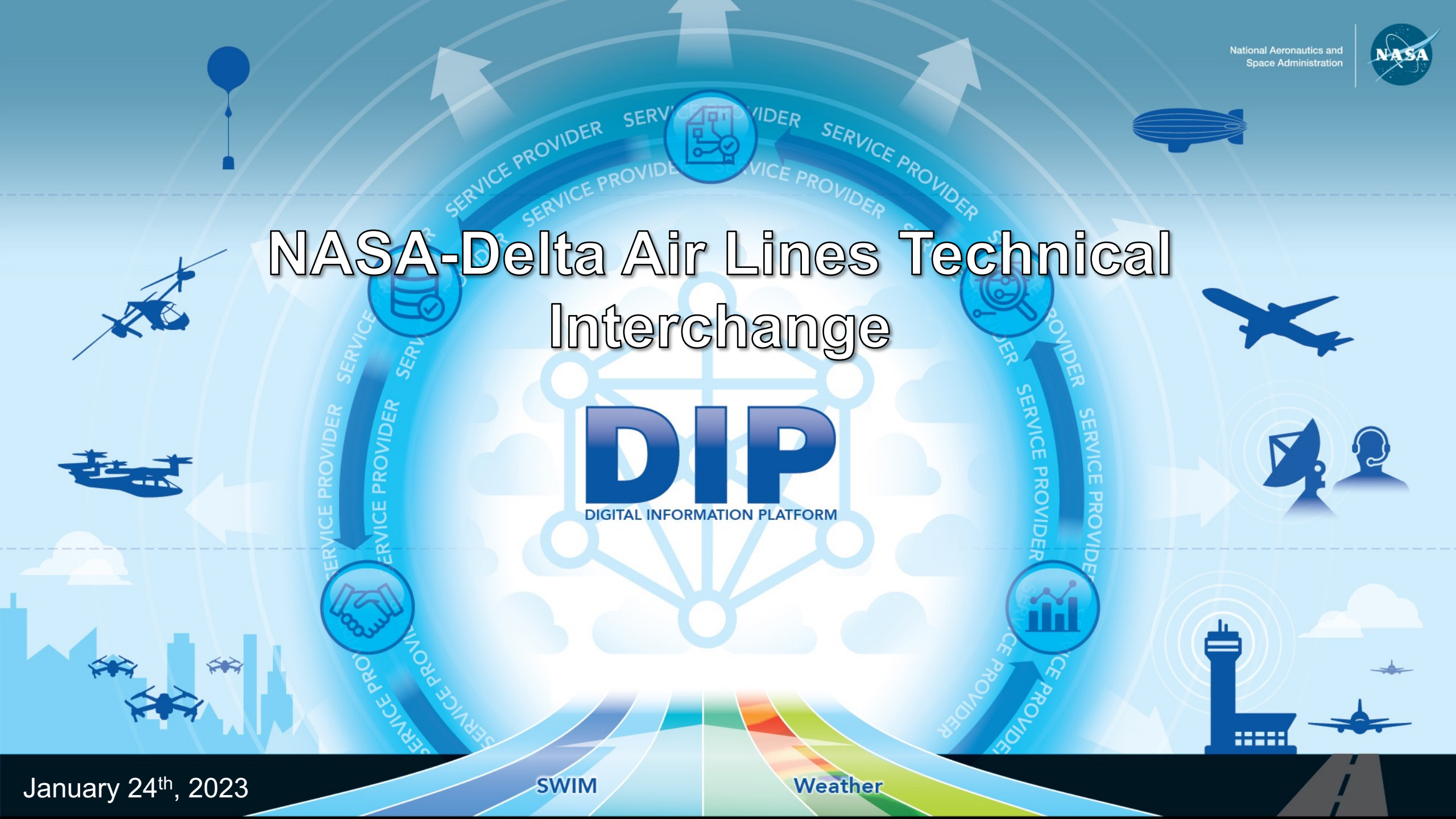

National Aeronautics and Space Administration
NASA
NASA-Delta Air Lines Technical Interchange
DIP
DIGITAL INFORMATION PLATFORM
SERVICE PROVIDER
SWIM
Weather
January 24th, 2023

Agenda

Time	Topic
8:45 am	NASA visitors arrive
9:00 am – 9:30 am	Delta Ops Meeting
9:30 am – 9:40 am	Introduction
9:40 am – 10:20 am	Delta Operations Control Center (OCC) Tour
10:20 am – 11:50 am	DIP Overview
11:50 am – 12:20 pm	Working lunch
12:20 pm – 1:10 pm	DIP Team with Dispatch
1:10 pm – 2:00 pm	DIP Team with SPT (ATC Coordinators)
2:00 pm – 3:00 pm	DIP Team with Data Team
3:00 pm – 3:30 pm	Place holder
3:30 pm – 4:00 pm	Wrap up and next step (with ATM)

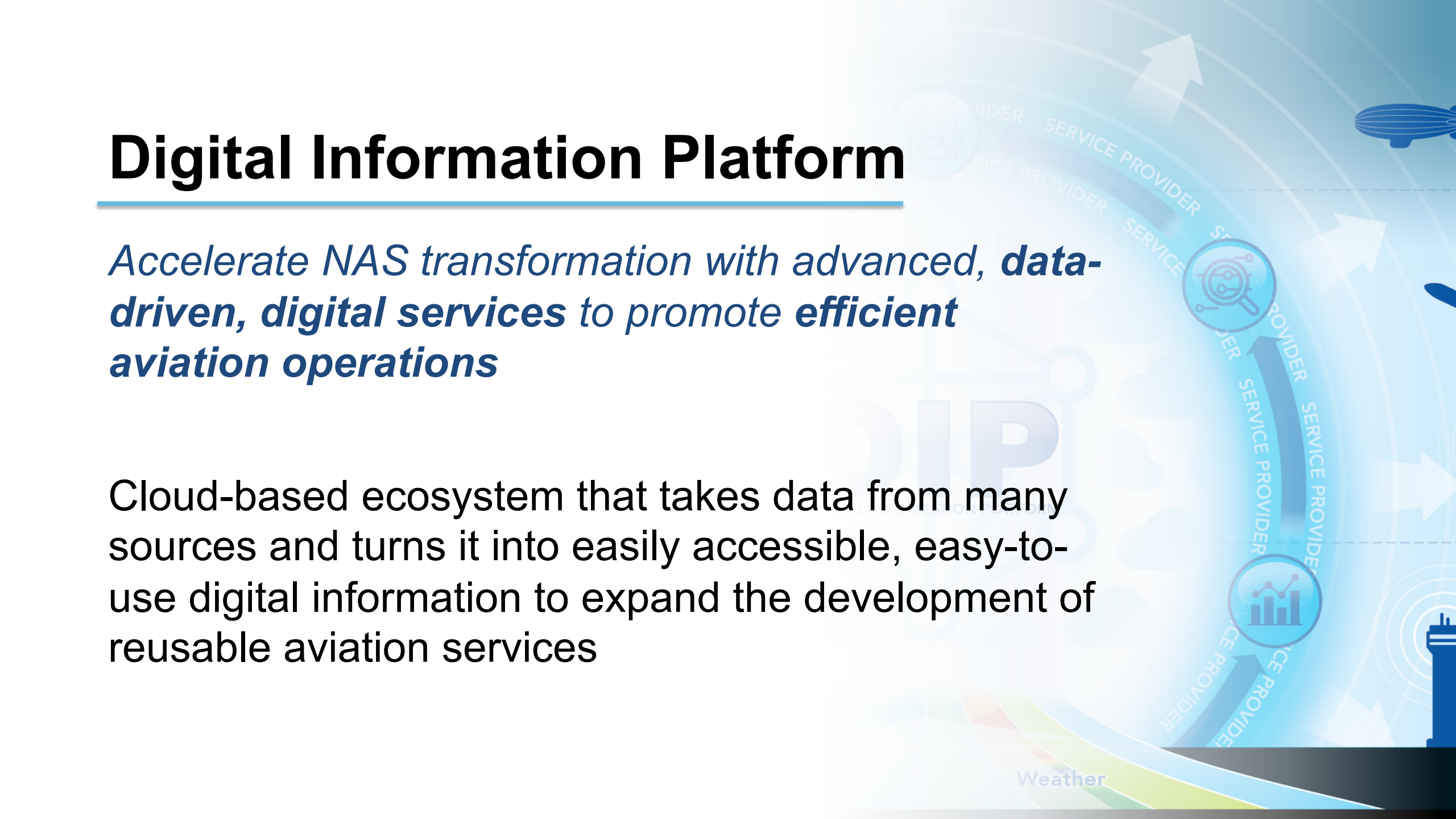
DIP Overview

Mirna Johnson

Digital Information Platform

Accelerate NAS transformation with advanced, ***data-driven, digital services*** *to promote* ***efficient aviation operations***

Cloud-based ecosystem that takes data from many sources and turns it into easily accessible, easy-to-use digital information to expand the development of reusable aviation services



Stakeholder Needs

Increase Access to NAS Information	Easy access to organized airspace data and information **Common, simplified API** to fused information
Improved Data Quality	**Trusted** and **reliable** data sources with safeguards Unified, aggregated, and **validated data** for consumption
High Reuse Solutions	Support **data-driven predictive** models **Scalable** and **adaptable** services
Commercialization Methodology	Architecture that **connects high reuse solutions** for exchange of services and information to create an ecosystem
Services for Efficiency and Sustainability	Advanced services to increase efficiency and predictability Digital Re-route, disruption management, trajectory optimization, etc

Sept – Nov 2019 - collected formulative input from **airline operators, airport operators, NBAA, FAA and vendor groups**.

March 2021 - DIP published a **Request for Information**; Received over 40 responses from flight operators, service providers, data integrators from traditional and emerging operations stakeholders

Digital Information Platform for Sustainability Services

Current Limitations

Segmented ATM Systems

Inconsistent Data Quality

Limited Paths to Enter Market

Demand for Sustainability

Problem Statement:

Hard to access and decipher data to provide advanced digital services for digital NAS transformation

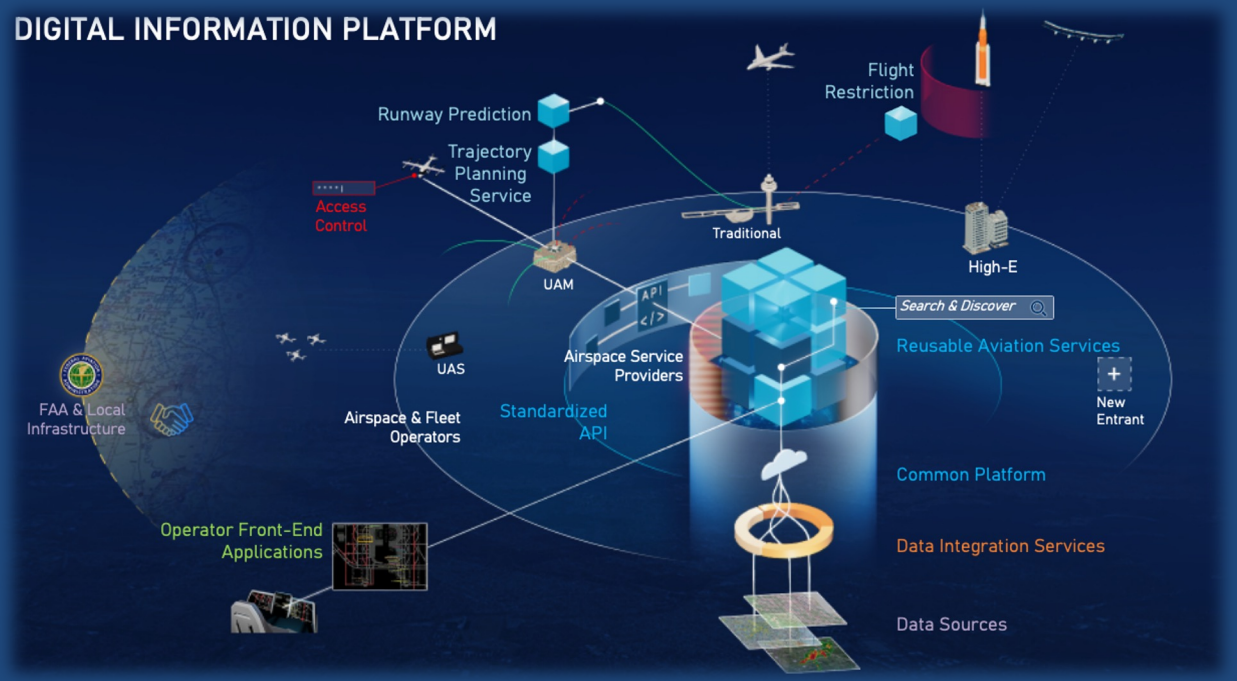
Pursued Solution:

Pave the way for improving data accessibility to enable high-reuse digital service solutions that can scale and be more quickly discovered on a platform

Digital Services
Building blocks for reuse

Data Integration
Combine and simplify data for holistic information

Common Platform
Cloud-based (smaller) footprint and standard APIs for simpler integration

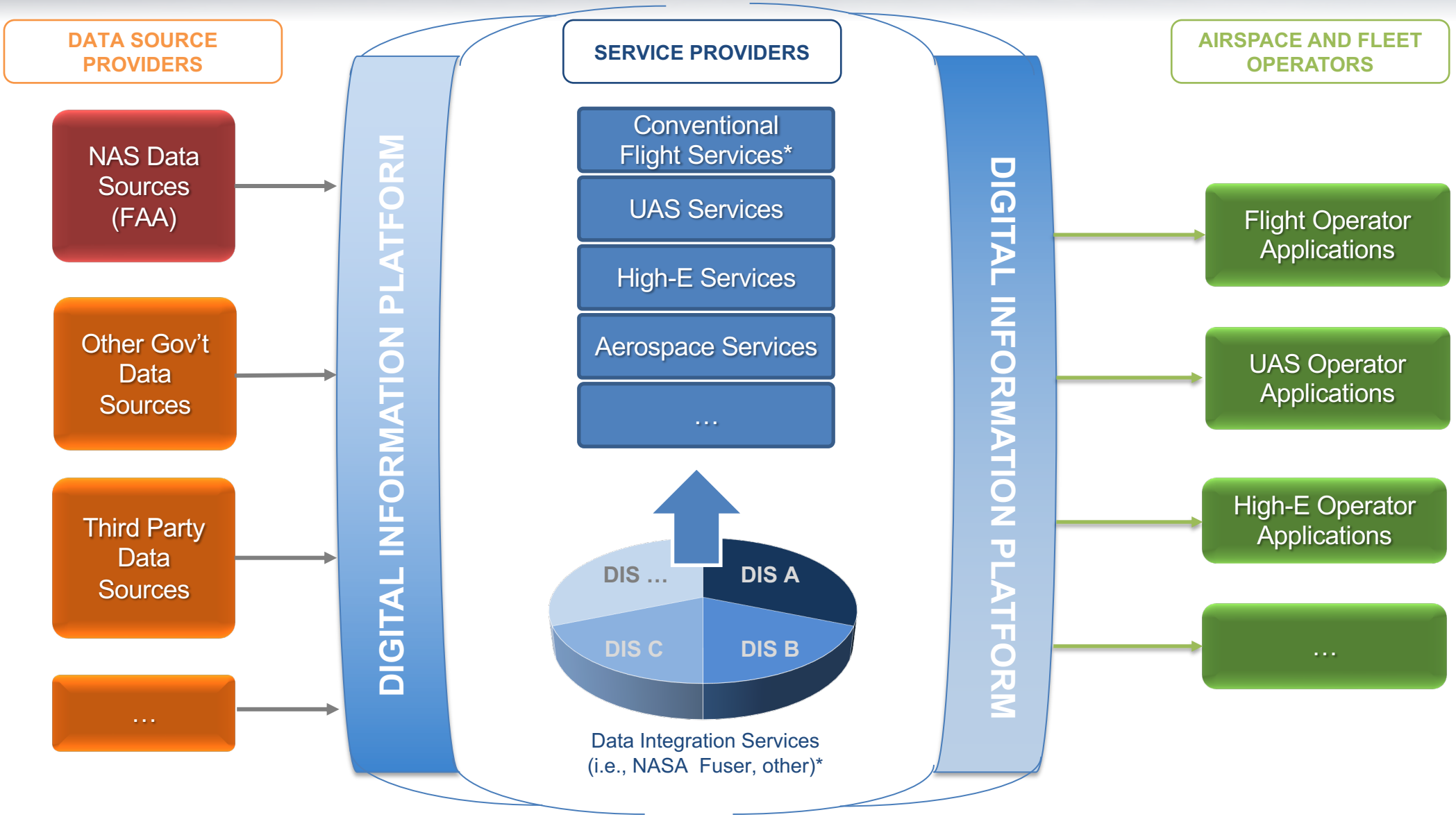


Advanced Technologies
Apply ML/AI to improve adaptability and extensibility of services

Performance Monitoring
Promote quality and build trust in information

Sustainability
Inform decision making to optimize efficiency

DIP Ecosystem



DIP Research Areas

NASA Led DIP-Enabled Services for Sustainability

Ground and flight deck services focused on improving the sustainability of aviation operations

“SFNP-Ops Demos”

Industry Led Partner Service Evaluations

Integration and demonstration of Partner services with DIP for validation of the platform

“PS Evals”

University Challenges

NTL NASA Tournament Lab

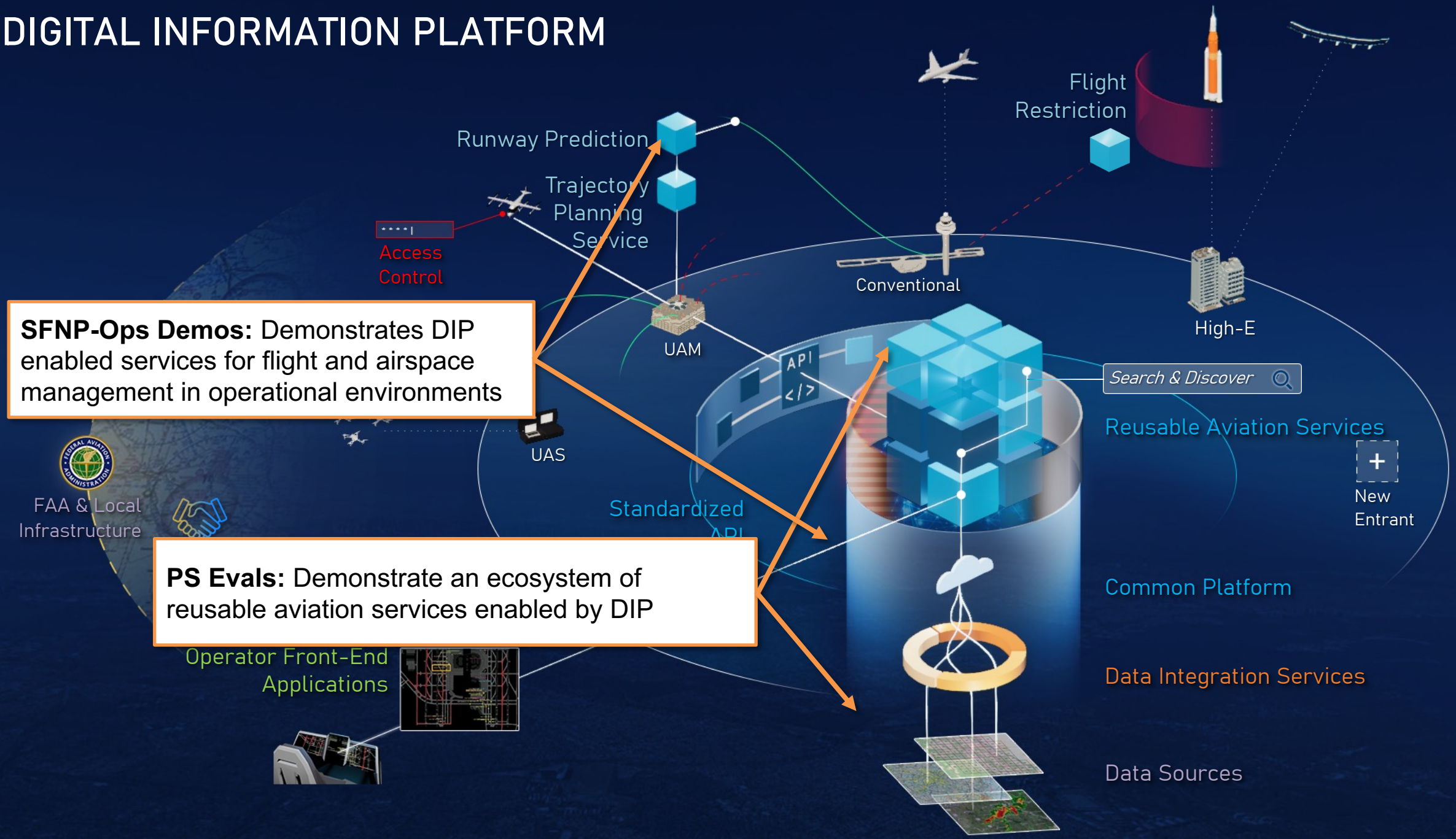
Development of innovative solutions and advanced algorithms for aviation services

Reference Digital Information Platform (DIP)

Development of a platform for advanced, data-driven, digital services for flight operators and service consumers

SFNP-Ops = Sustainable Flight National Partnerships - Operations

DIGITAL INFORMATION PLATFORM



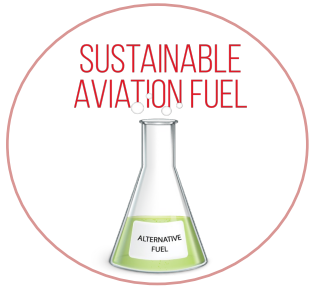
SFNP-Ops Demos: Demonstrates DIP enabled services for flight and airspace management in operational environments

PS Evals: Demonstrate an ecosystem of reusable aviation services enabled by DIP

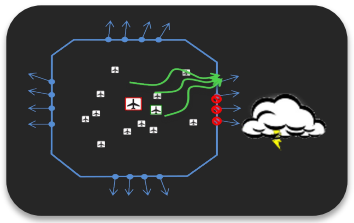
DIP-Enabled Services for Sustainability

Ground Services

Flight Deck Services



GLOBAL Aviation Industry's Goal:
50% reduction in carbon emissions by 2050 relative to 2005 and possible net zero emissions by 2060 through these three means



Collaborative Digital Departure Reroute (SFNP-Ops-1, FY22-25)

Sustainable Oceanic Airborne Re-Routing (SFNP-Ops-2, FY26)

Irregular Ops Recovery/ Disruption Management (SFNP-Ops-3, FY27)

4D Trajectory Optimization (SFNP-Ops-4, FY28)

SFNP-Ops = Sustainable Flight National Partnerships - Operations

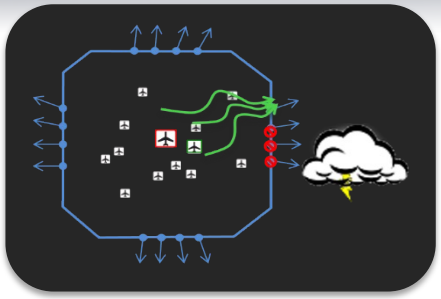
DIP Supports Sustainability Goals: Deliver reduction in emissions and optimize air operations through digital services

Image Credits: NASA

Collaborative Digital Departure Re-Routing (CDDR) for SFNP-Ops-1

Jeremy Coupe

SFNP-Ops- 1 | *CDDR Demonstration Updates*



SFNP-Ops-1: Collaborative Digital Departure Re-Route (FY22 - 25)

Demonstrate CDDR via Trajectory Option Set (TOS) by rerouting flights and departures starting at NTX towards a high-density operational area

Benefits: *Reduced fuel burn and emissions through reduced surface departure delay. Benefits rerouted flight as well as all departures*

SFNP-Ops 1 system-wide aggregated savings (individually re-routed + other flights)

at **D10 North Texas Metroplex** (01 Jan 2022 – 16 Sep 2022)

Fuel Savings

Over **24K** lbs.

Emissions Savings

Over **76.6K** lbs. **CO^2**

Over **569** urban trees

Delay Savings

OFF delay	**IN** delay
3.9+ hrs	**4.7+** hrs

Cost Savings

Passenger	**$31.7K**
Flight Crew	**$6.9K**

1038 CANDIDATE flights ➡ 102 Airline Re-Route Requests ➡ 41 ATC-approved re-routes

DIP can scale these savings across the NAS; additional validation in FY24 in more complex airspace

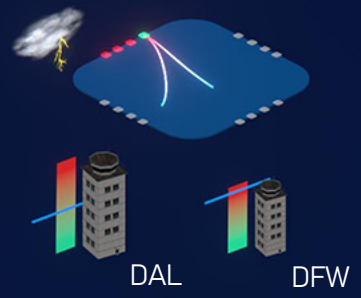
Collaborative Digital Departure Re-Routing

1 Preconfigure
TOS Parameters

Alternate Routes

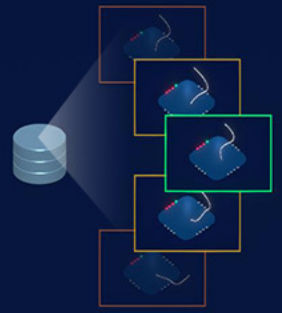
TOS database

2 Monitor
Demand & Capacity



System continuously assesses imbalance

3 Present
Candidate TOS



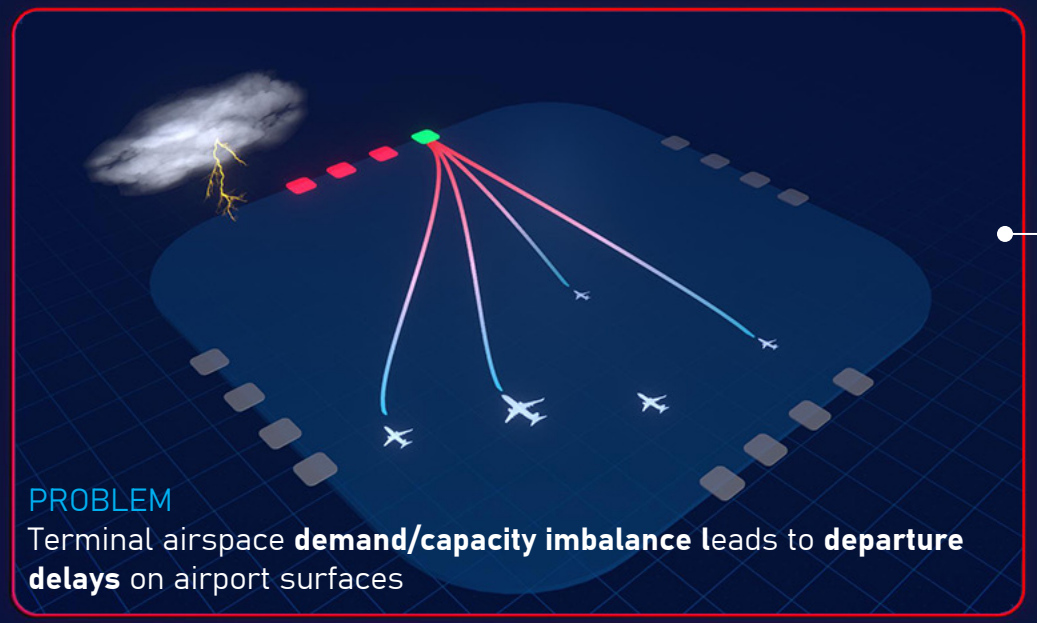
Delay savings > Relative trajectory cost

4 Submit
TOS to ATC

all users notified

5 Evaluate
Post Operation

Benefits
Refinements
Lessons
Analyses
Reports



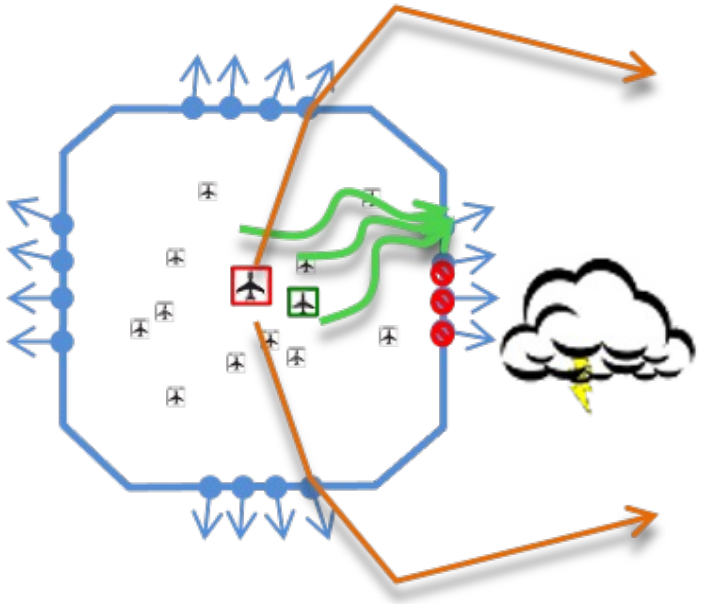
PROBLEM
Terminal airspace **demand/capacity imbalance** leads to **departure delays** on airport surfaces

Metroplex airports with departure fixes

4

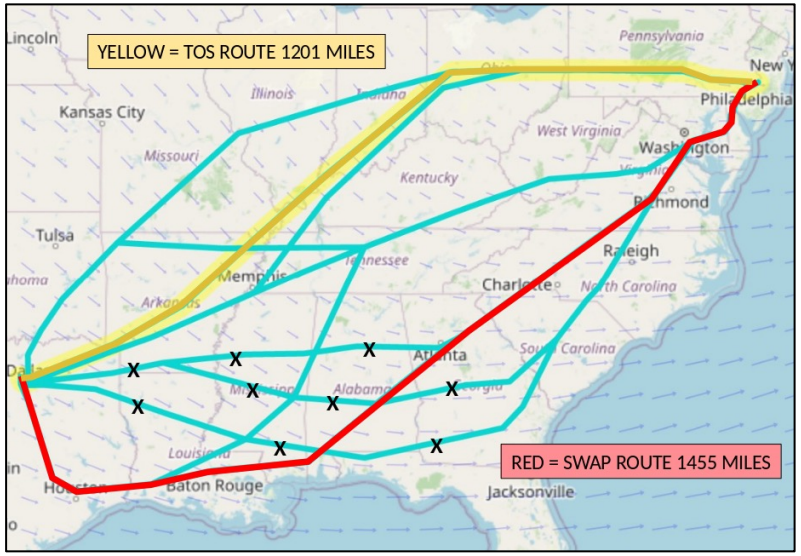
SOLUTION
CDDR system enables flight operators to **intelligently request reroutes** from the Air Traffic Control for **departure fix load balancing**

CDDR Use Cases and Benefit Mechanisms



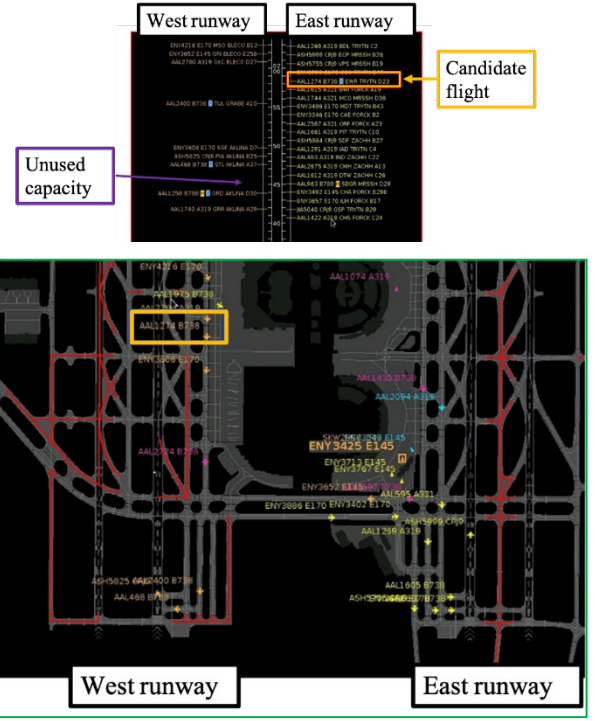
Traffic Management Initiative (TMI)

- Filed route is most direct route but subject to TMI
- Filed route remains through the original departure gate
- TOS route through adjacent departure gate and requires additional flight time
- TOS reroute reduces surface delay in exchange for increased flight time



Recovery from SWAP

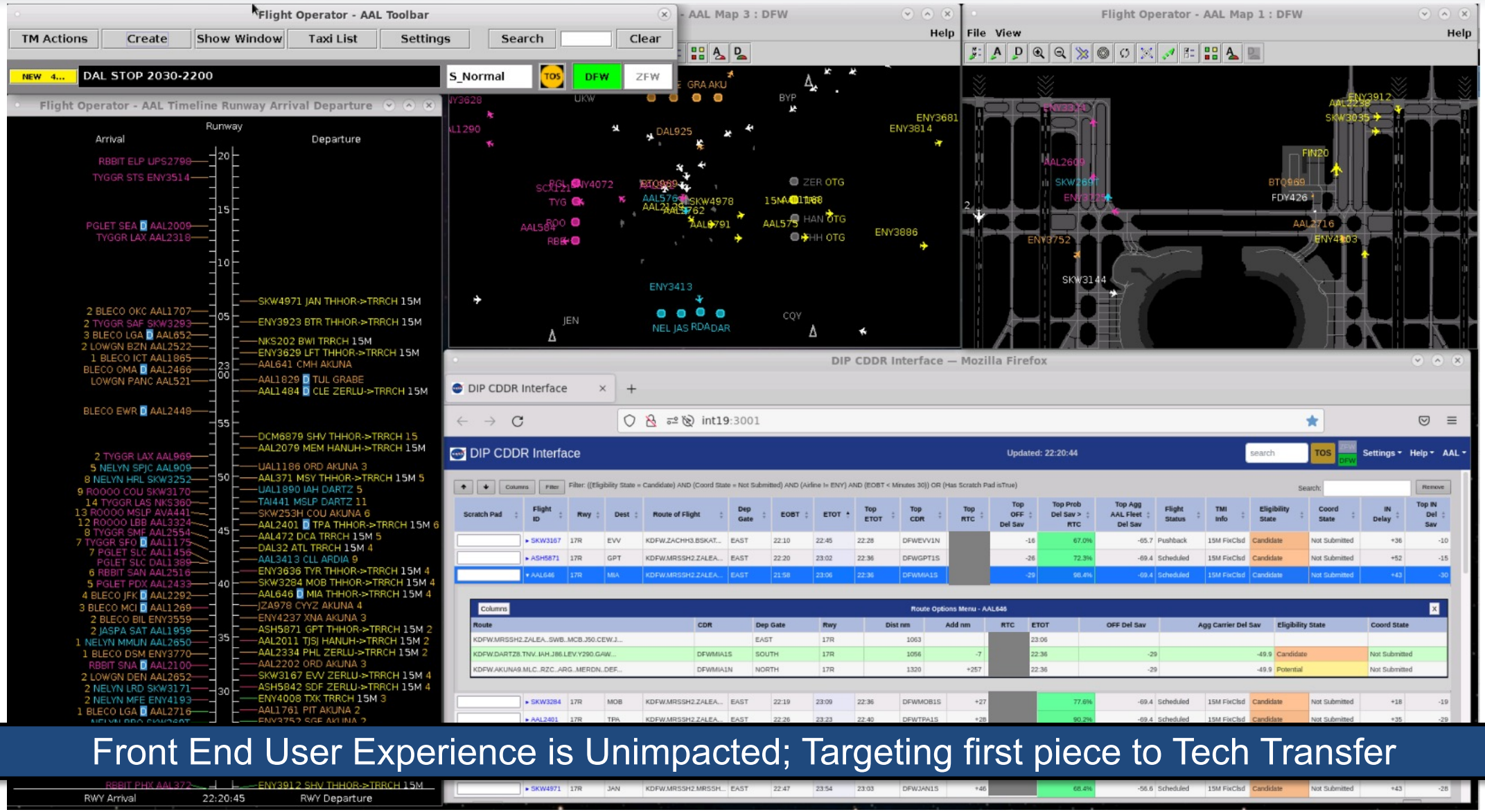
- Filed route is amended by ATC through an adjacent departure gate during a SWAP event
- SWAP event ends and TOS routes through the original Filed departure gate much shorter than SWAP route
- TOS reroute reduces surface delay and also has shorter flight time compared to SWAP route



Non-TMI Tactical Reroutes

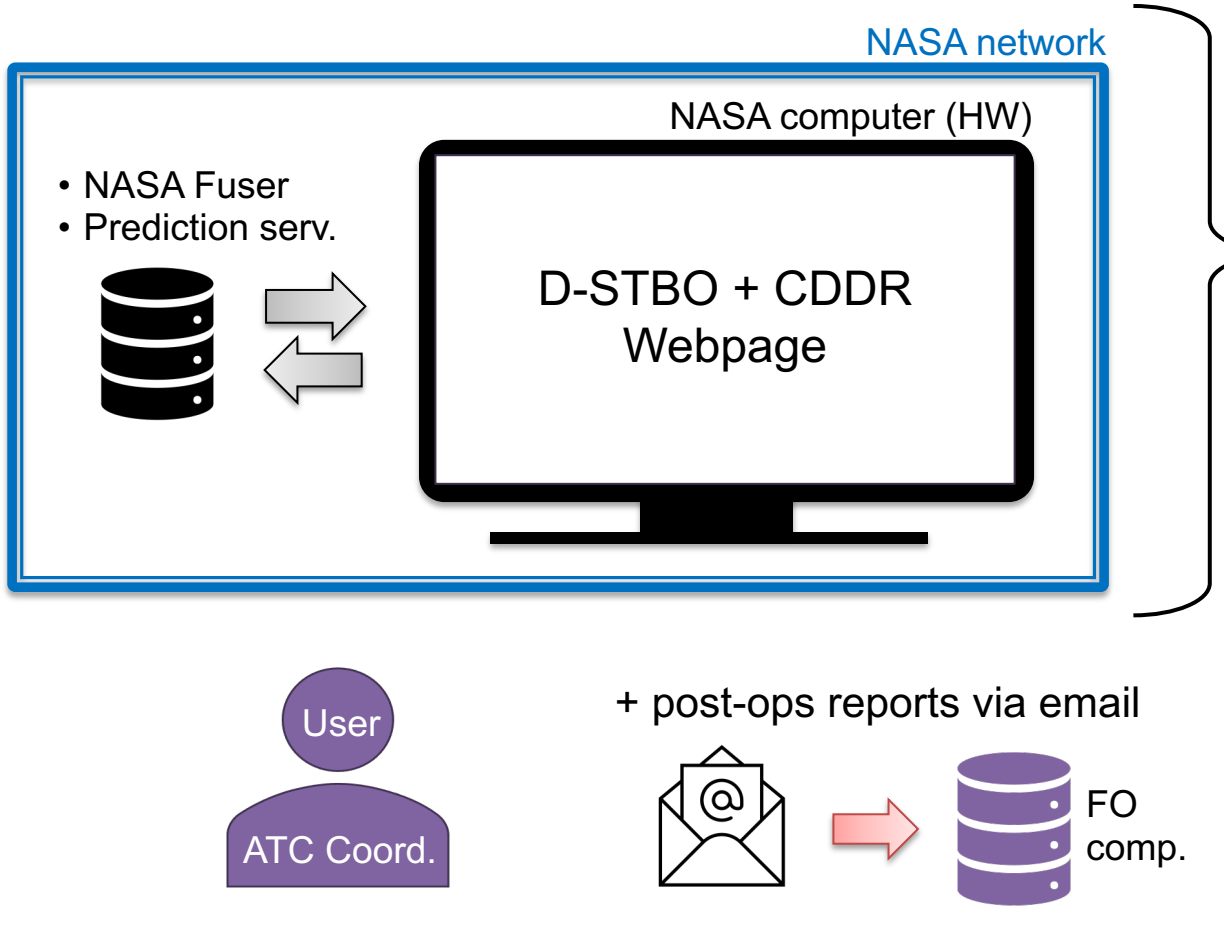
- Often occurs when the parking gate is physically closer to the TOS runway than the Filed route runway
- Provides tactical opportunities to load balance runway demand to take advantage of unused capacity

CDDR User Interface in North TX (SFNP-Ops-1a)



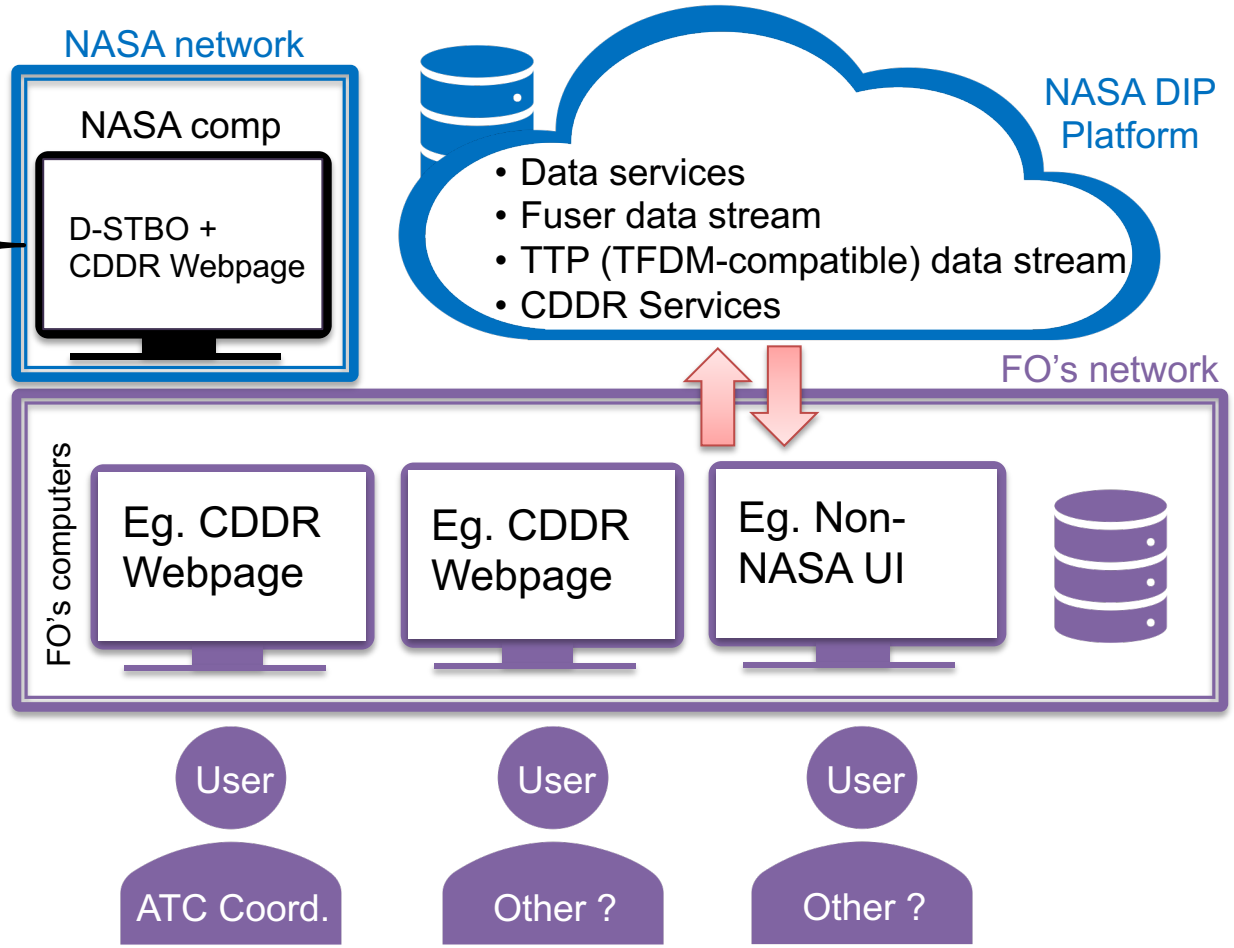
Transition to SFNP-Ops-1b with CDDR in the Cloud

In FY22



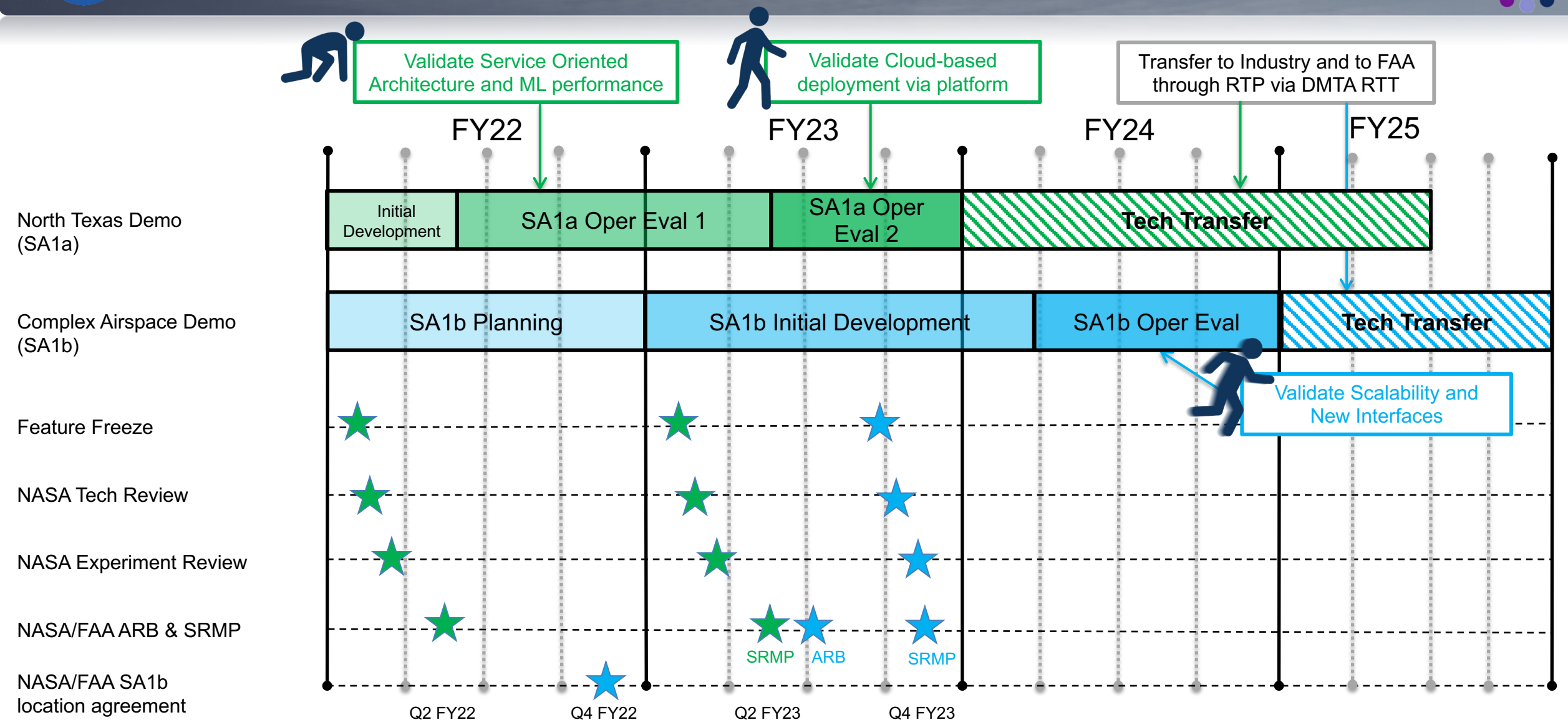
Access to data, services and interface *is limited to* a NASA computer behind a firewall

Starting in FY23 and beyond



Access to data, services and interface *is available* from the cloud

SNFP-Ops-1 Progress and Milestones



SNFP-Ops-1a North Texas Milestones in Green

SNFP-Ops-1b Complex Airspace Milestones in Blue