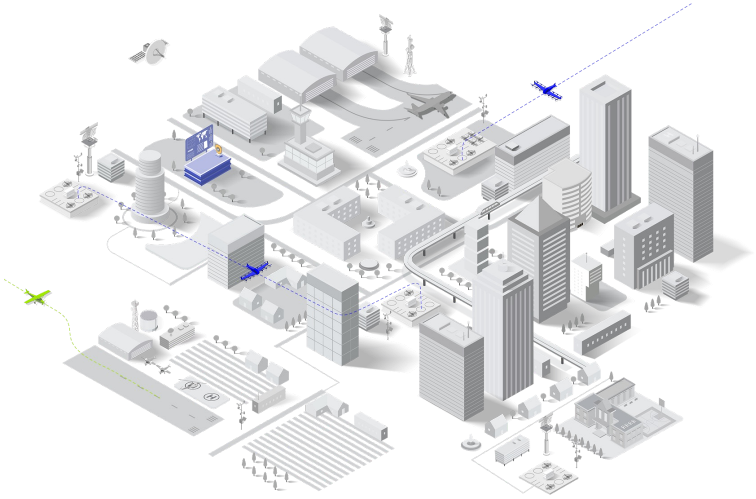
SKYGRID

Airspace Integration and Air Traffic Management for Advanced Aviation

Prepared for the Aeronautics and Space Engineering Board (ASEB)
The National Academies

Jia Xu
CEO, SkyGrid, A Boeing Company

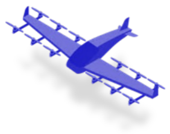
AAM: SANDBOX FOR INNOVATIONS



Vehicle Innovations	Airspace Innovations
• High-voltage electrified powertrain • Over-actuated flight controls with fly-by-wire • Expanded automation scope • Detect-and-avoid • Ground control station integration	• Approved Third-Party Services providing data and functions • Assured cloud computing platforms • Expanded low-altitude CNS coverage • Digital airspace and Autonomous Flight Rules • Ground-based traffic surveillance

Crewed and Uncrewed* | *Uncrewed

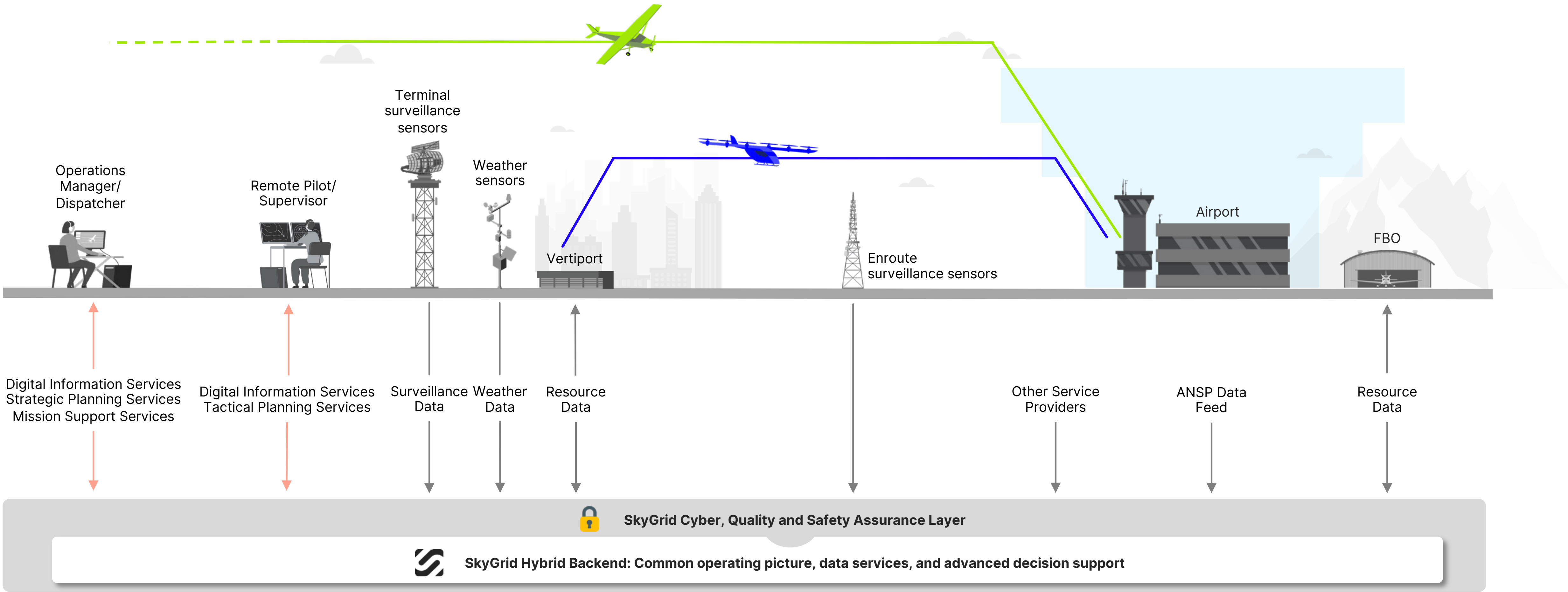
PROBLEM SPACE FOR ADVANCED AVIATION INTEGRATION

Segment		Use Cases	Challenges and Opportunities
	**High assurance sUAS**	BVLOS delivery and inspection	• Traffic data and DAA at low altitude • UTM-ATM integration
	**Uncrewed CTOL**	Middle-mile cargo over remote areas and hub airports	• Reliable traffic awareness • Machine-readable data • Increasingly digital ATC coordination
	**Crewed eVTOLs**	Intra and inter-city passenger and cargo flights	• Safe operations in congested airspaces • Operational efficiency and predictability • Sharing operational intent • Scale capacity and reduce controller workload
	**Uncrewed eVTOLs**		• Reliable traffic and weather awareness • “IFR access + VFR flexibility”

SKYGRID PLATFORM

Builds approved digital infrastructure to help integrate autonomous aircraft and AAM into the airspace.

Help enable new operations in the NAS. Accelerate xTM and ATM modernization.



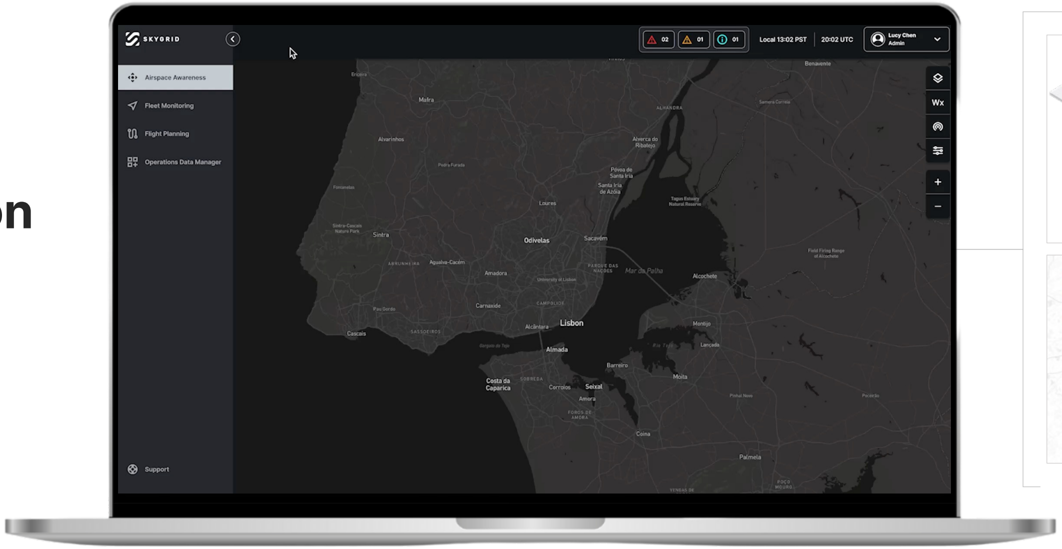
SKYGRID PLATFORM

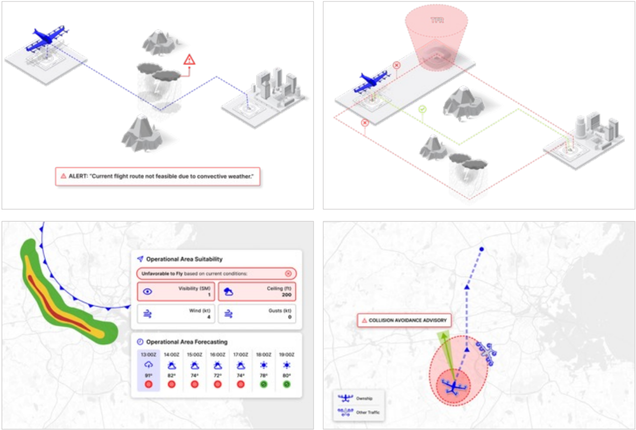
Uplifts and integrates **data**

Creates an integrated **common operating picture**

Delivers strategic and tactical **decision support**

High fidelity and integrity data





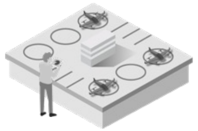
Strategic and tactical decision support

Delivered via API or UI

Remote Operators

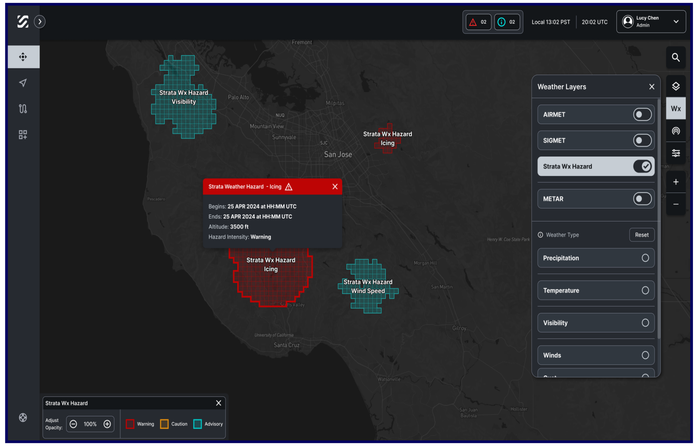
Fleet Managers and Dispatcher

ANSPs



Vertiport Managers

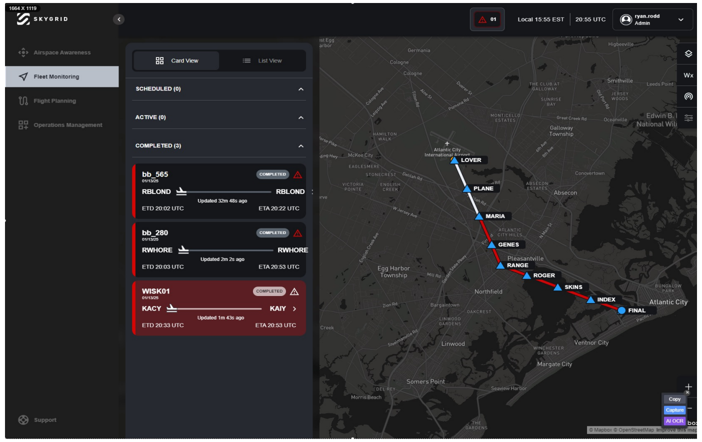
SERVICES SUPPORTING AAM INTEGRATION



Digital Information Services

Create a high-fidelity "digital twin" of the operating environment

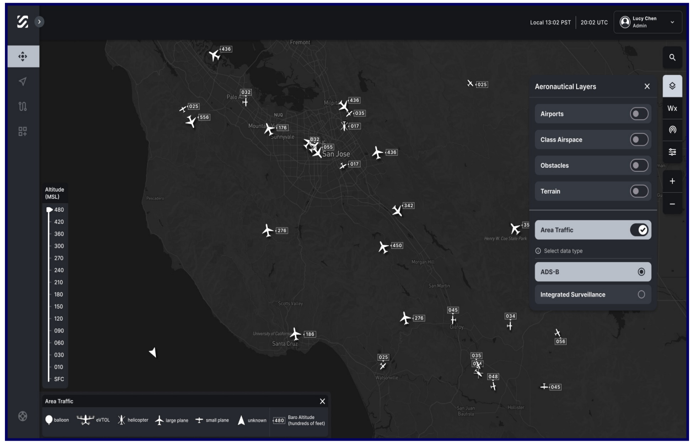
- Terrain and Obstacles
- Weather
- Ground-Based Traffic Surveillance
- CNS Coverage and Status



Strategic Planning Services

Help the operator plan safe, efficient, and strategically deconflicted flights

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



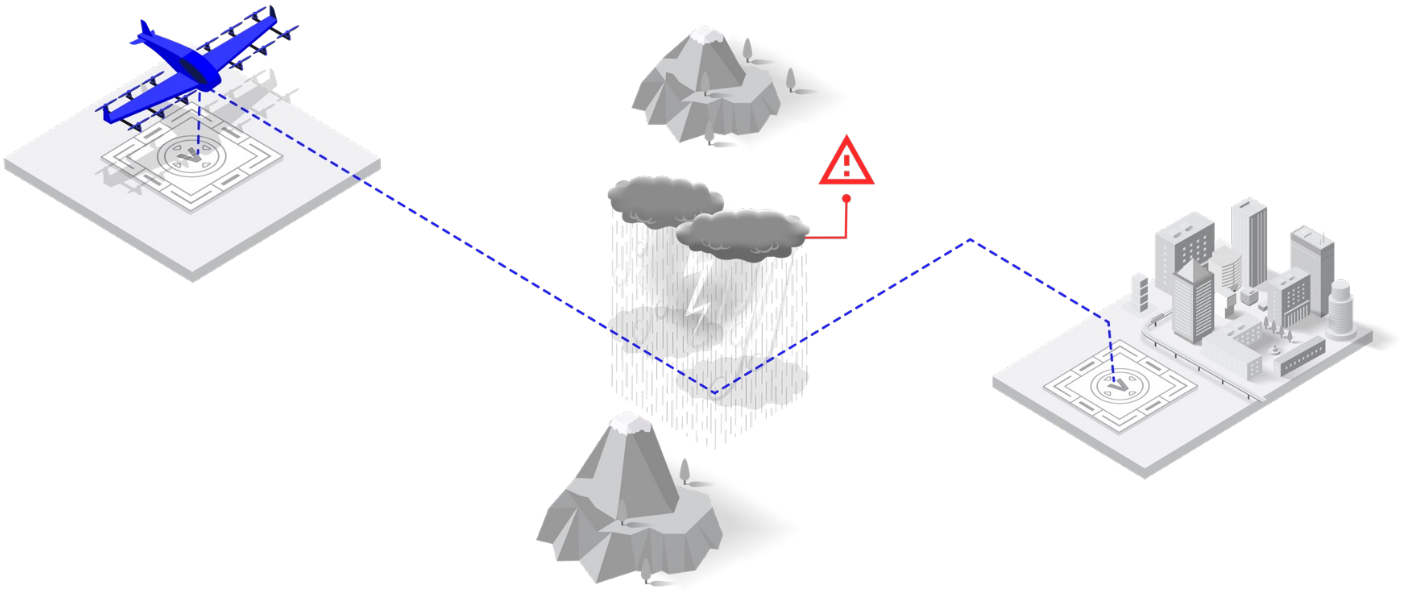
Tactical Planning Services

Support real-time decisions against airspace constraints and hazards

- Conformance Monitoring
- Dynamic Rerouting
- Hazard and Constraint Monitoring
- Flow Management

- Provide ground-based capabilities to enable uncrewed operations
- Increase AAM operational efficiency
- Streamline airspace access and help scale AAM ops

EXAMPLE: FLIGHT PLAN VALIDATION



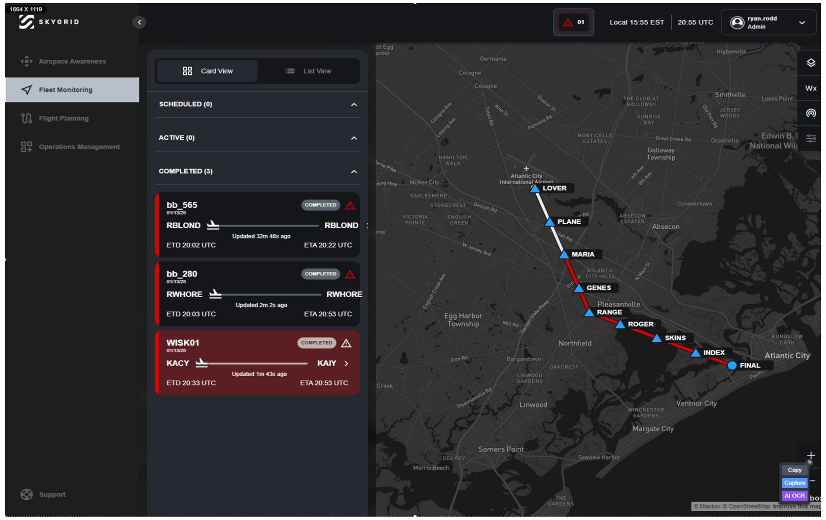
⚠ ALERT: “Current flight route not feasible due to convective weather.”

Flight Plan Validation (FPV) can help operators plan flights that are deconflicted from hazards and constraints.

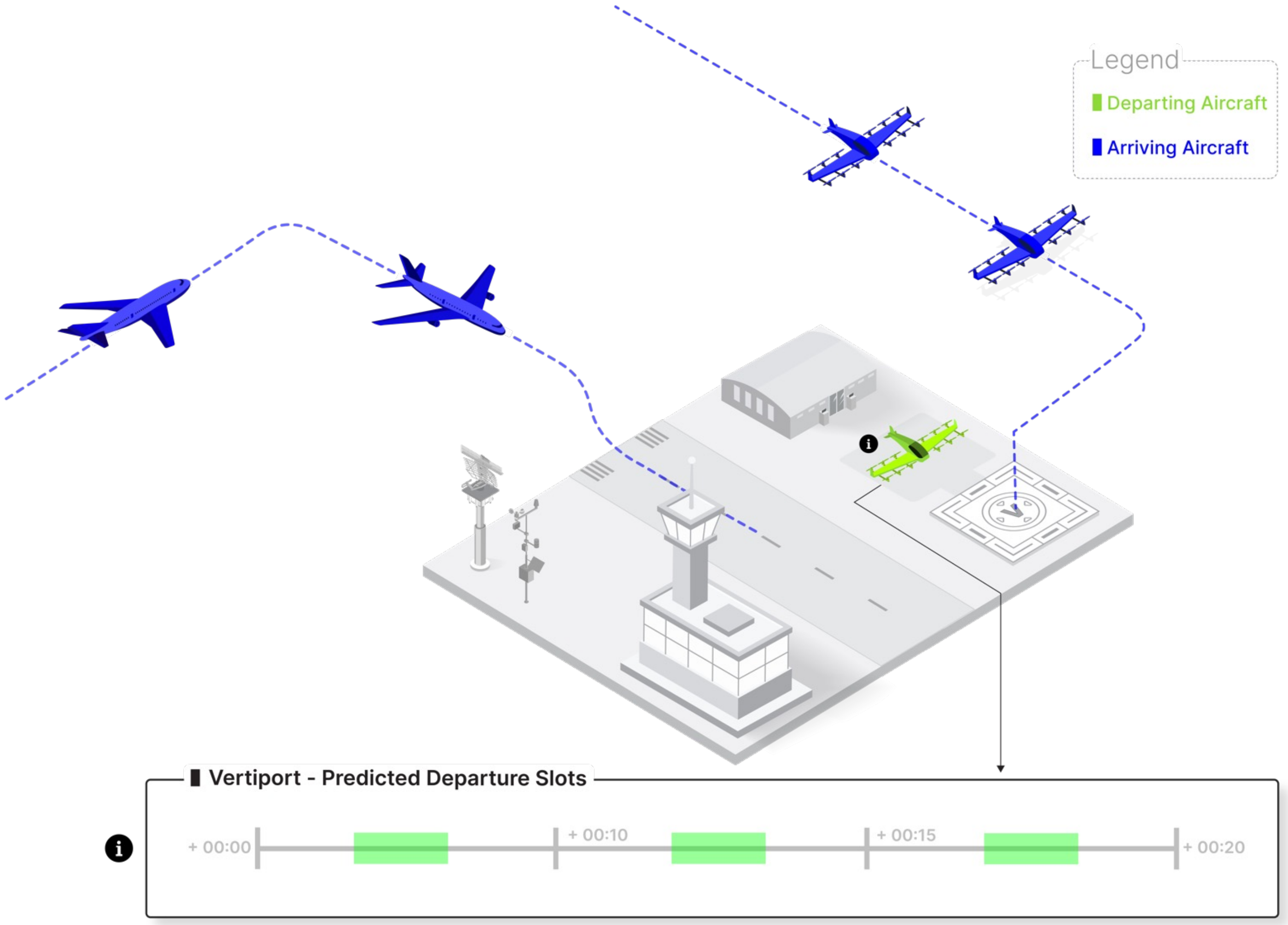
FPV will alert the operator if a flight becomes infeasible.

Initially, provide **decision support.** Evolve to support automated flight plan approvals.

Connectionist AI can be used to predict future traffic volume and capacity as functions of environmental state



EXAMPLE: TRAFFIC SYNCHRONIZATION



Green segments indicate times when traffic separation is adequate for a VTOL departure from the vertiport.

A Traffic Synchronization service can advise operators of *optimal* departure windows based on **real-time traffic conditions**.

Traffic Synchronization issues a **predicted departure time** to the operator.

Improve traffic flow in the air and service reliability for the travelers

Connectionist AI can be used to predict future traffic state and ATM/vehicle behavior to improve synchronization

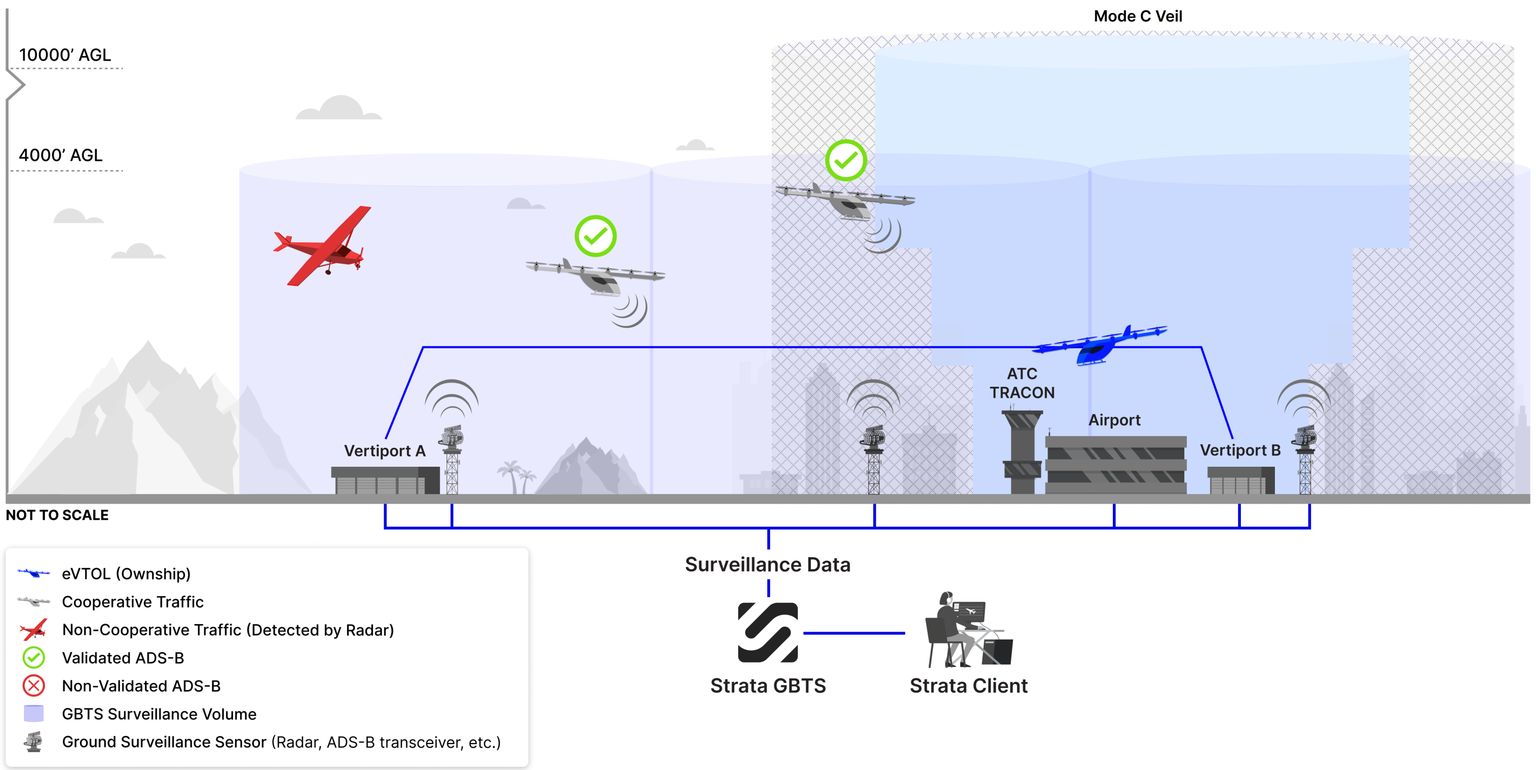
EXAMPLE: GROUND-BASED TRAFFIC SURVEILLANCE (GBTS)

Uncrewed aircraft need new solutions to retain traffic awareness and **remain well clear** of other aircraft:

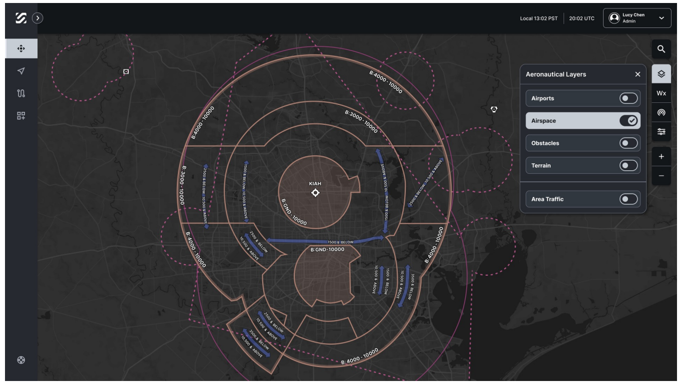
- Cover low-altitude airspace
- Detect cooperative and non-cooperative traffic
- Low latency and high integrity

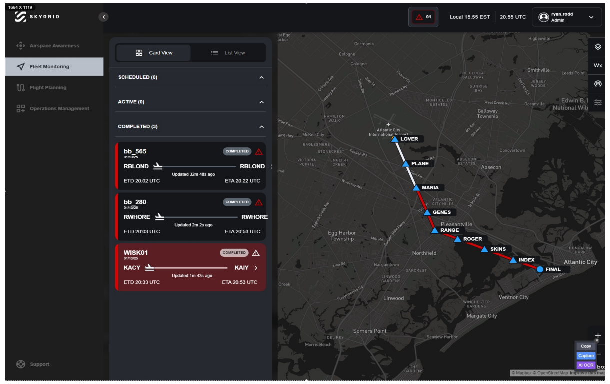
GBTS can support advanced tactical functions like cooperative separation (see FAA UAM CONOPS 2.0)

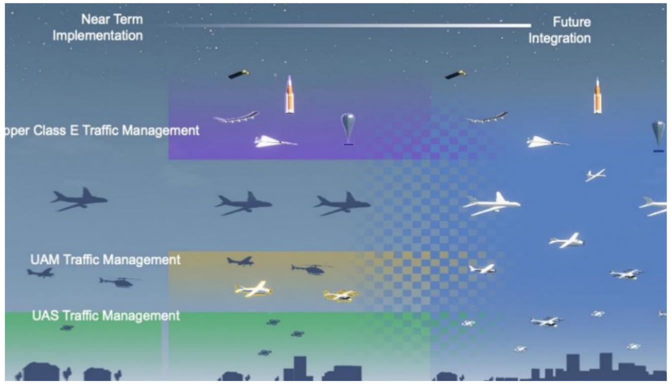
Classical approaches (e.g., POMDP) are sufficient to achieve the desired performance



PATH TO ATM 2.0







Today: Assured Foundation

Build third-party services **foundation** to improve safety and efficiency

- Make autonomy a business
- Plumbing and infrastructure matters

Midterm: Advanced Functions

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

- AAM needs approved platforms
- Improve operational efficiency and control ATM workload

Future: Aviation Unleashed

Deliver **airspace automation**. Improve safety and efficiency

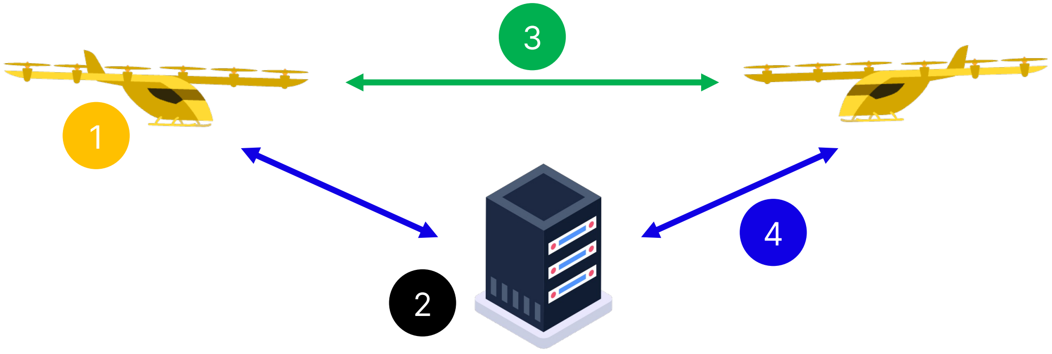
- Grow from the AAM sandbox to enable digital flight
- Digital flight rulemaking can unlock scale

- We have much foundational work to do beyond integrating AI
- The complexity and scale of new operations may motivate AI applications

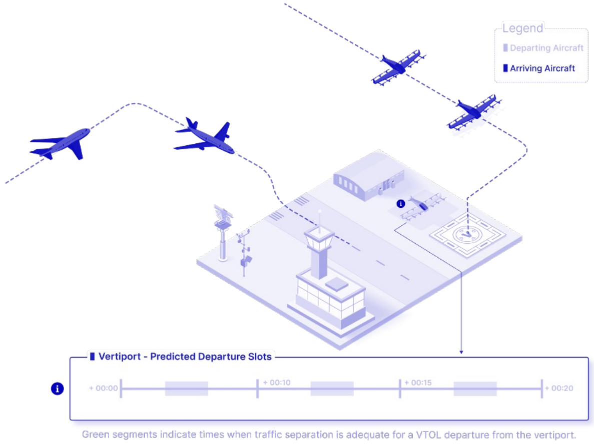
Figure Credit (far right): NASA

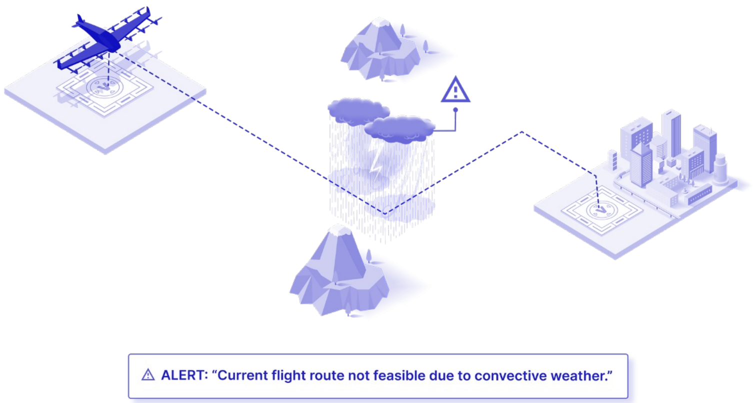
AUTONOMOUS FLIGHT OPERATIONS AND RULES (AFO/AFR)

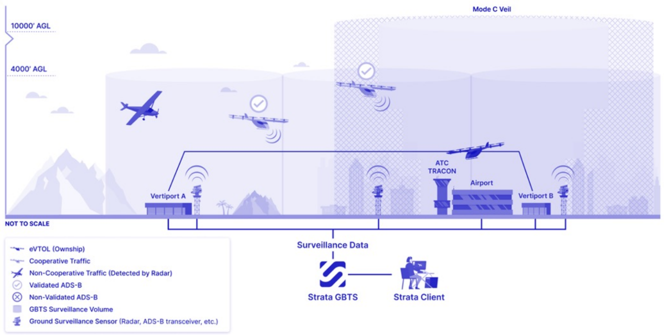
1. Aircraft automation
2. Ground Automation
3. Aircraft-aircraft connectivity
4. Aircraft-ground connectivity



Can we close the loop on decision support functions?

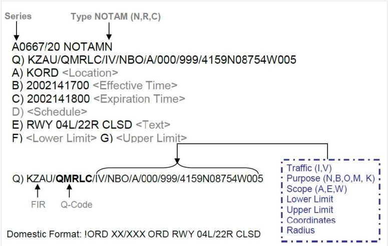


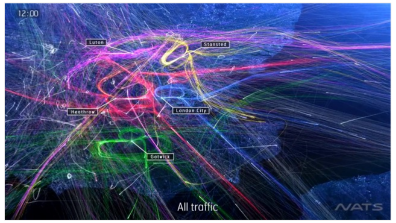


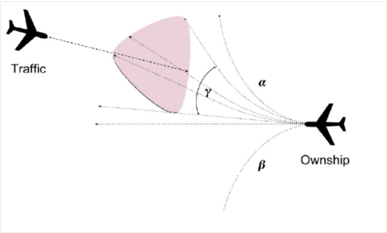


For more on autonomous flight operations/rules, see RTCA Digital Flight Whitepaper, and NASA papers on digital operations (1, 2).

AI FOR ATM







Application Space	Examples	Challenges
Tame and digitize unstructured data	• Contextualize and check NOTAMs • Make voice data machine operable • Construction digital twins from text	• Data is already becoming more structured • Assurance and explainability
Find and use complex patterns	• Infer operational intent • Predict future traffic state • Procedure design with AI • System-wide anomaly detection	• Explainability • Data pedigree
Plan in high-dimensional space	• Detect conflicts and find mitigations • Respond to contingencies • DAA and separation (ACAS-X)	• System integration • Assurance and explainability • Data pedigree

Dimensionality of the search space | ***Availability and saturation of data*** | ***Safety-assured requirements***

Image Sources: NASA, ICAO, UK NATS

AI IN ATM

Tackle the classic assurance problems in AI

- Explainability and interpretability
- Bounded input to bounded output
- Data pedigree and statistical representativeness
- Ensemble V&V (statistical, formal method, etc.)

Bootstrap to safety-criticality

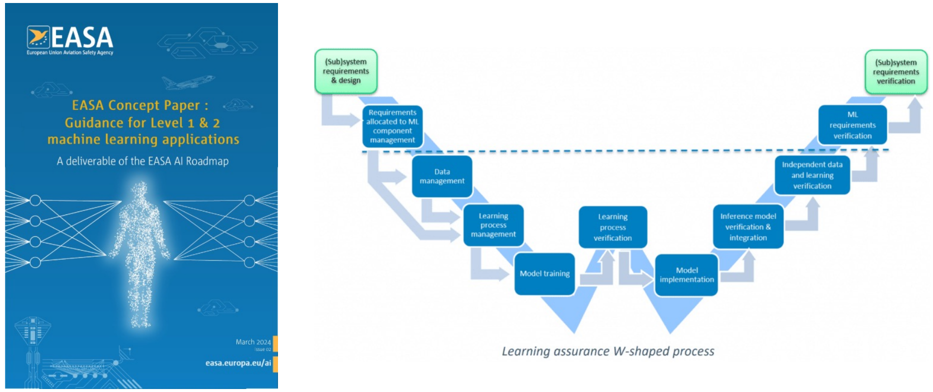
- Start non-certified: situational awareness, anomaly detection
- ATM before primary flight controls
- Pre-strategic => strategic => tactical

Create safe systems

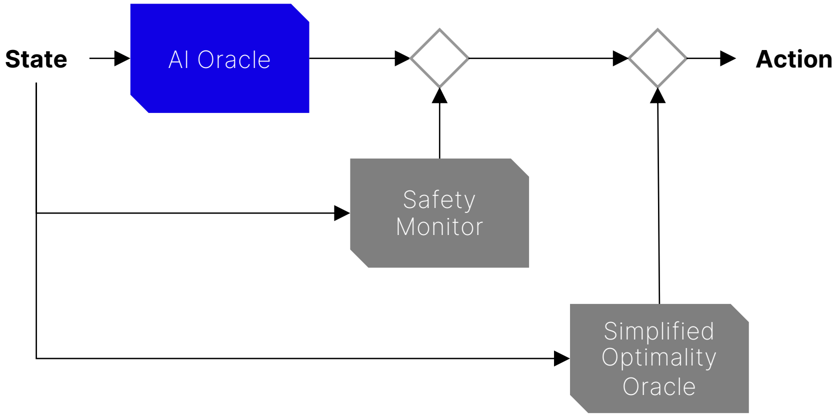
- Bound AI/ML black boxes with certifiable safety monitors

Create pathways to certification

- Get industry and regulators on the same page (e.g., CoDANN)
- Do we need traceability if we can bound the black box?



Source: EASA. Concepts of Design Assurance for Neural Networks (CoDANN)




Corporate strategy decks from 2017: **AI solves all our problems.**
Plateau of productivity: **AI for the right problems, at the right level of assurance, with the right architecture**
Serious civil aerospace in 2025: **We don't AI. We don't need AI. They are not certifiable.**

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