Digital Information Platform

SERVICES FOR AVIATION

Towards Sustainable Aviation with Efficient Airspace Operations

ICAS2024_1247

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NASA Ames Research Center

Agenda

- NASA's Sustainable Flight National Partnership Operations
- Machine Learning Airport Surface Model
- Pre-departure Reroute Operational Evaluation and Benefits
- Summary

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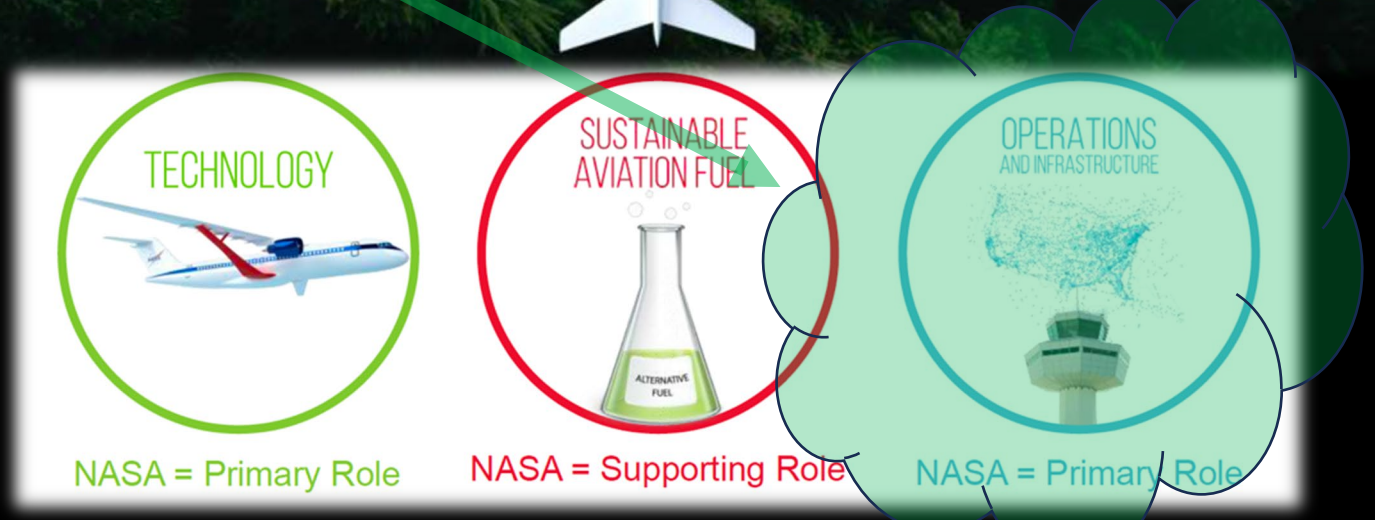
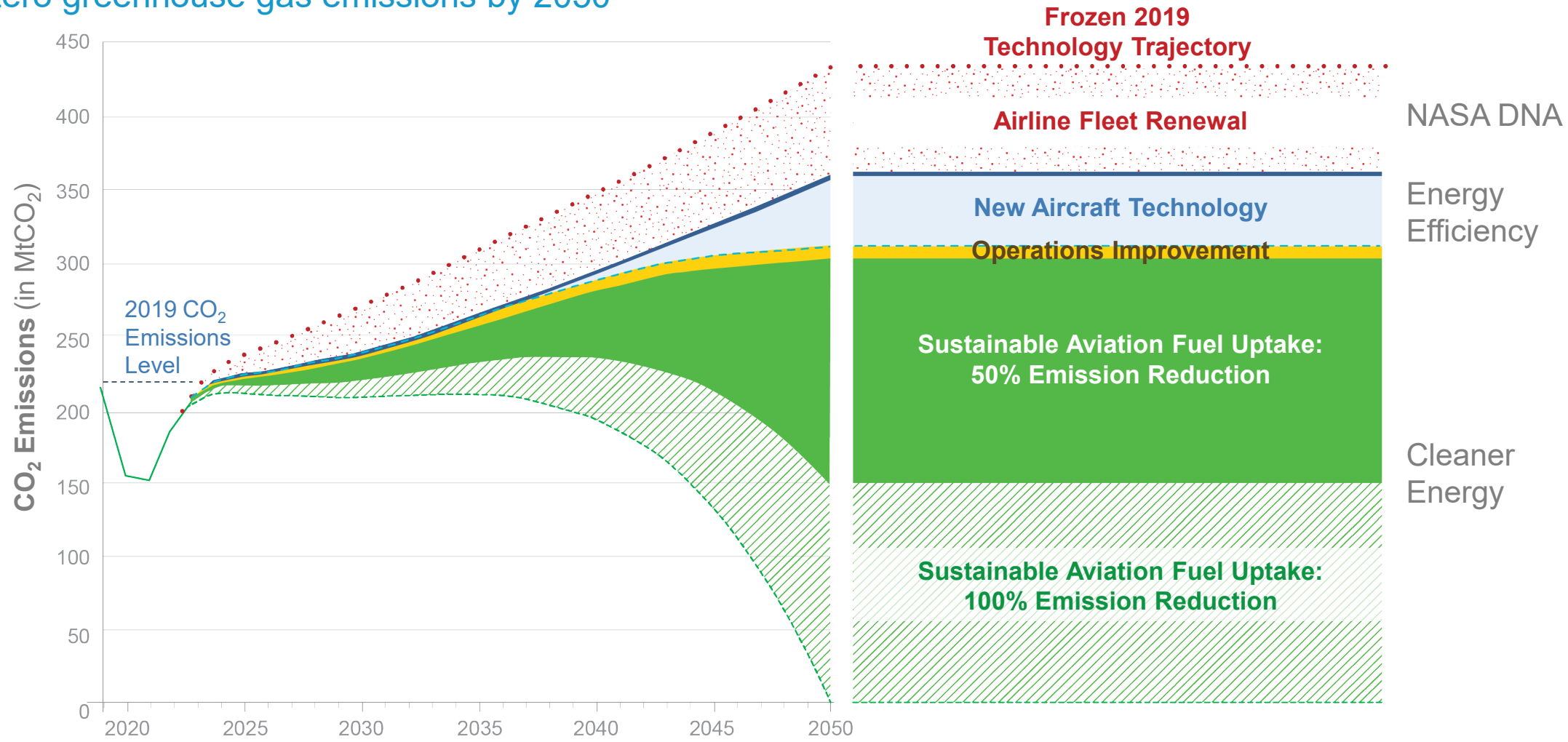
NASA's Sustainable Flight National Partnership

Accelerating Toward Net-Zero Greenhouse Gas Emissions and Reduced Non-CO_2 Climate Impact in the 2030s



U.S. Aviation Climate Action Plan – 2021

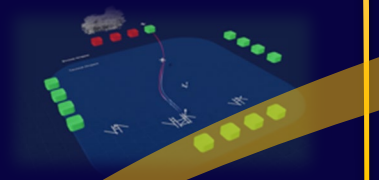
Net-zero greenhouse gas emissions by 2050



https://www.faa.gov/sites/faa.gov/files/2021-11/Aviation_Climate_Action_Plan.pdf

The U.S. is working with the global community to achieve net-zero greenhouse gas emissions by 2050 with reduced non-CO_2 (e.g. contrails), noise, and local air quality impacts

Sustainable Flight National Partnership Operations (SFNP-Ops) Demo Plan Supporting FAA's Future Airspace Architecture



Pre Departure Rerouting

FY22-25

Gate-to-Gate Trajectory Management

FY23-27

Fleet Wide Disruption Management

FY24-28

Capstone Demo

FY25-30

Utilizing NASA, FAA, and partner assets to support the SFNP Mission to demonstrate reduction in emissions and fuel for aviation operations

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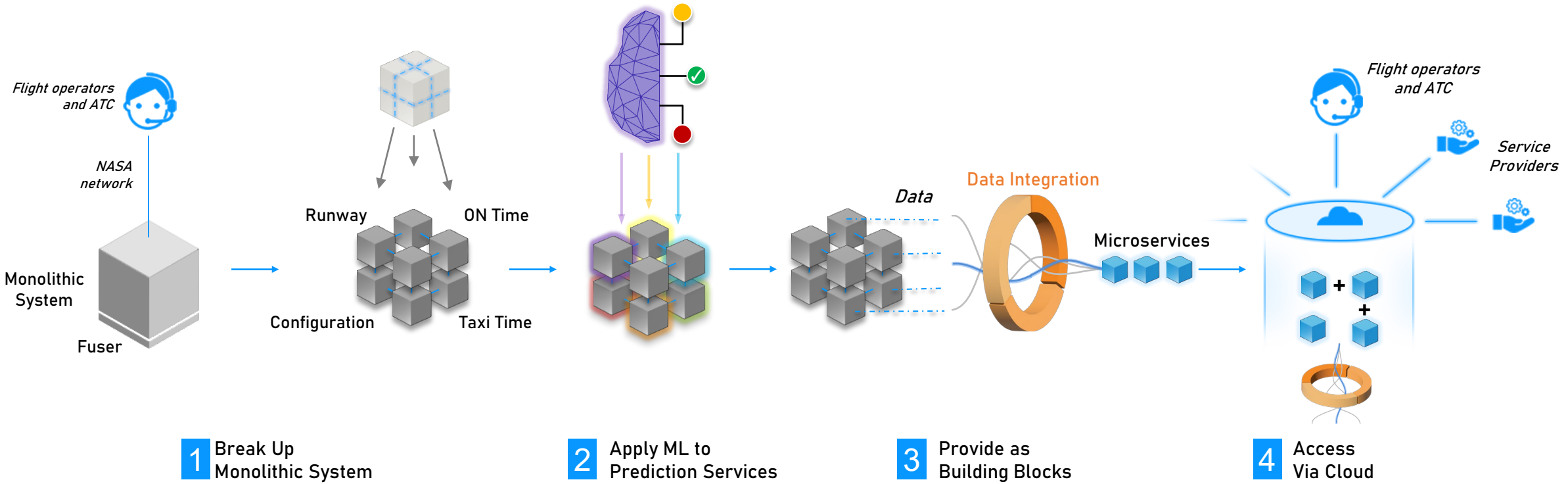
Digital Transformation:
Service Oriented Architecture, AI/ML, and Cloud Deployment

Previously: Airspace Technology Demonstration-2

Monolithic service for single application, using adaptation-based algorithms to generate trajectory predictions as input to terminal scheduler; requiring site-to-site deployment

Current: Digital Information Platform

Transformed into service-oriented architecture of highly reusable digital services accessible on the platform to support many advanced applications; upgraded to machine learning-based algorithms for predictions to enable NAS-wide scalability



1 Break Up Monolithic System

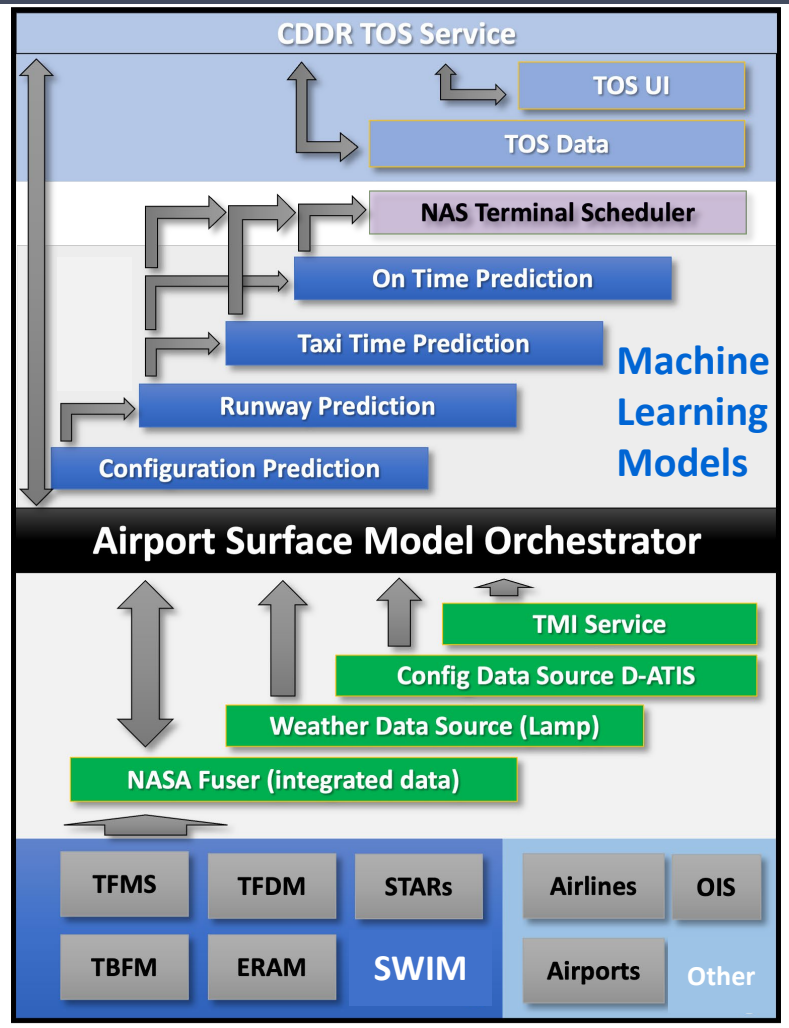
2 Apply ML to Prediction Services

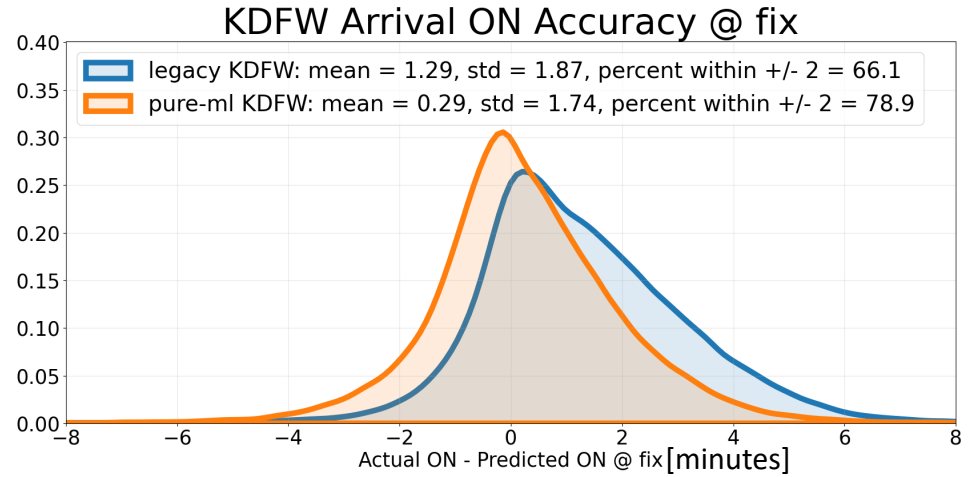
3 Provide as Building Blocks

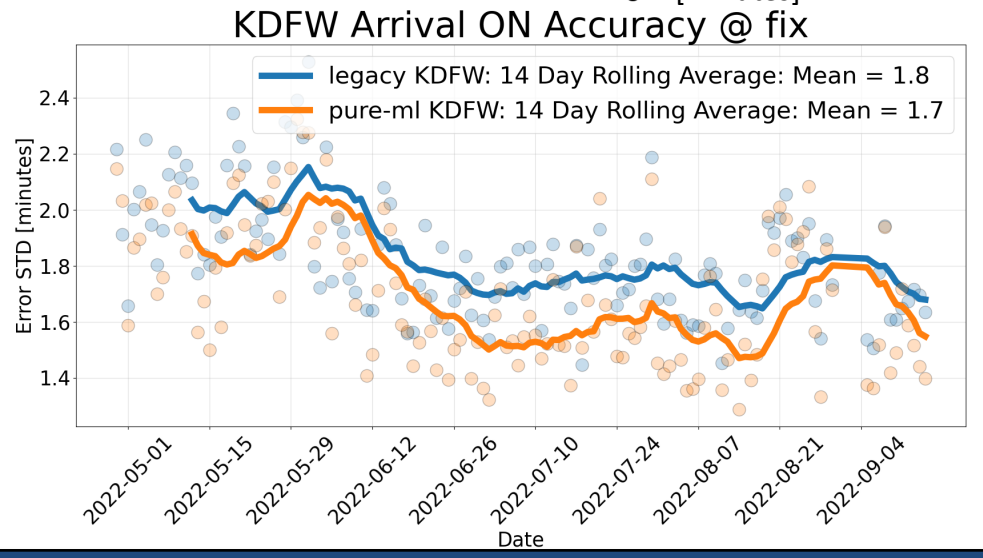
4 Access Via Cloud

Digital transformation aligned with FAA vision for future airspace architecture:
Learning, adaptable, and lightweight interacting systems

Machine Learning Airport Surface Model







Machine Learning Airport Surface Model outperformed legacy physics-based models

TFMS: Traffic Flow Management System
TFDM: Terminal Flight Data Manager
TOS: Trajectory Option Set

STARs: Standard Terminal Automation Replacement System
TBFM: Time-Based Flow Management
CDDR: Collaborative Digital Departure Reroute

ERAM: En Route automation modernization
SWIM: System Wide Information Management
NAS: National Airspace System

OIS: Operational Information System
D-ATIS: Digital-Automatic Terminal Information Service
TMI: Traffic Management Initiatives

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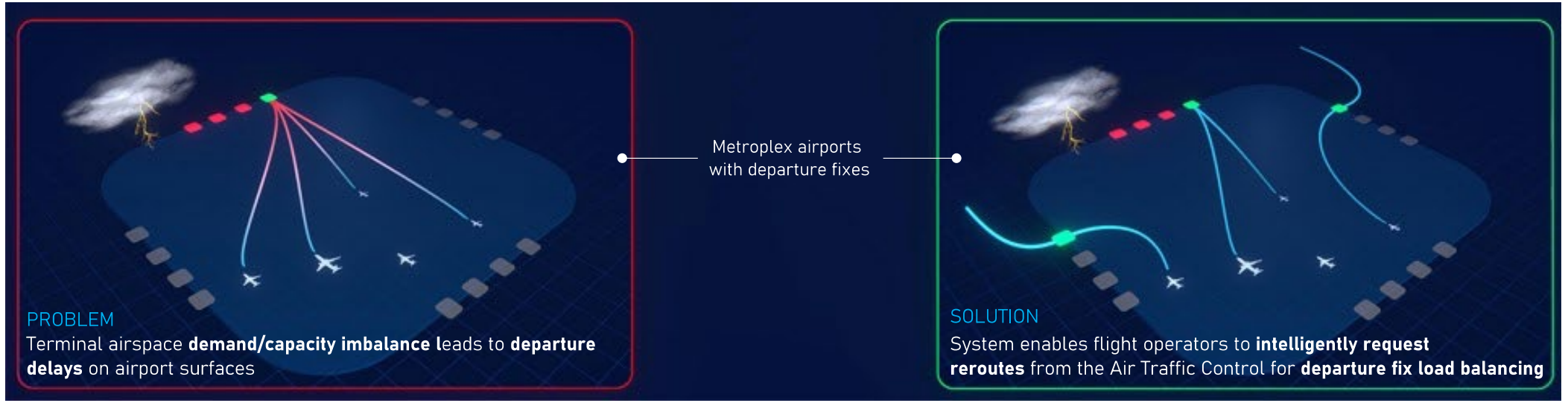
Pre-Departure Trajectory Option Set Reroutes

Operational Problem:



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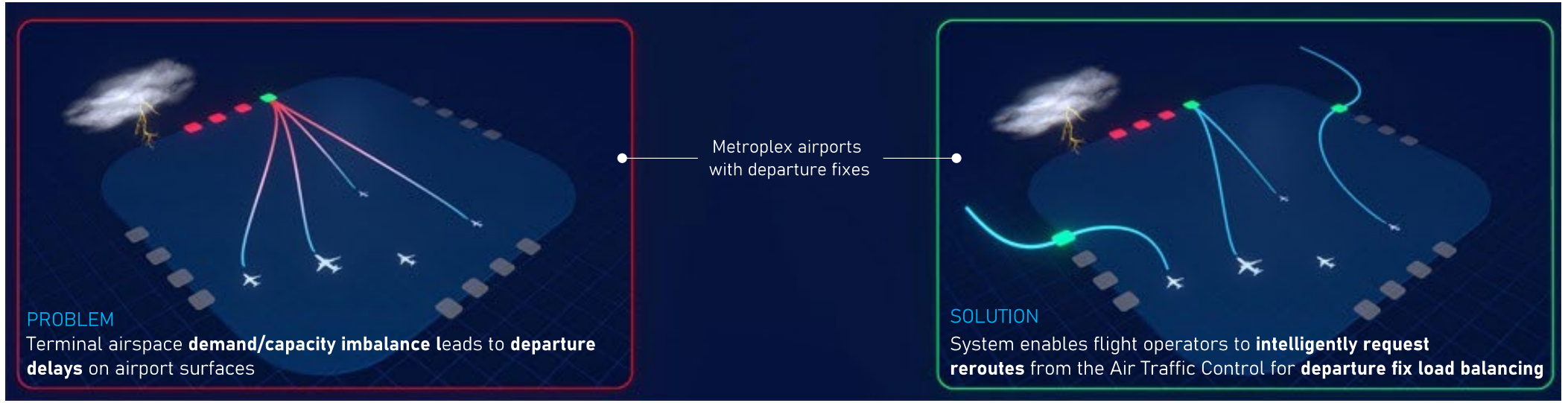

Workflow:

1. **Configure System:** Train ML models
2. **System Monitors:** Demand & Capacity
3. **Candidate Flight** Presented to flight operator
4. **Submitted Flight** Submitted to Air Traffic Control
5. **Evaluate** Post Operation

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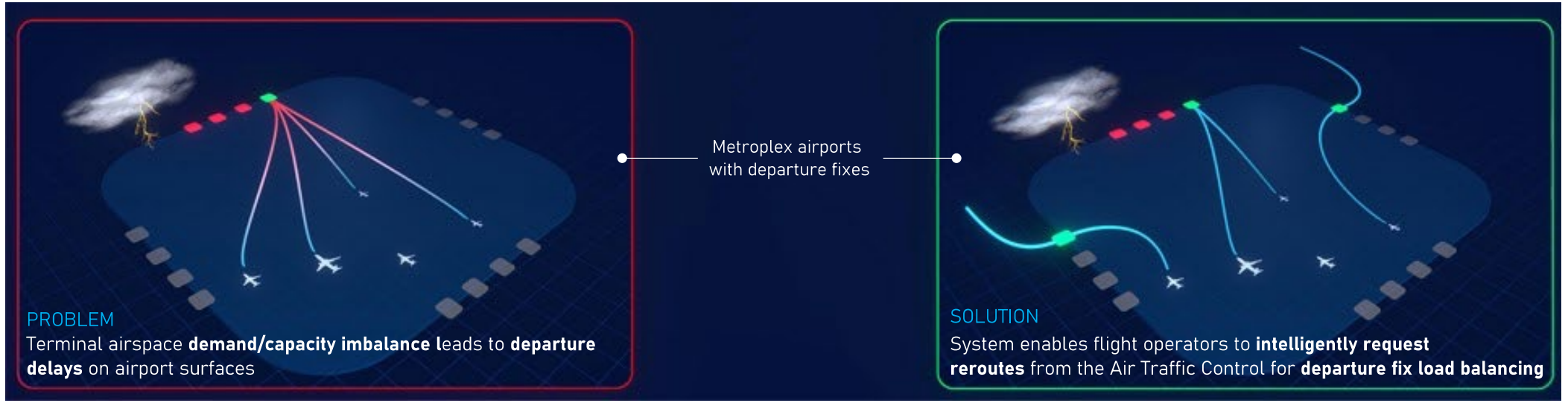

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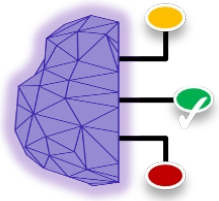

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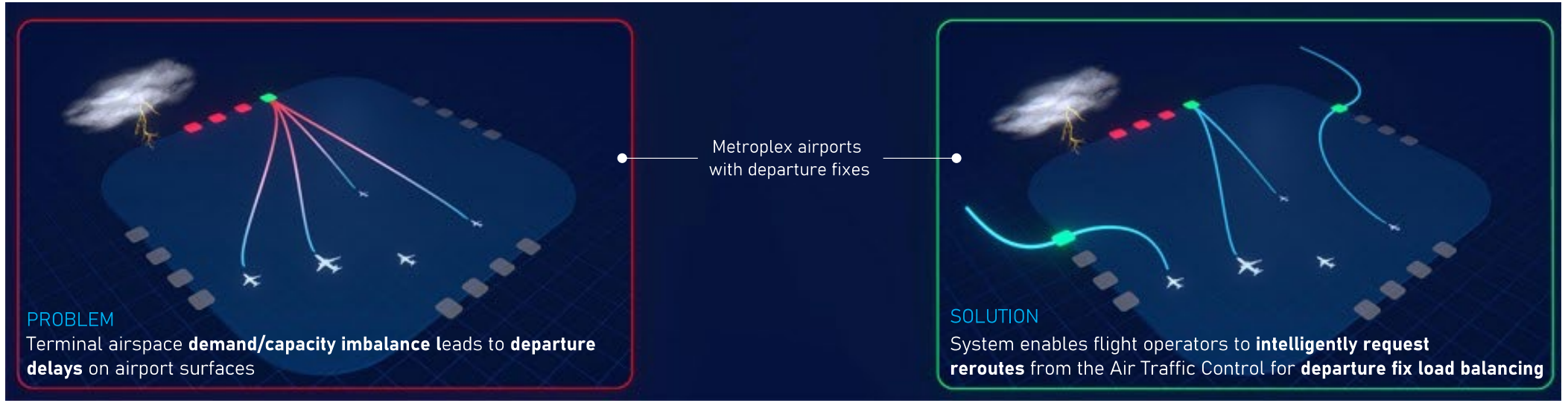

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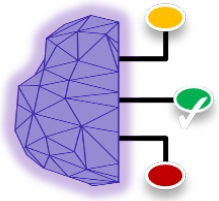

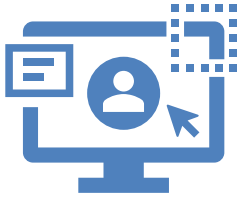

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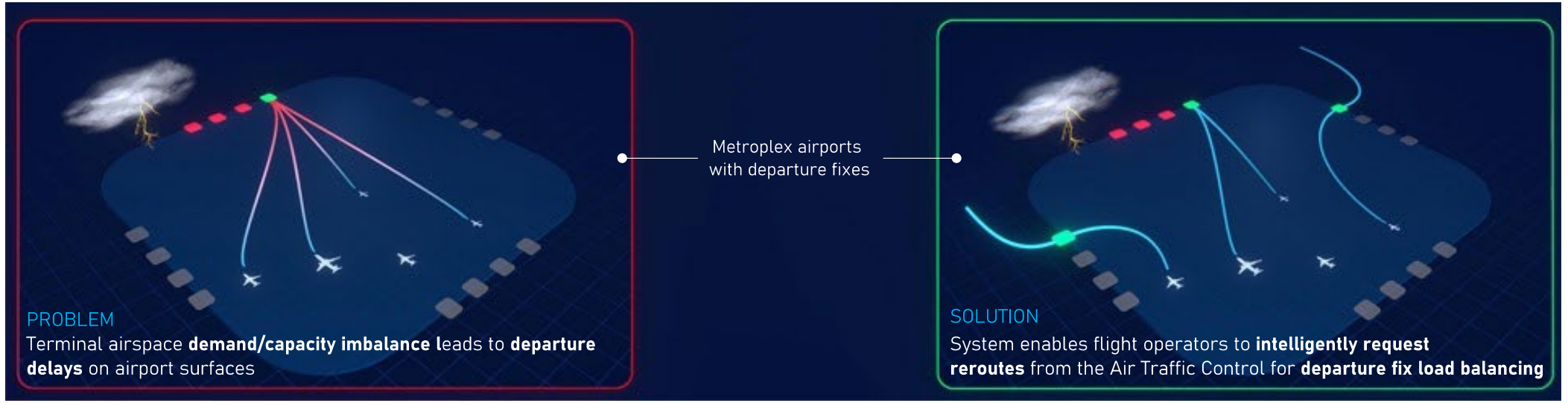

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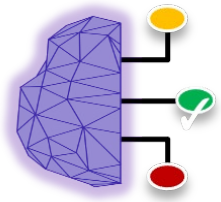
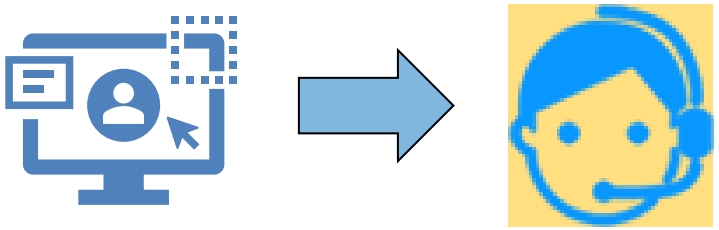


Candidate Flight for reroute



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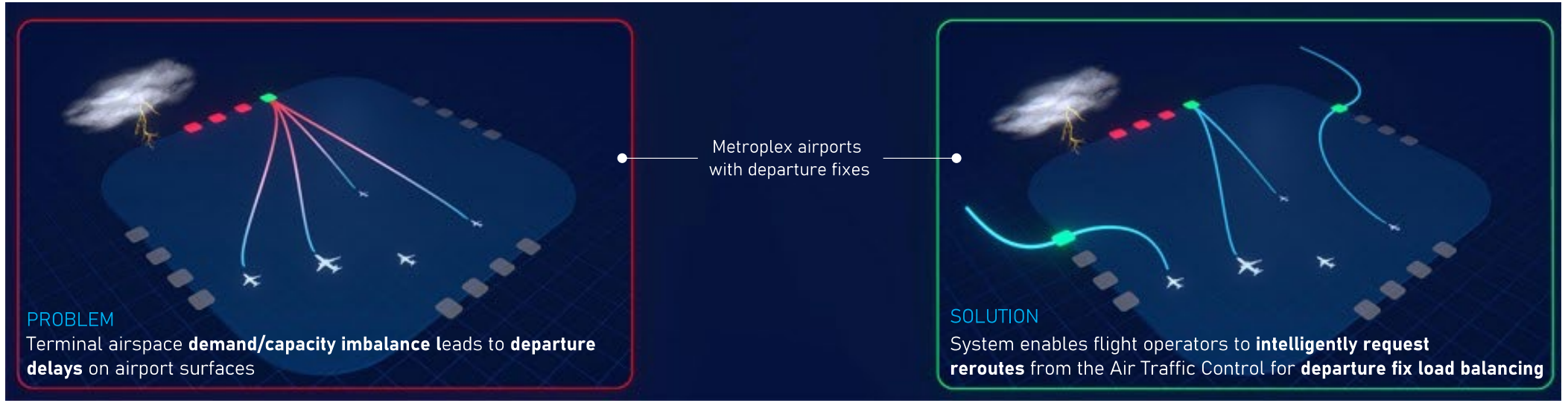

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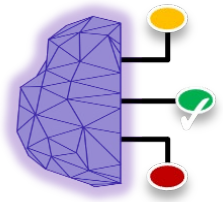

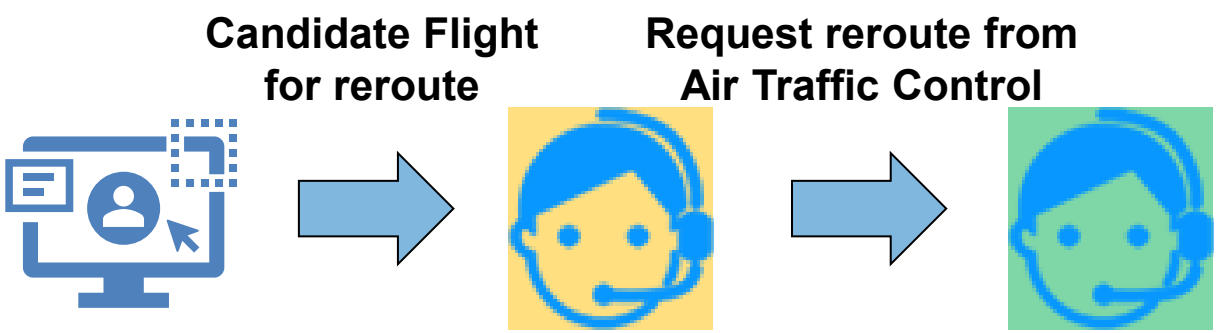

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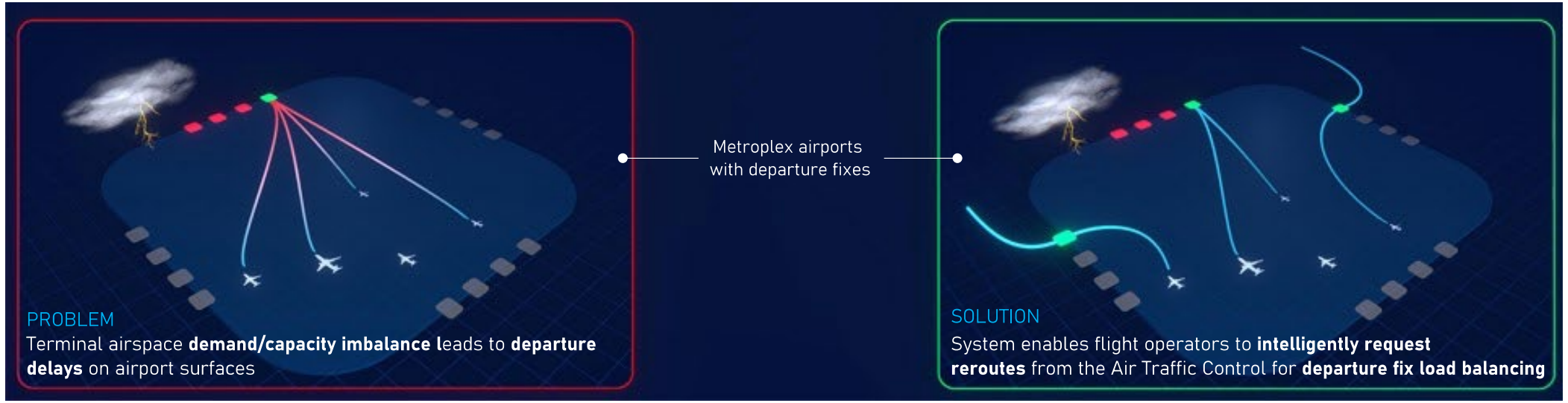

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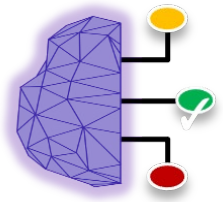

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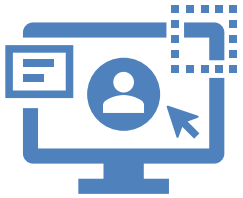
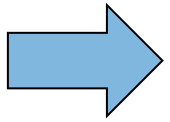
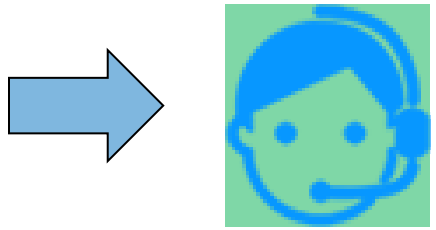




Request reroute from Air Traffic Control



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SFNP Predeparture Rerouting Operational Evaluation
Sustainability Benefits

2024 Environmental Benefits in North Texas

631 CANDIDATE Flights for pre-departure rerouting → 109 TOS Reroute REQUESTS Submitted to ATC → 47 APPROVED and REROUTED Flights

Average reroute saves 938 lbs of fuel, 2,890 lbs of CO_2, and 21 urban trees

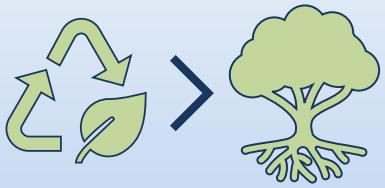
44 reroutes were included in the 2024 benefits analysis

Total Fuel Savings

~41k lbs. **Fuel**

Total Emissions Savings

~127k lbs. **CO_2**



~945 urban trees

Individual time/money savings

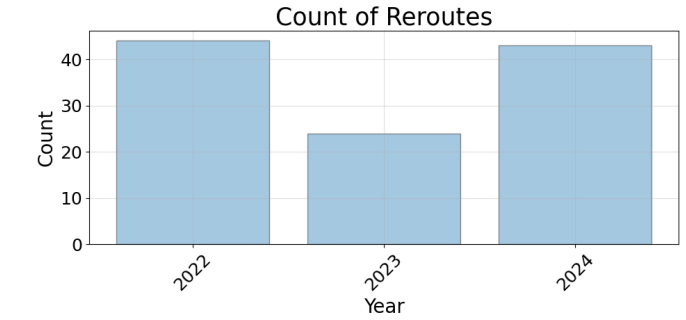
Passenger cost savings: $42,556.73

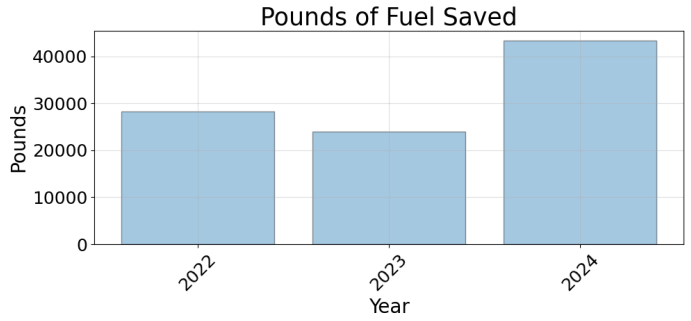
Crew cost savings: $8,792.09

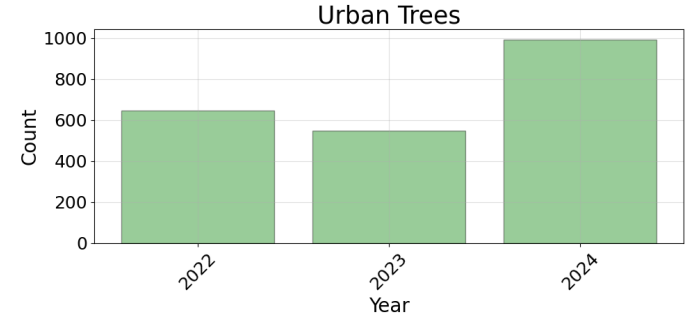
Total OFF delay savings: 4.82 hours

Total IN delay savings: 5.97 hours

2022 – 2024 Benefits







Sustainability benefits achieved now with pre-departure reroutes and designed to scale

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Summary

- NASA is supporting the Sustainable Flight National Partnership Mission through execution of real-world operational evaluations
- ML Airport Surface Model a result of digital transformation from legacy (adaptation/physics) system to scalable ML system in alignment with future airspace architecture
- Pre-departure reroute **is delivering sustainability benefits today** with average reroute savings of 938 pounds of fuel, 2,890 pounds of of CO2, equivalent to planting 21 urban trees
- Working on expanding partnership ecosystem (both US domestic and international)

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Questions?

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