverse trip purposes and income groups
- Multi-modal integration
  - How much does UAM improve ground transportation during rush hours?
  - How UAM can be best connected with existing ground transportation systems to improve the multimodal transportation?

Thank you!

DATA, DECISION & NETWORK ANALYTICS
LAB FOR RESILIENT URBAN SYSTEMS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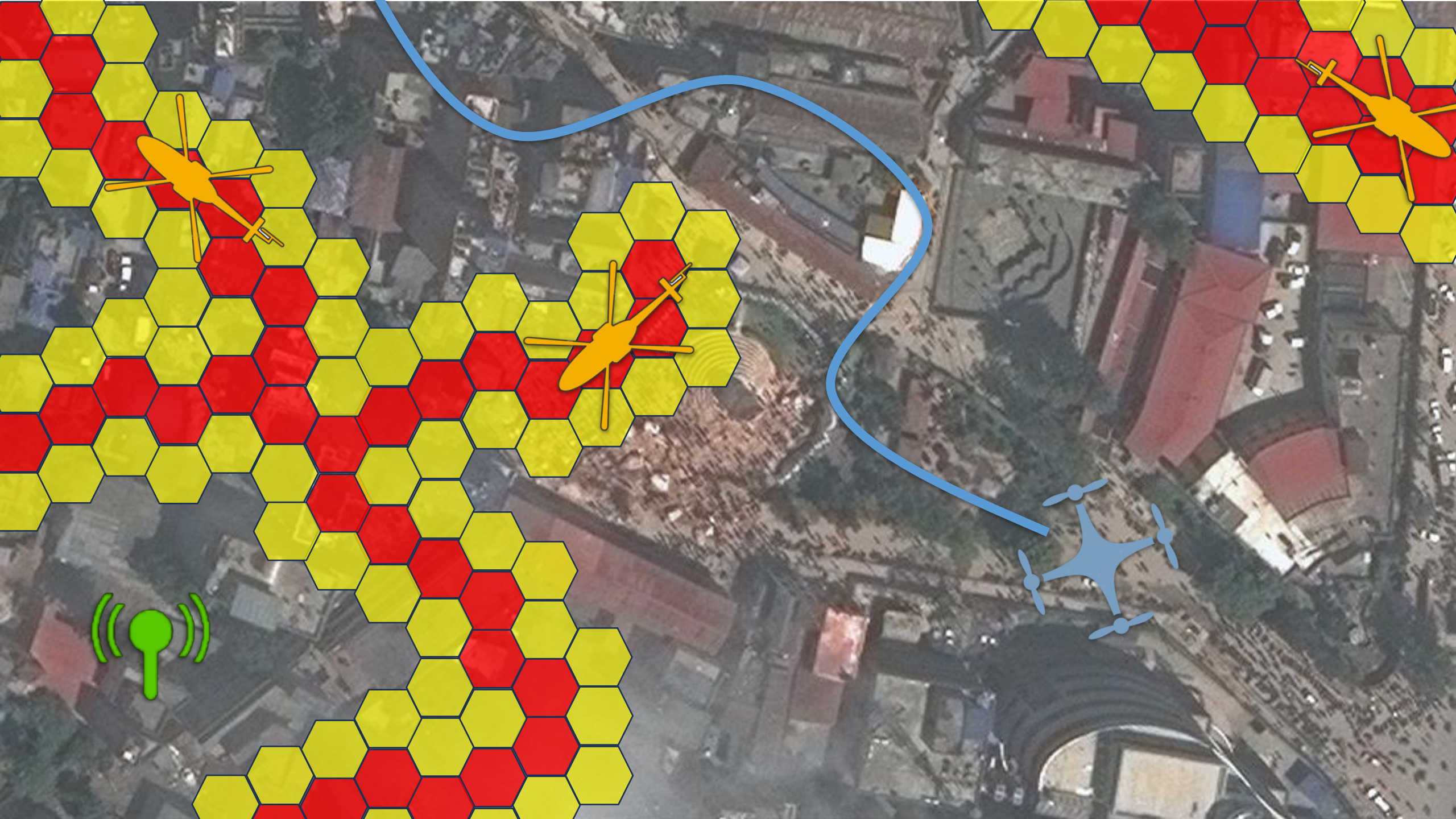
DRONE
ADVENTURES

Home / India News

Nepal bans use of drones following earthquake.

Breaking News

Drone operation deemed problematic for low-altitude helicopter safety




Meet
INVOLI

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Finalist of GENIUS NY Accelerator 2024-2025

GENIUSNY

International HQ

Relationship with FOCA/EASA
R&D – HW and SW
Manufacturing & Test
Sales, Support & Operations

North America branch

Relationship with the FAA
Sales & Marketing NA
Support NA
Operations NA


How it works

G-1090 UAT Air Traffic Receiver

- Detects: **ADS-B**, **Mode-S**, **Mode A/C**, and **UAT** messages
- Plug-and-Play
- Made in Switzerland
- Developed to follow **DO-260C** requirements
- Developed to be installed over **TowerCo**
- **Standalone Watchdog**: Independent hardware system to monitor and debug receivers without electricity or internet access;
- Other G-1090 versions include **FLARM** detection or Remote ID instead of UAT

Our Philosophy

Drone Operators are on a mission

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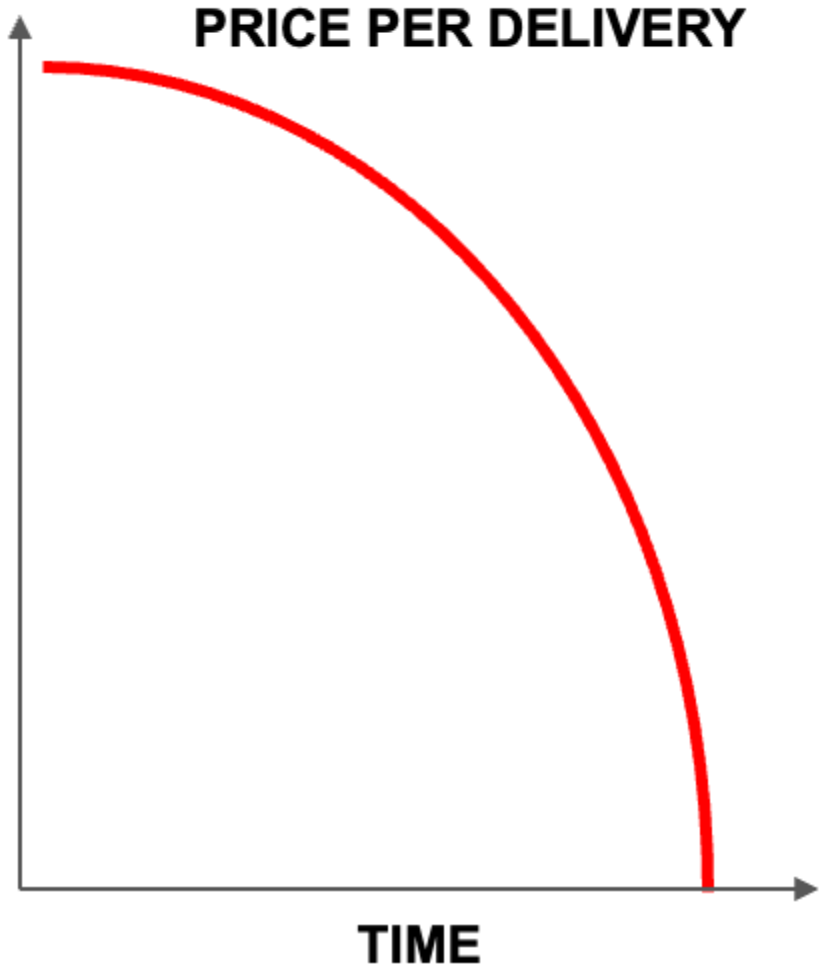

Regulators are on a mission

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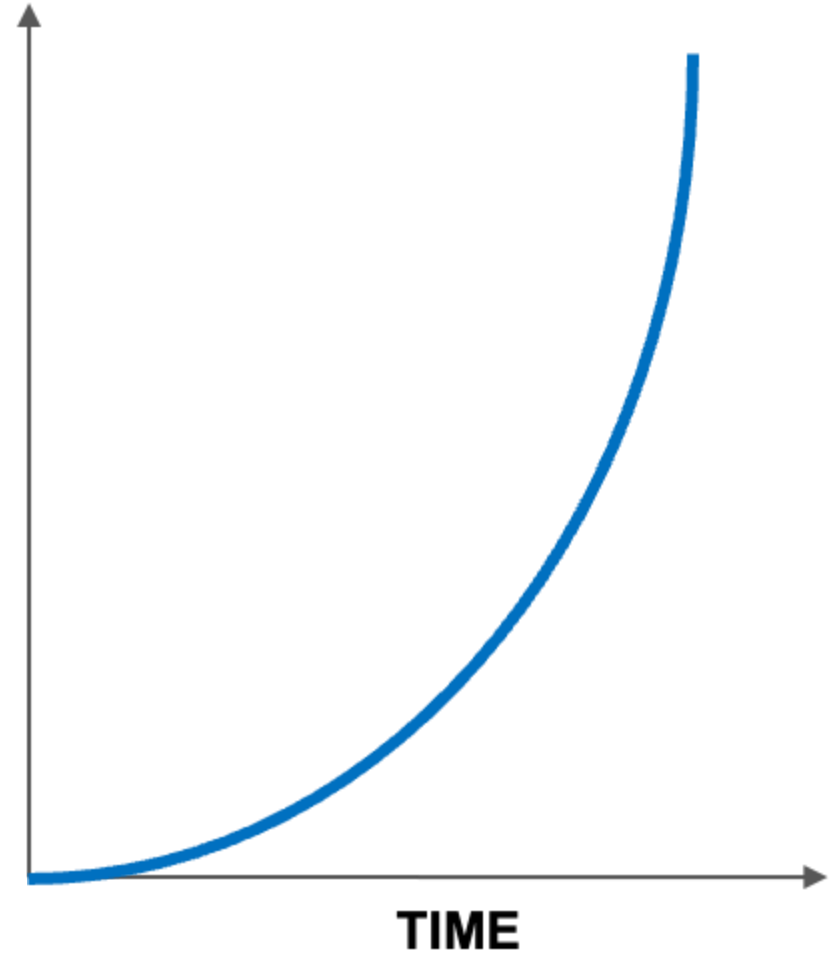
Safety
Reliability
Compliance
Trust
Quality
Easiness to Approve
Data security
Transparency
Resilience
Interoperability
Adaptability
…



Regulators are on a mission

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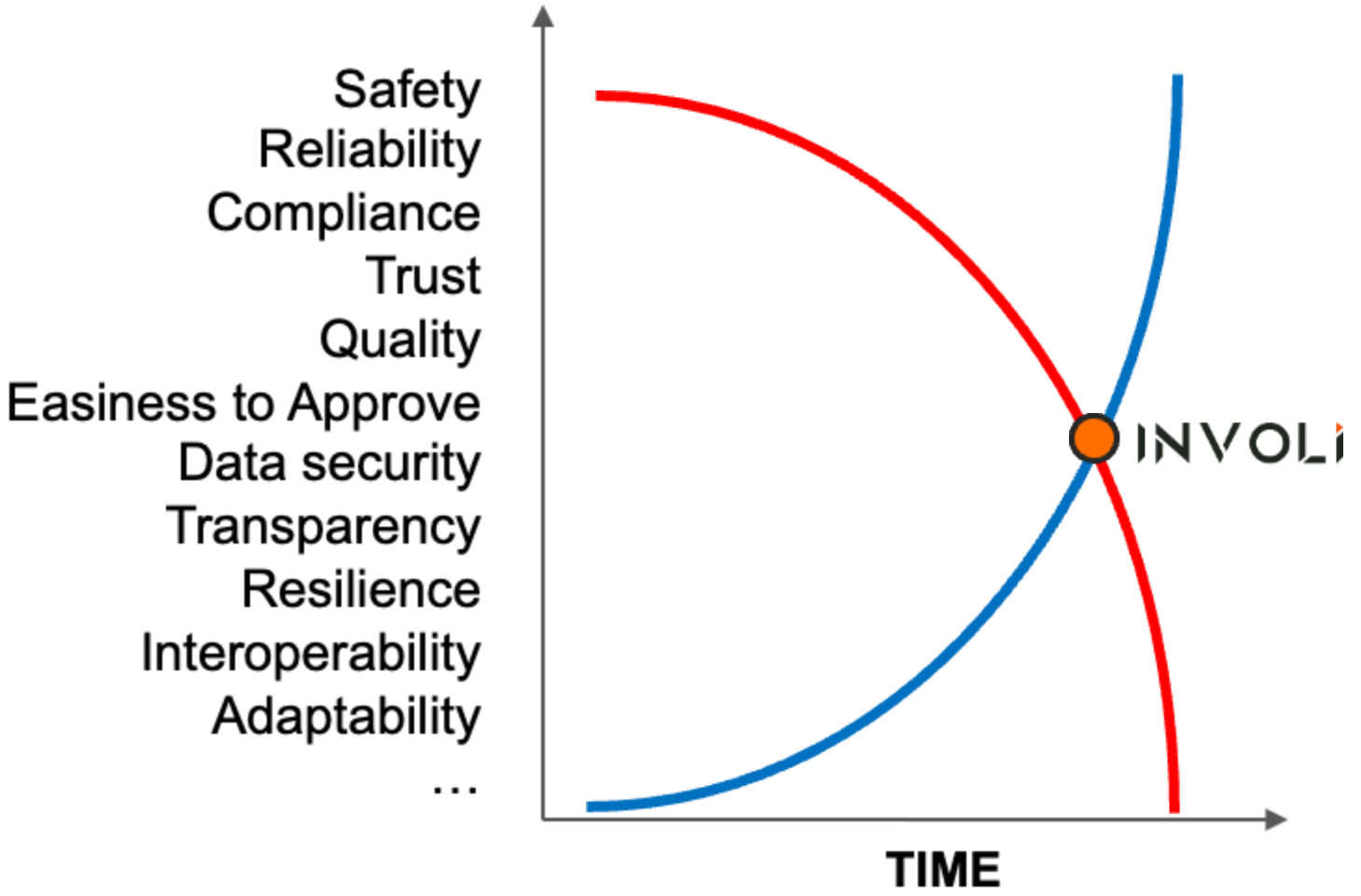


Following Standards / Regulations

Hardware

•The **G-1090 UAT** surveillance receiver is labeled **FCC/CE** and **Swiss Made**.

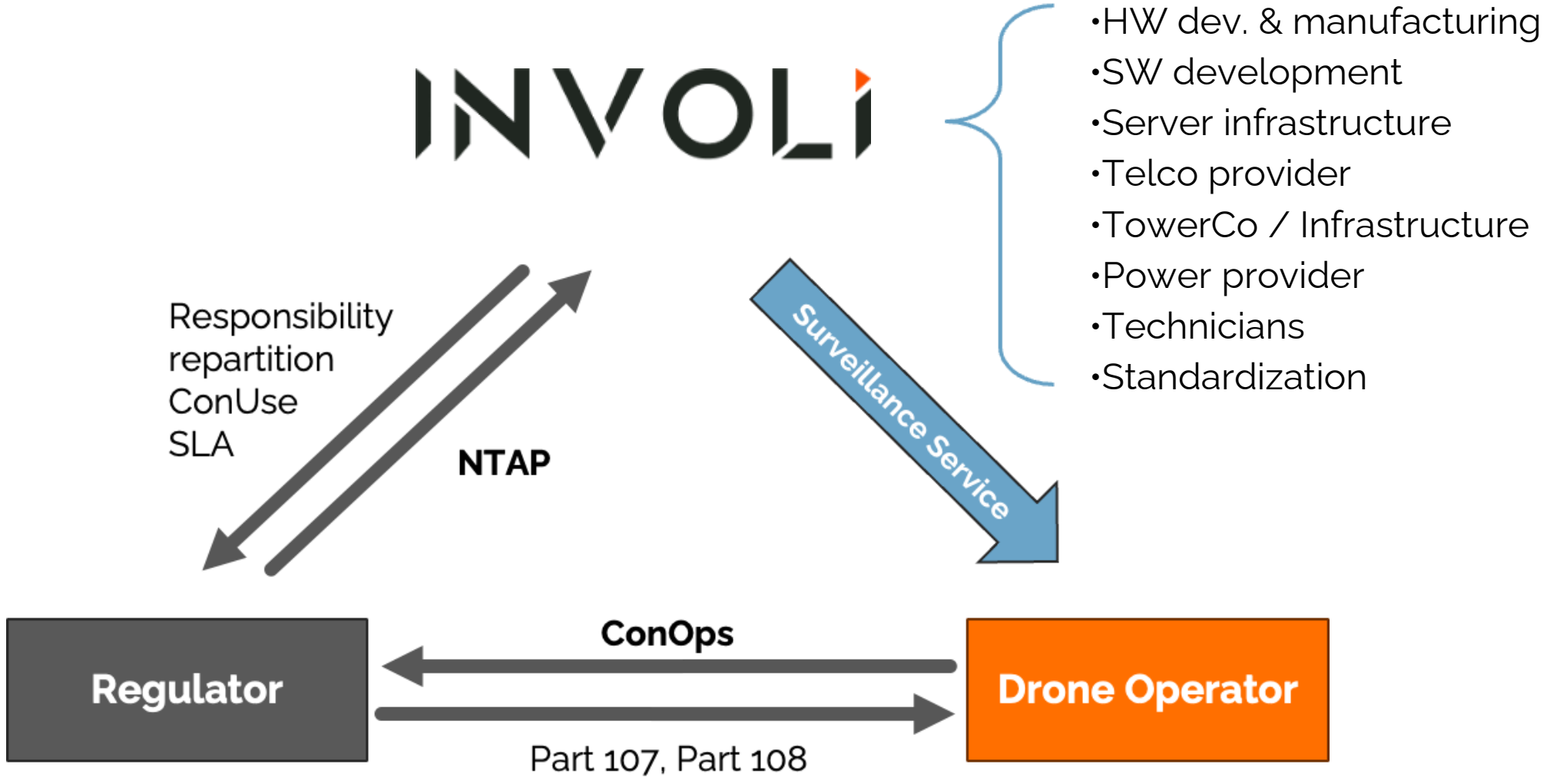
Software / System

- INVOLI's **Multilateration certified** by DFS for control of aviation obstacle lights for wind turbines.
- INVOLI system is compliant with the **ASTM Standard F3623-23** "*Standard Specification for Surveillance Supplementary Data Service Providers*" (Co-led by Manu Lubrano).
- [in progress] **NTAP** with the FAA for Syracuse, NY area

Company

- **ISO 9001** - Quality management system.
- [in progress] **ISO 27001** – Information security management system.

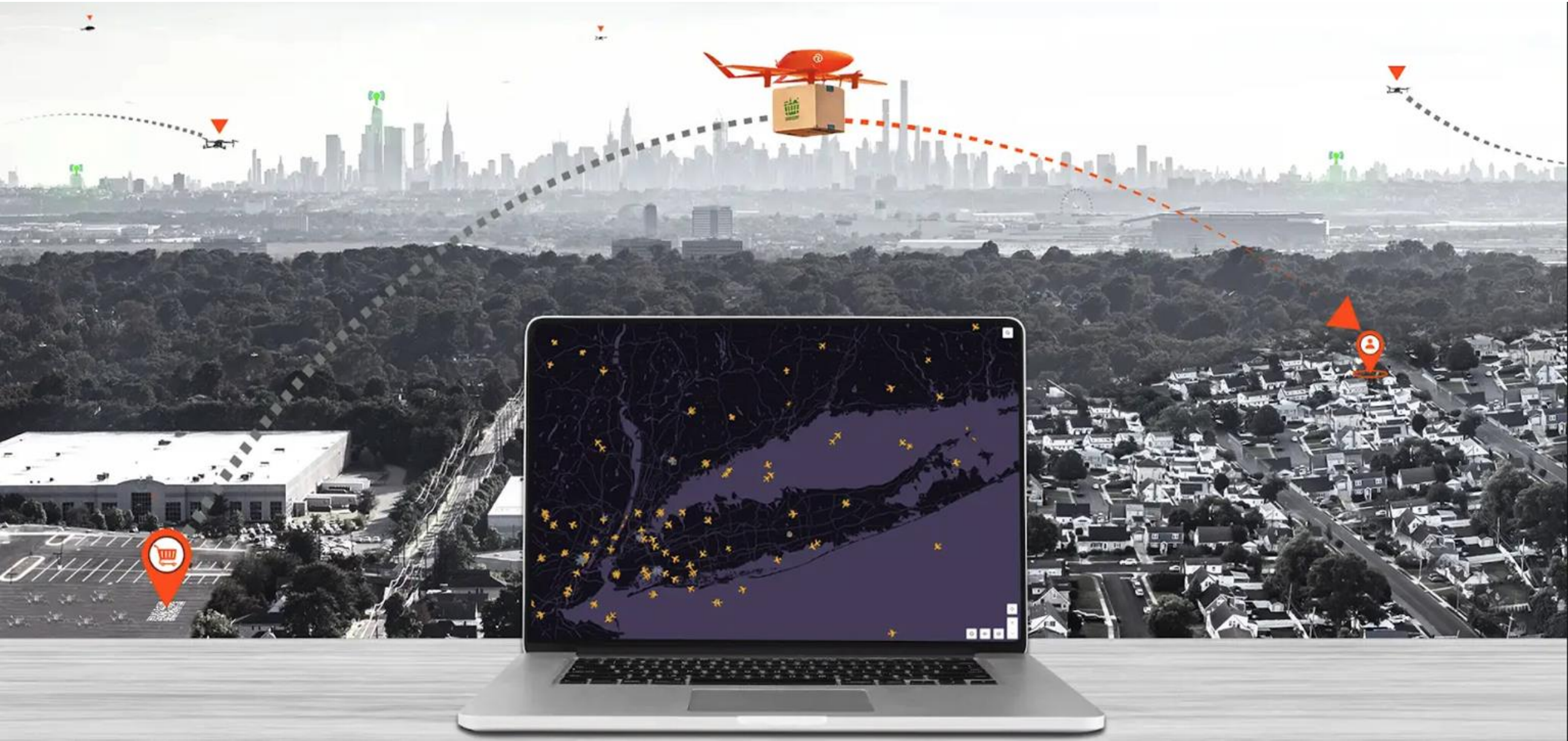
A Three-Ways Cooperation

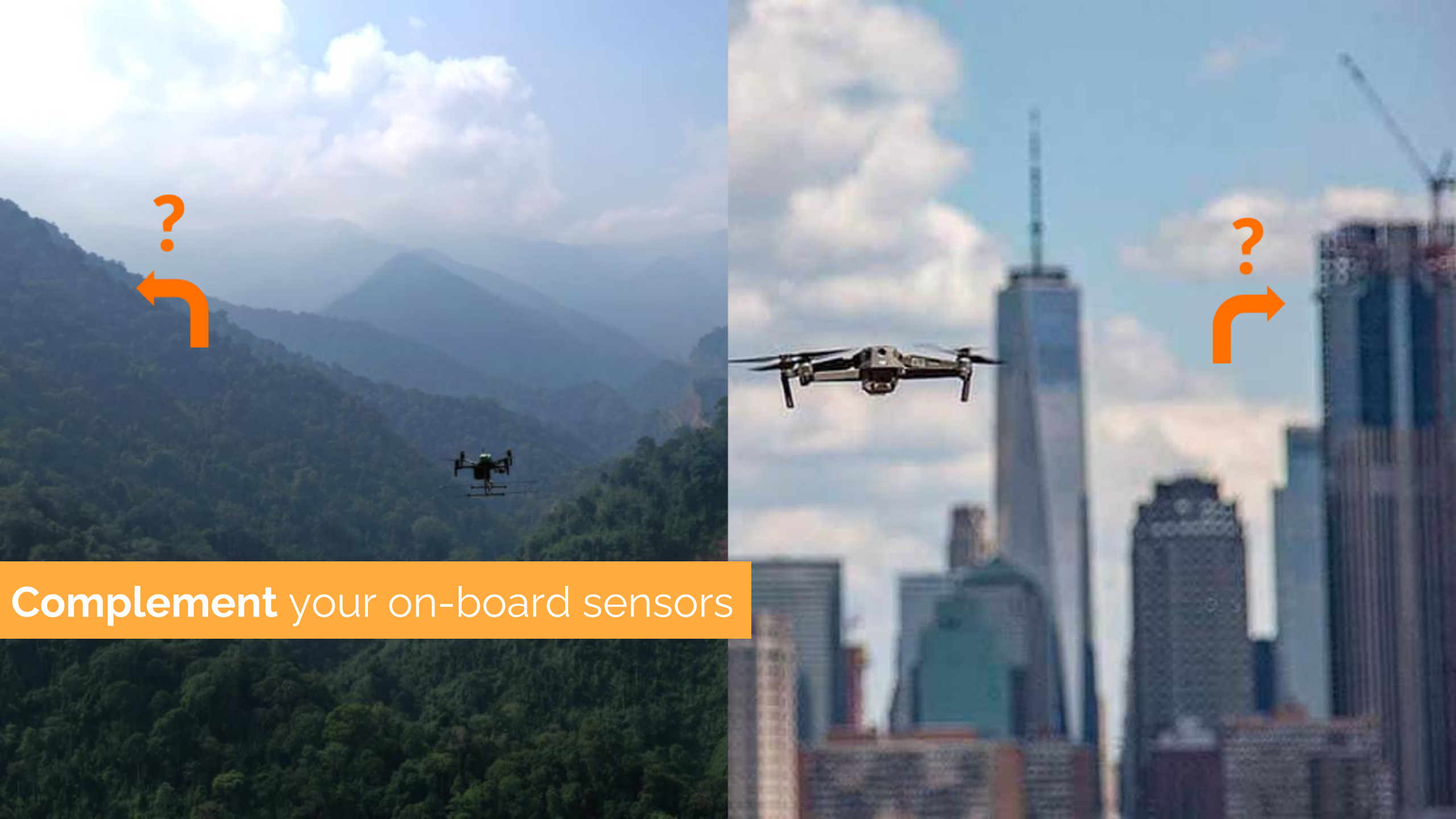


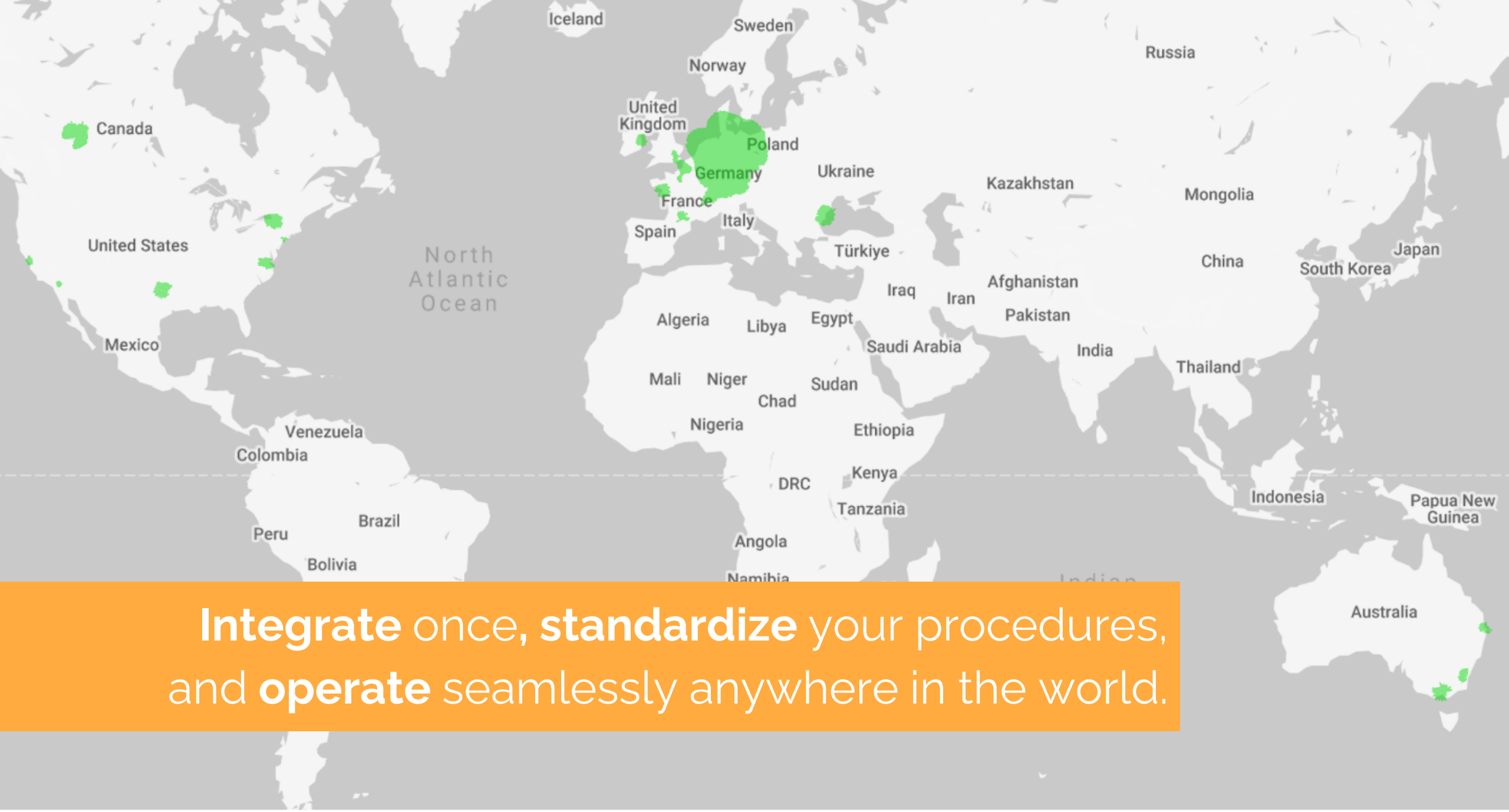
Benefits of the INVOLI system


Fly **BVLOS**
Enlarge your operation area to higher air risk areas

Enhanced Situational Awareness for Safe & Efficient Operations




Complement your on-board sensors

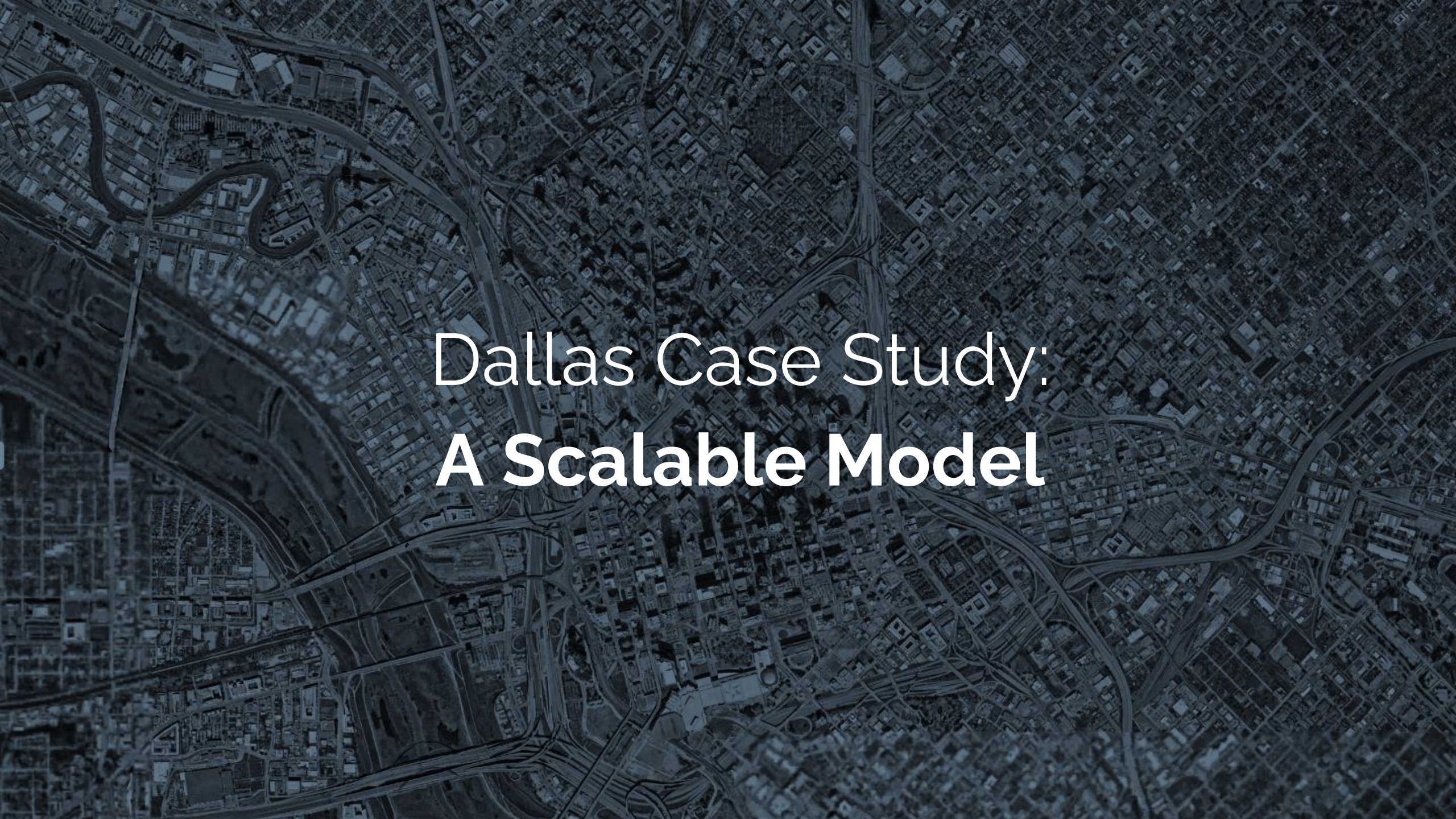


Integrate once**, standardize** your procedures,
and **operate** seamlessly anywhere in the world.

Focus on operations

Not this…

Or this…



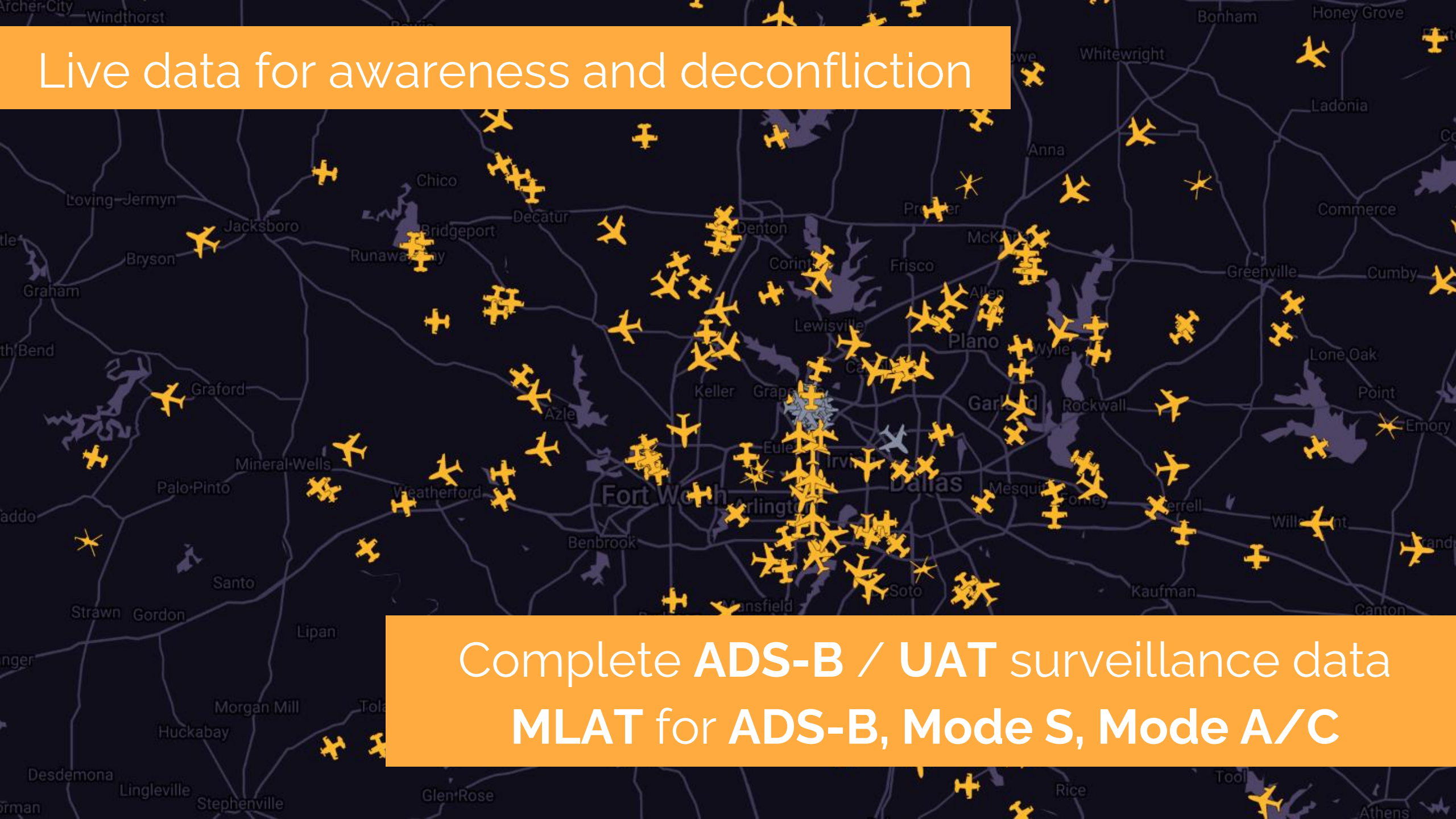
Dallas Case Study:
A Scalable Model

Our infrastructure provider

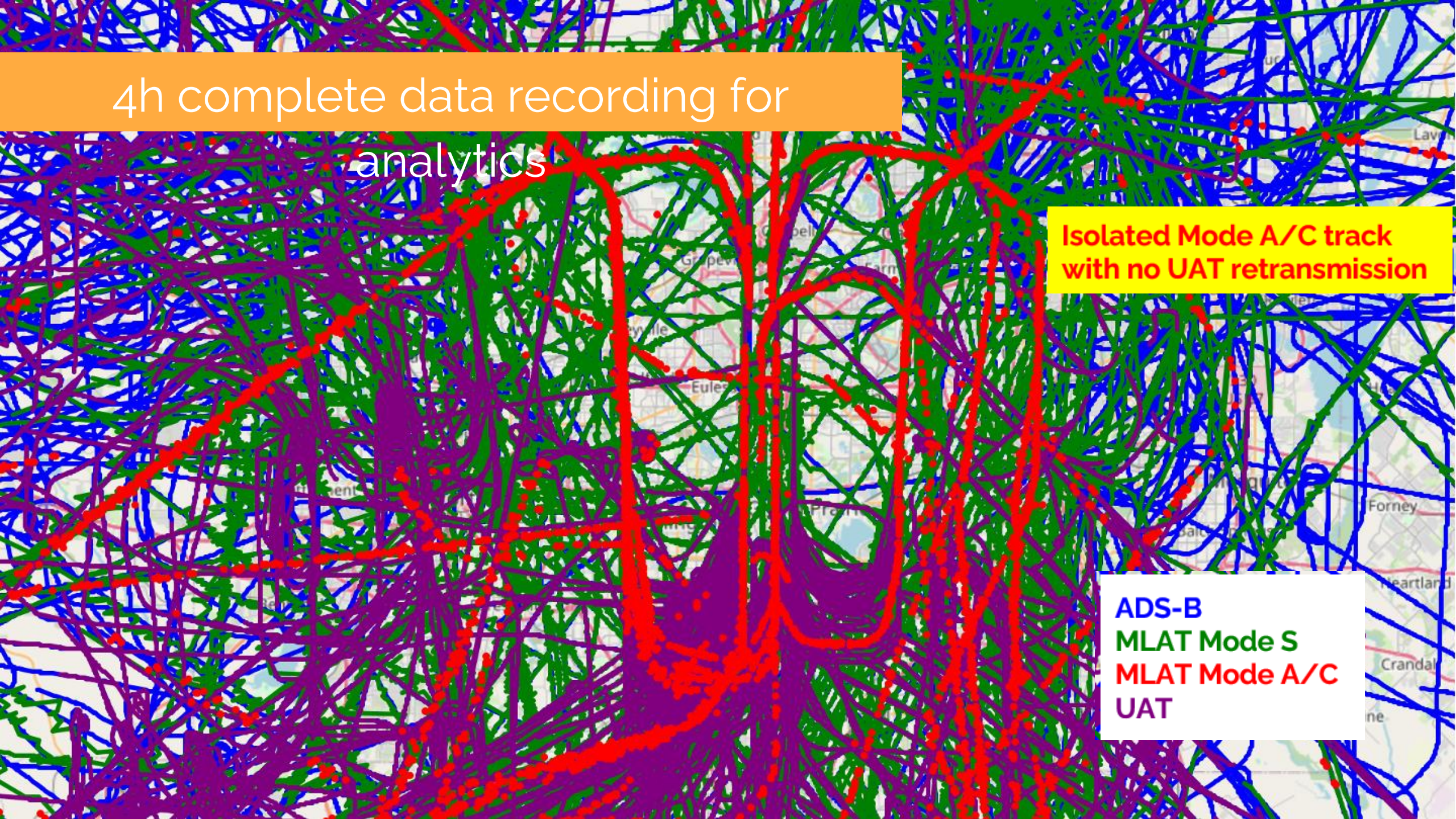
CROWN CASTLE

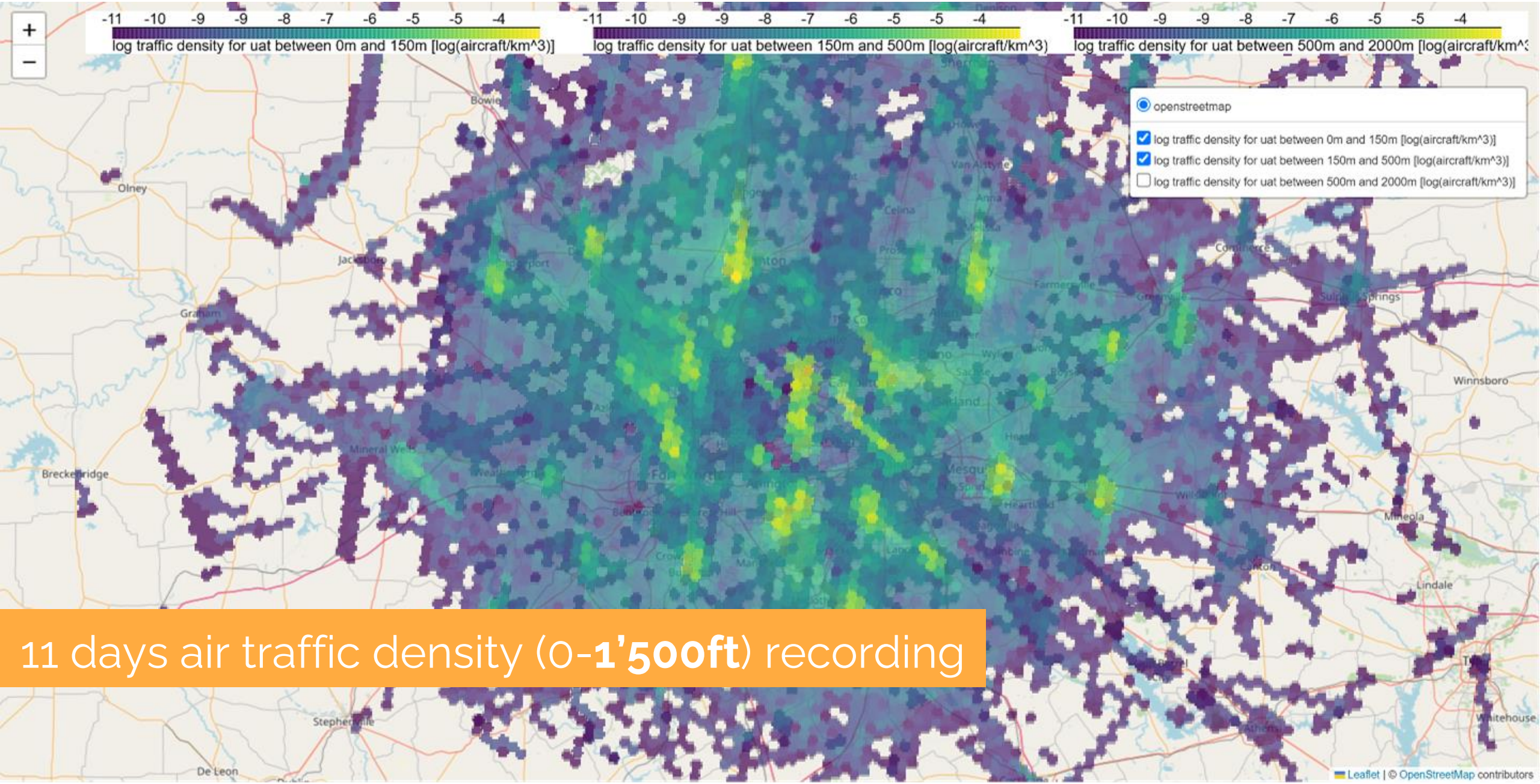
Live **ADS-B** / **UAT** coverage at *200 ft AGL*

12 Receivers currently active

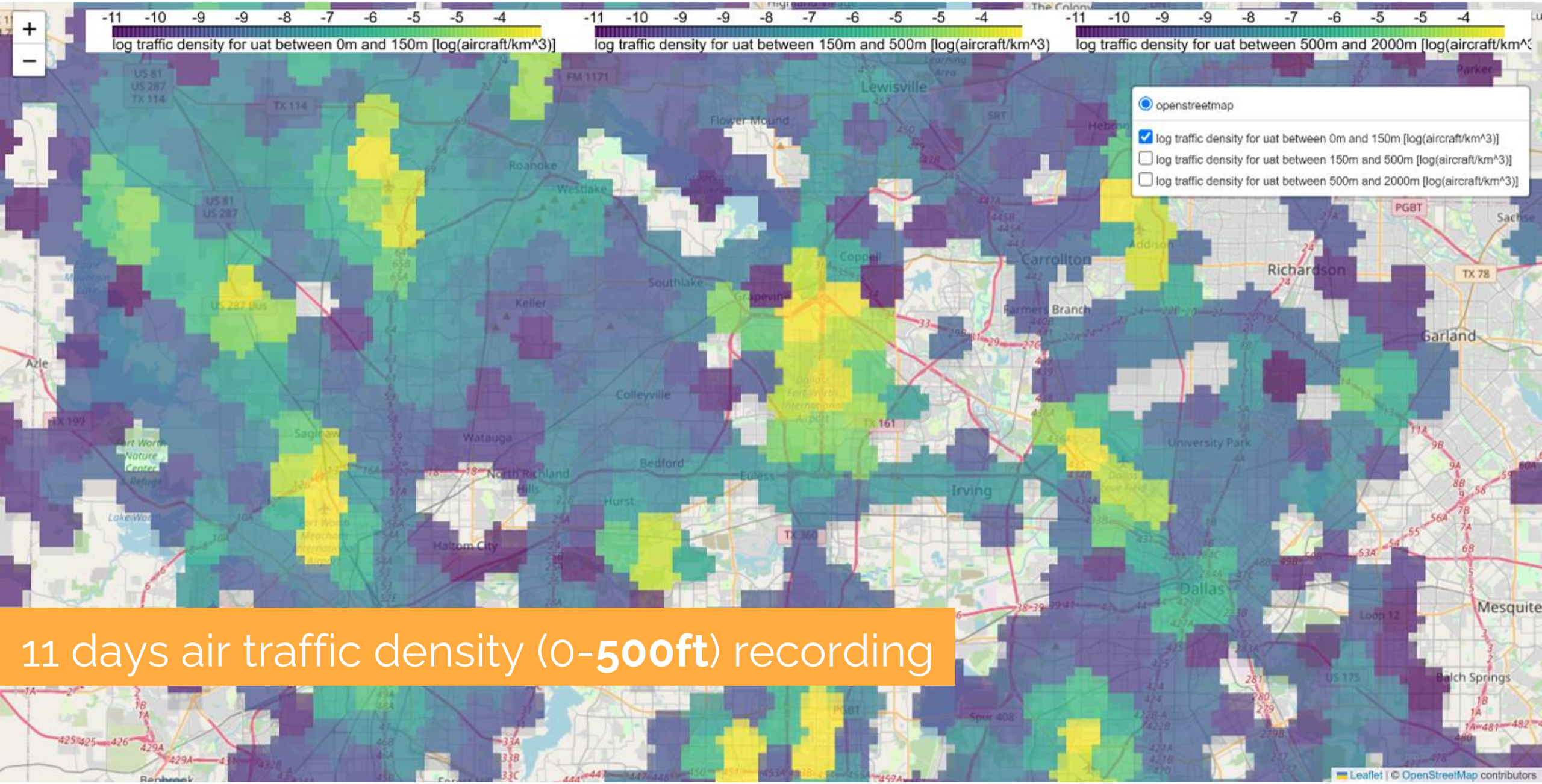

Live data for awareness and deconfliction
Complete **ADS-B** / **UAT** surveillance data
MLAT for **ADS-B, Mode S, Mode A/C**

4h complete data recording for analytics





11 days air traffic density (0-**1'500ft**) recording



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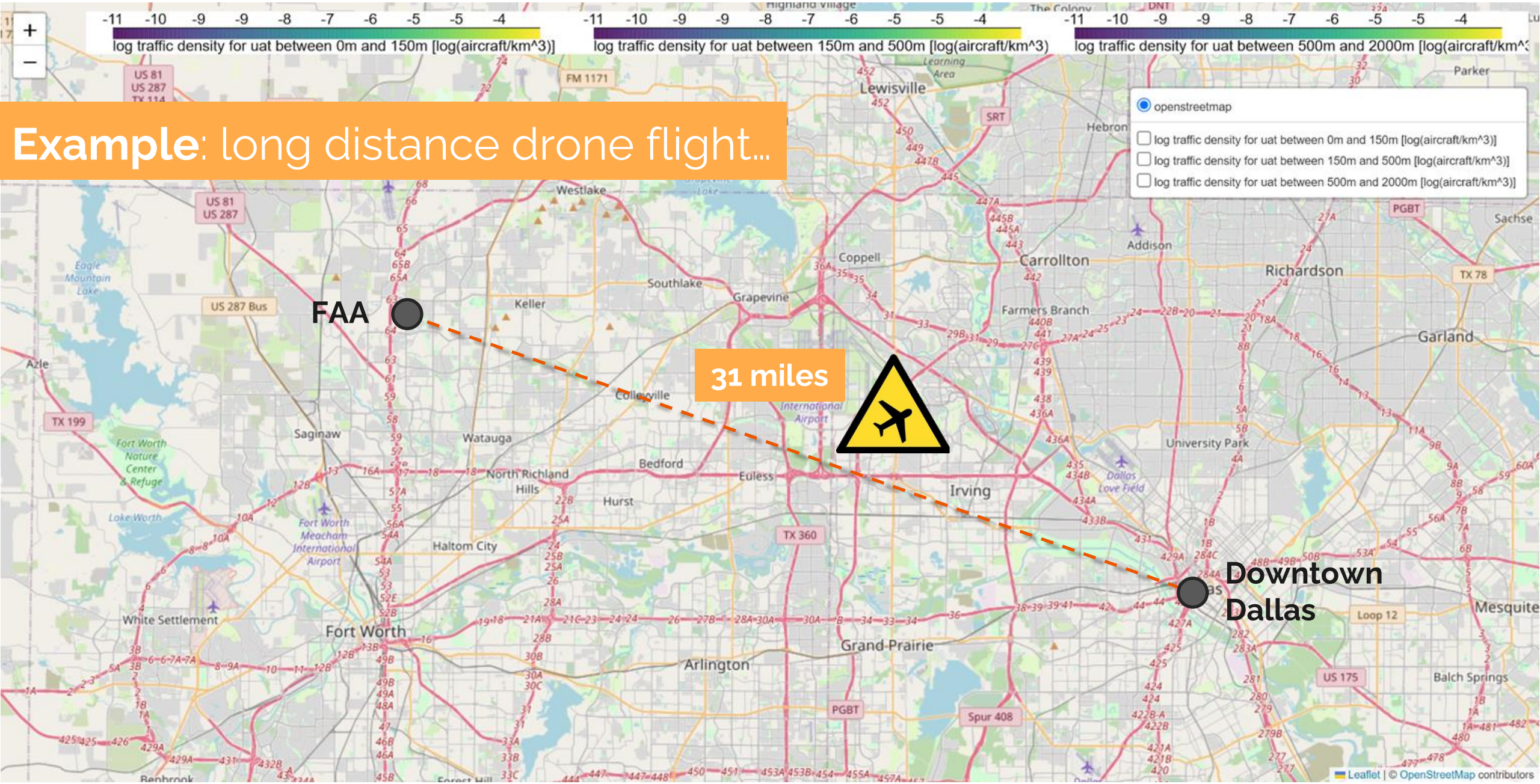
-11 -10 -9 -9 -8 -7 -6 -5 -5 -4
log traffic density for uat between 0m and 150m [log(aircraft/km^3)]
log traffic density for uat between 150m and 500m [log(aircraft/km^3)
log traffic density for uat between 500m and 2000m [log(aircraft/km^3
openstreetmap
log traffic density for uat between 0m and 150m [log(aircraft/km^3)]
log traffic density for uat between 150m and 500m [log(aircraft/km^3)]
log traffic density for uat between 500m and 2000m [log(aircraft/km^3)]
Example: long distance drone flight...
FAA
31 miles
Downtown Dallas
Lewisville
Carrollton
Coppell
Southlake
Grapevine
Keller
Westlake
Addison
Richardson
Garland
Farmers Branch
University Park
Irving
Euless
Bedford
Hurst
North Richland Hills
Watauga
Saginaw
Colleyville
Haltom City
Fort Worth
White Settlement
Arlington
Grand Prairie
Mesquite
Balch Springs
Hebron
Parker
Sachse
Azle
Eagle Mountain Lake
Lake Worth
US 81
US 287
US 287 Bus
FM 1171
SRT
PGBT
TX 78
TX 199
TX 360
Loop 12
US 175
Spur 408
Fort Worth Nature Center & Refuge
Fort Worth Meacham International Airport
Dallas Love Field
International Airport
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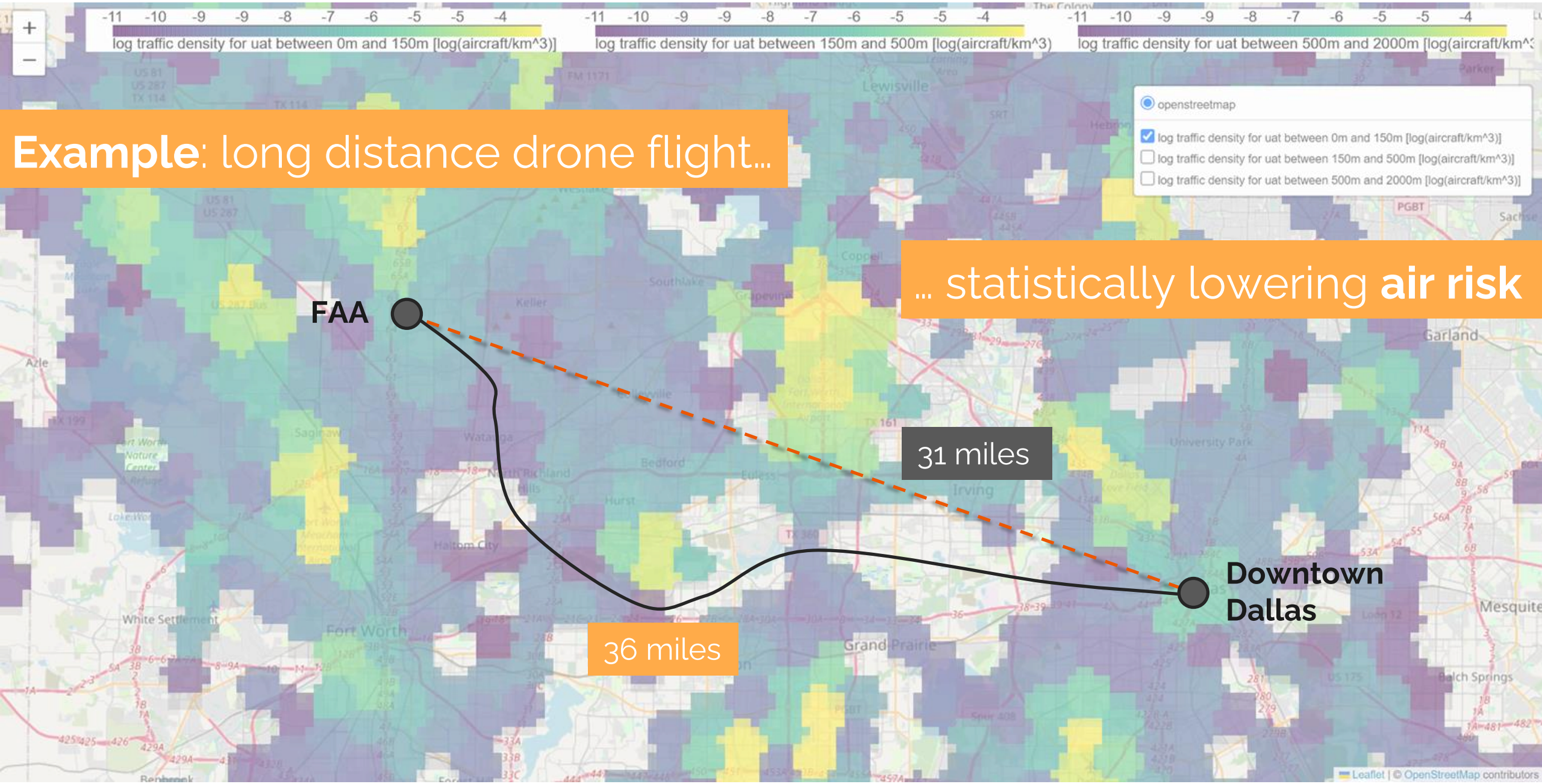
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log traffic density for uat between 150m and 500m [log(aircraft/km^3)]
log traffic density for uat between 500m and 2000m [log(aircraft/km^3)]
Example: long distance drone flight...
... statistically lowering air risk
FAA
31 miles
36 miles
Downtown Dallas
Leaflet | © OpenStreetMap contributors

Scaling our approach to **Drone Surveillance.**

Anywhere in the world!

+500 receivers online worldwide!

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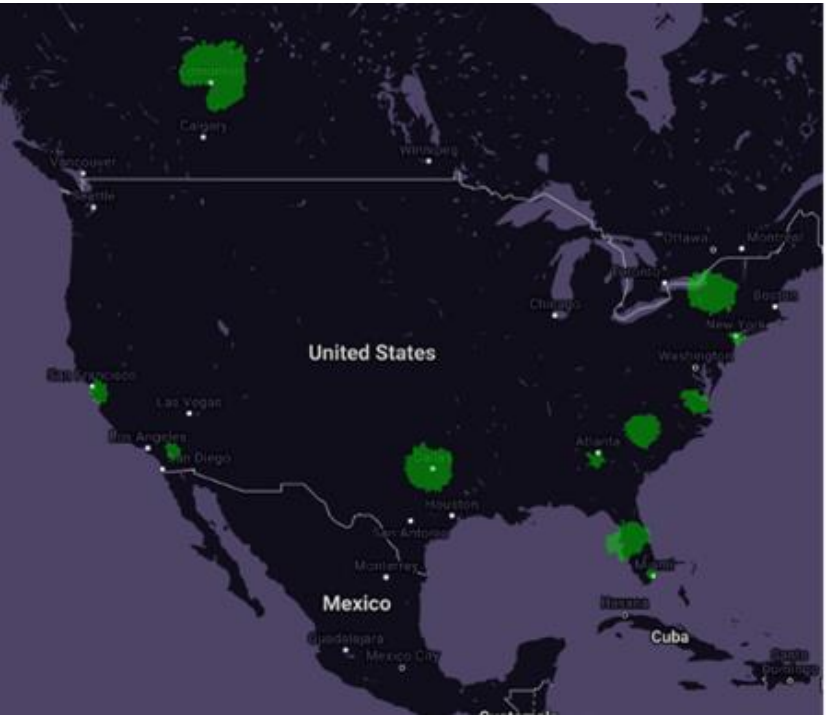

...and more coming!

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Try INVOLI.live now free!

Visualize live air traffic data in all existing coverage areas.

INVOLI.live

Create a free INVOLI.live account at:

https://registration.involi.live

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Need more?

- Acquire receivers for **expanded coverage**
- Get premium data access via our **REST API**
- Leverage custom **data analytics** for deeper insights
- Possible **feature prioritization** to fit your needs
- Get support with **regulators** and **certification** processes

A Vision for Global Airspace Surveillance

"Our goal is to build a scalable & collaborative **surveillance infrastructure network** that enhances safety, efficiency, and affordability worldwide."