NASA ATD2/DIP SWIFT Update - Agenda

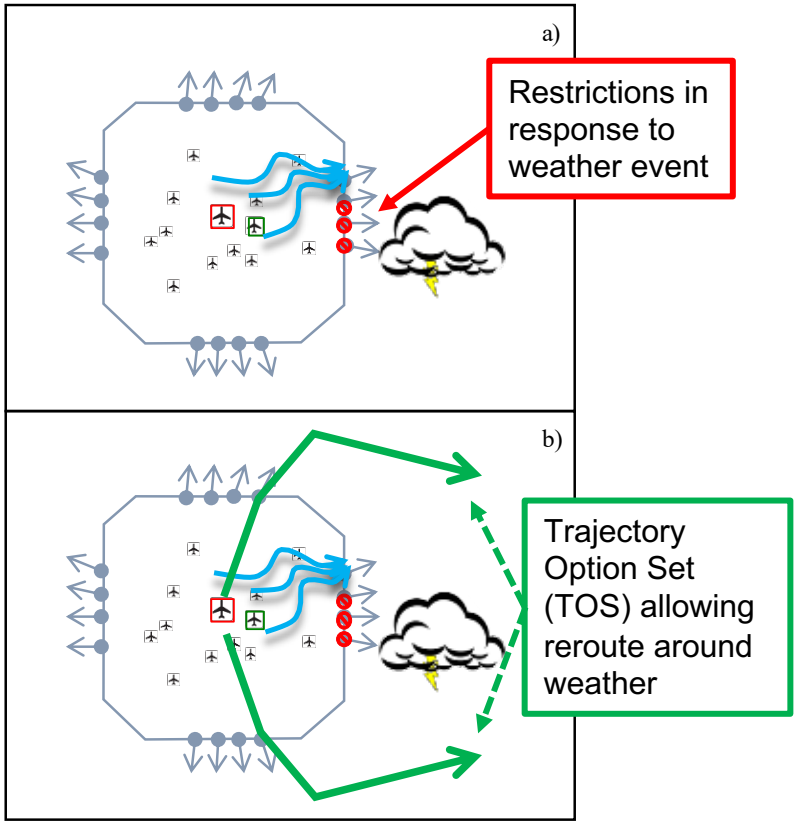
- Real-time machine learning based services – powered by SWIM
- Opportunity to engage in NASA's Digital Information Platform

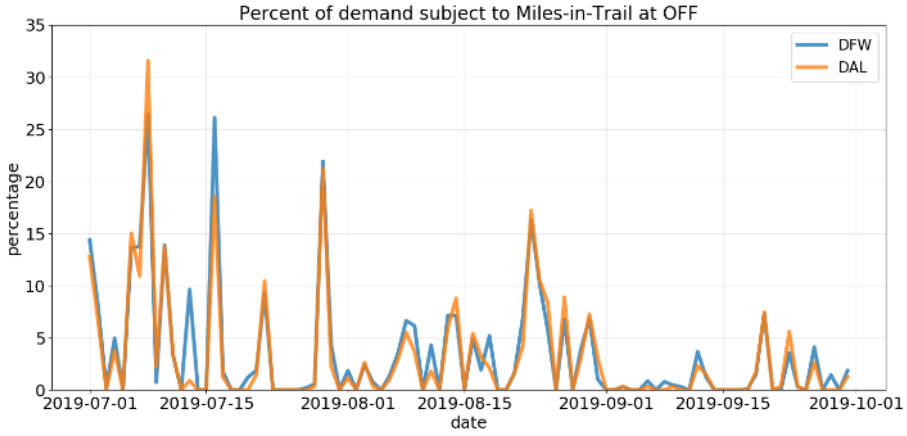
ML Airport Surface Model

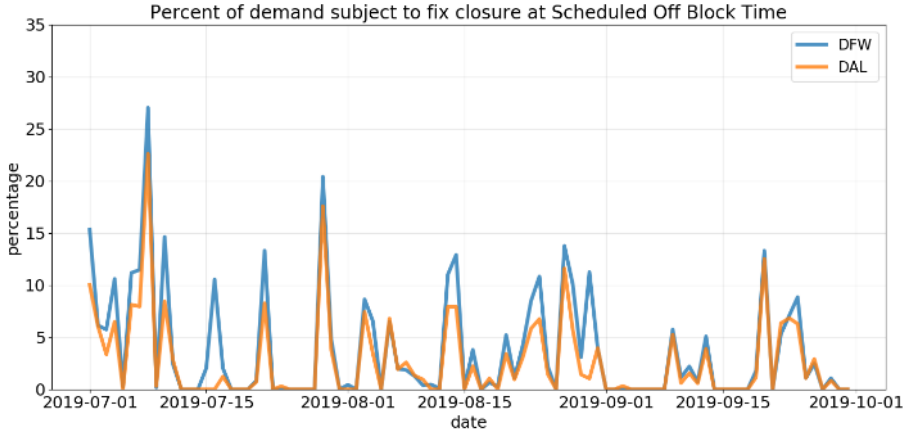
ML Airport Surface Model Outline

- What?
- Why?
- How?

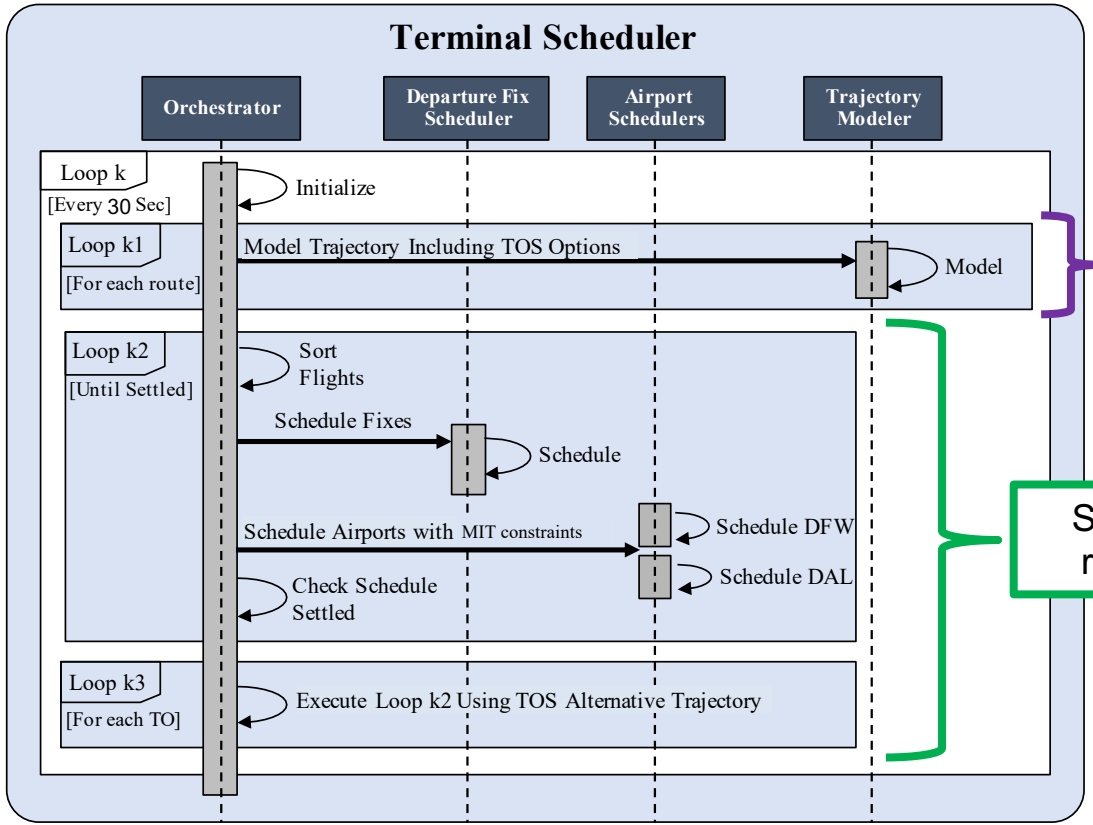
ATD-2 Phase 3 Trajectory Option Set (TOS) Reroute Capability Currently Running in North Texas Metroplex







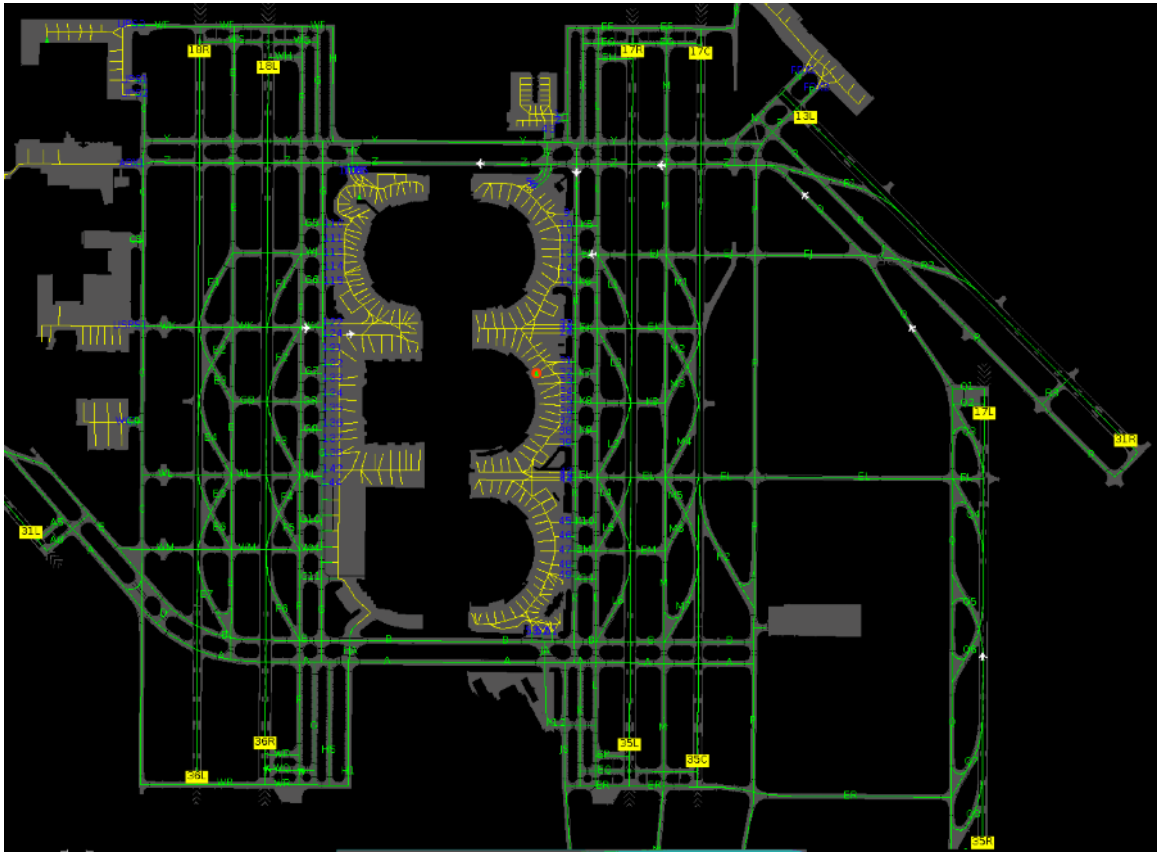
ATD-2 Phase 3 Metroplex Scheduling Algorithm



Modelling unimpeded trajectory requires significant adaptation

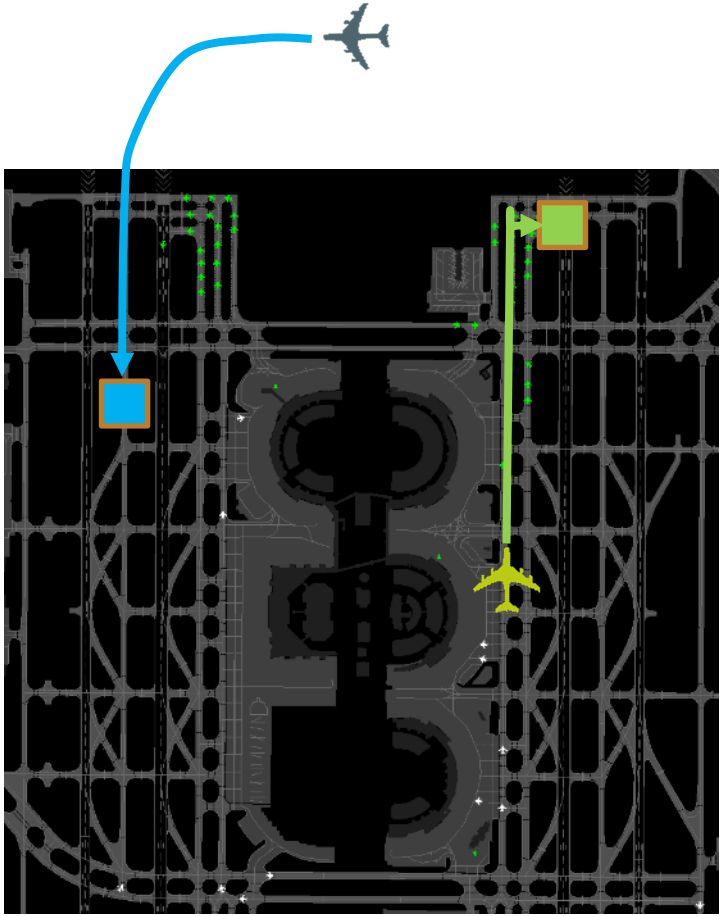
Scheduling at constraint points requires little to no adaptation

DFW Airport Adaptation Example



- Detailed link node network defines the airport surface structure including gate locations, runway locations, and taxi routes
- Adaptation goes beyond physical structure to include SME knowledge encoded in decision trees (for example the fix to runway mappings)
- Requires significant time and effort to build and maintain for each airport

Machine Learning Airport Surface Model



- Airport configuration
- Departure
  - Runway
  - Unimpeded Take OFF Time
  - Unimpeded Fix Crossing Time
- Arrival
  - Runway
  - Estimated ON Time

ML Airport Surface Model Outline

- What?
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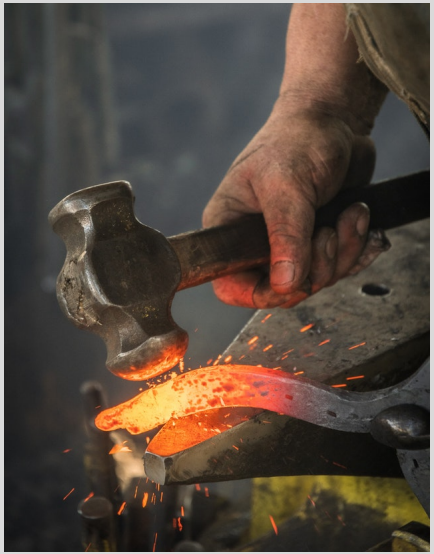
- How?

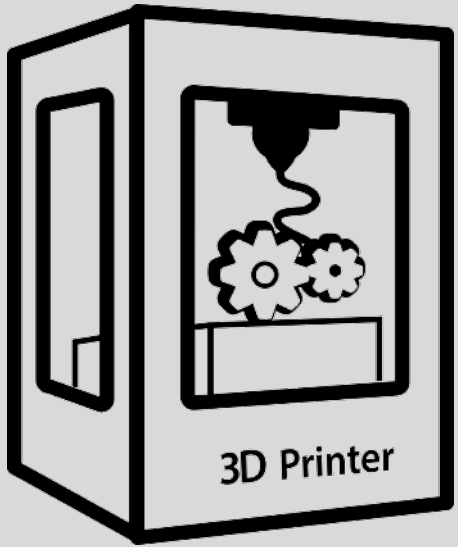
Machine Learning Provides Scalability

Traditional Methods



- Good at specific tasks (airports)
- Requires detailed knowledge
- Continuous maintenance

Machine Learning

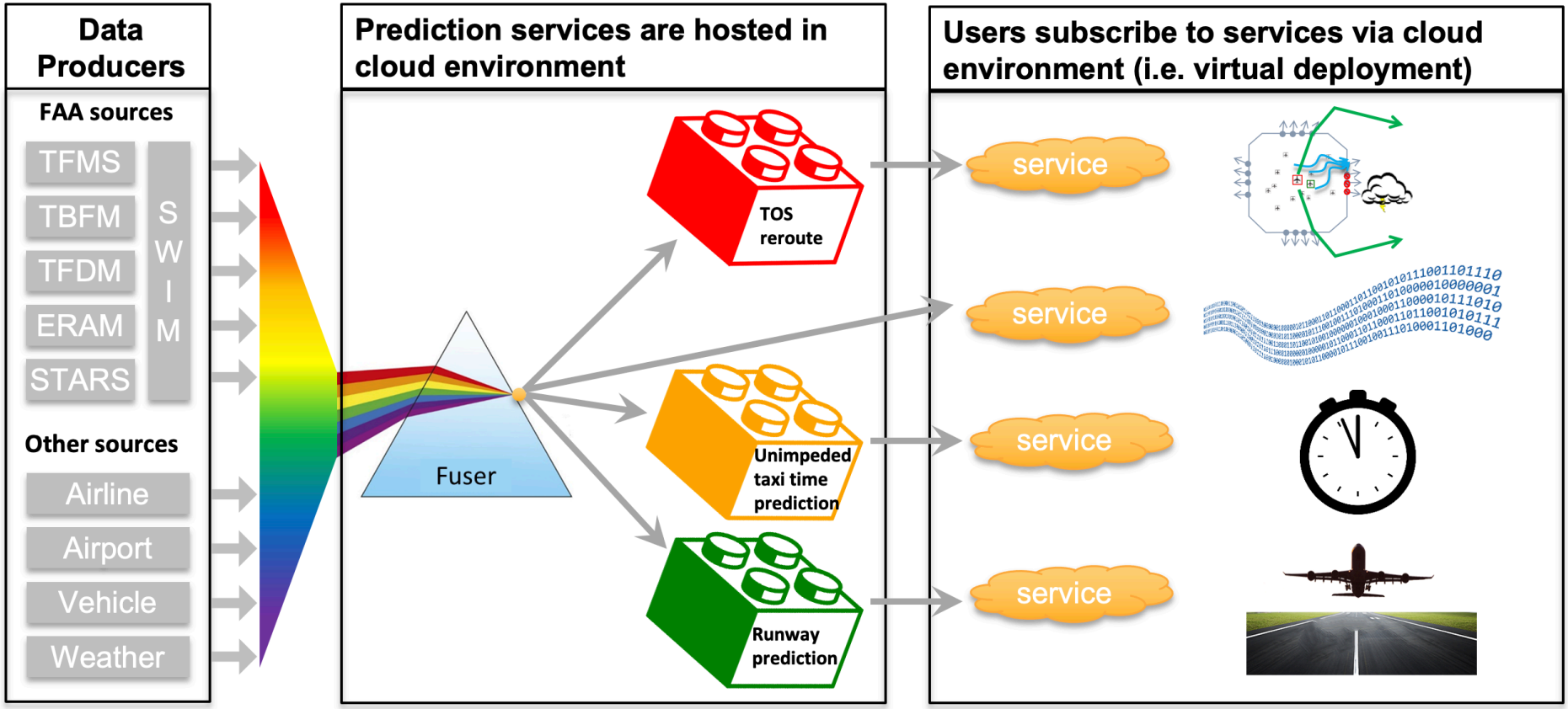


- Flexible to new tasks (airports)
- Learns detailed knowledge
- Semi-automated maintenance

ML Airport Surface Model Outline

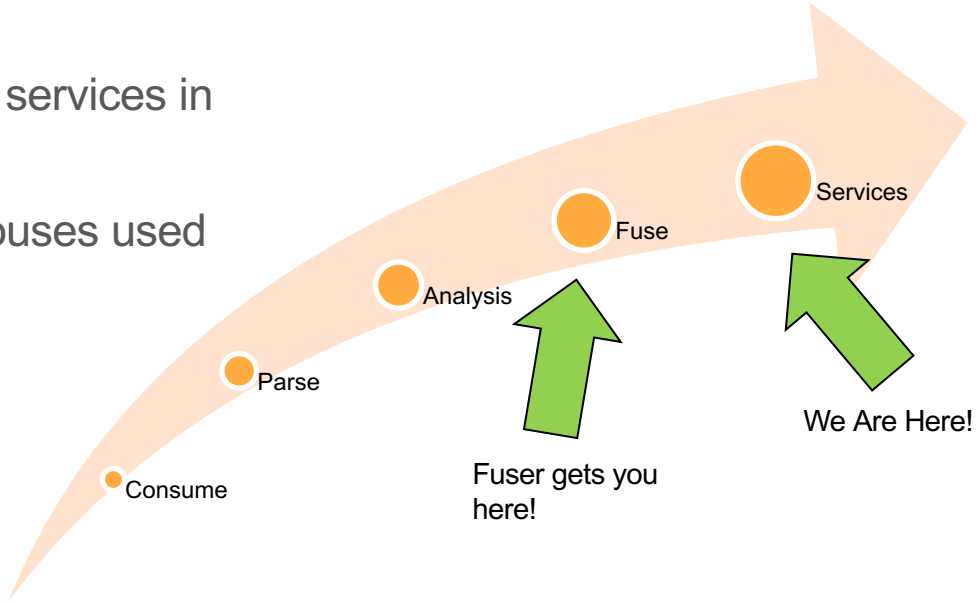
- What?
- Why?
- How?

Real-time ML Services Powered by SWIM



Fuser Enabling Services

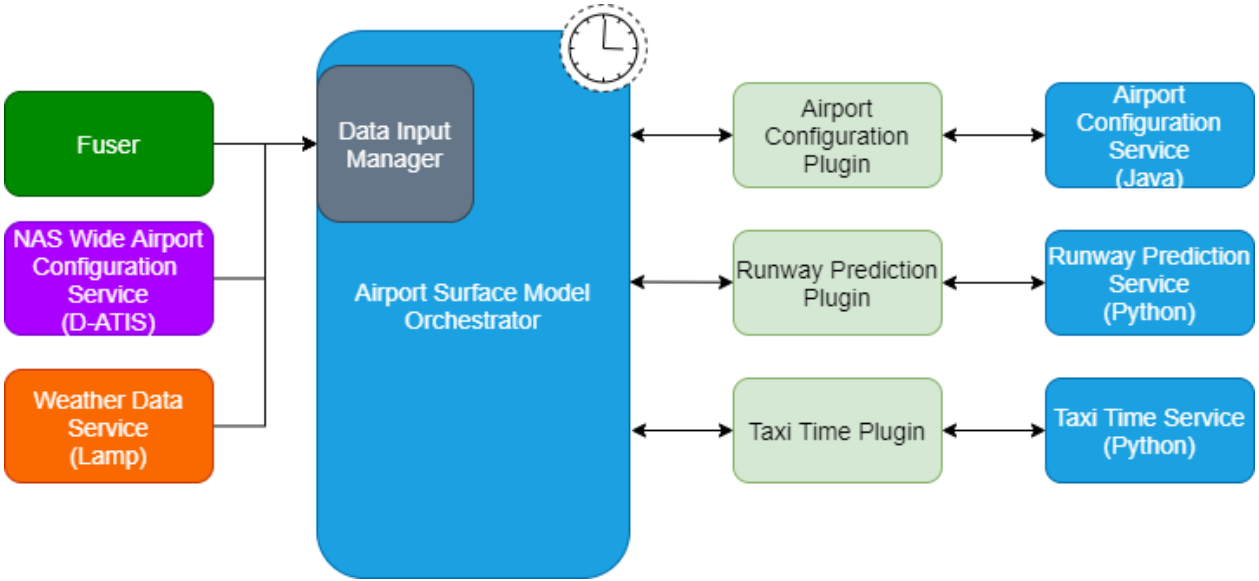
- Fuser is enabling faster development of data driven services
- Providing data to leverage services in real time
- ATD-2 Fuser Data Warehouses used for model training



https://github.com/nasa/atd2-fuser

Airport Surface Model Orchestration

- Services run independently
- We are using a mix of Java and Python Services
- Airport Surface Model Orchestrator gathers inputs and controls the order of execution



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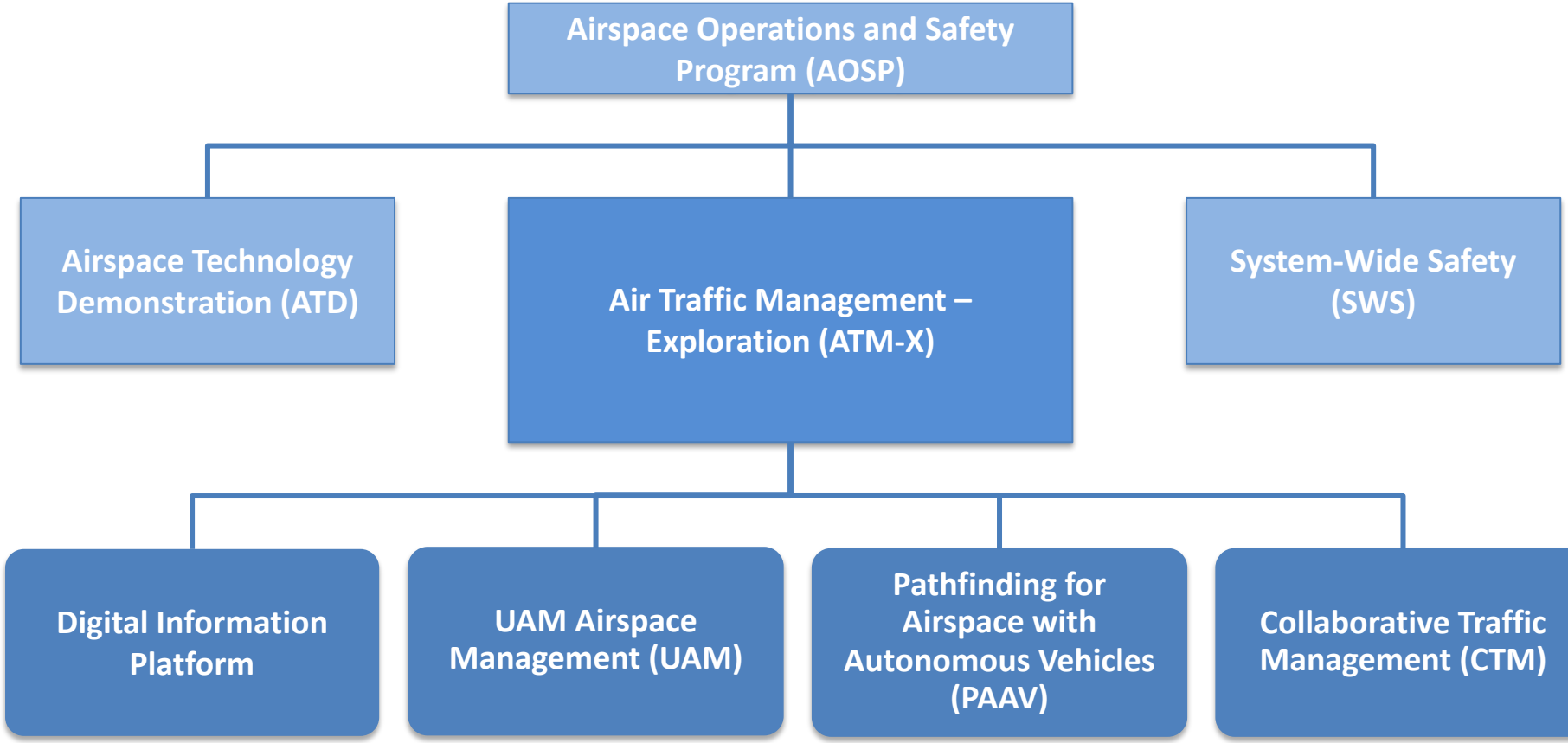
- Opportunity to engage in NASA's Digital Information Platform

Digital Information Platform

Jan 15, 2020

Mirna Johnson, DIP Sub-Project Manager
William N. Chan, ATM-X Project Manager

AOSP Project Organization



DIP Vision

Accelerate transformation of the NAS through the development of a **foundation** for advanced, **data-driven, digital services** from **traditional operations and new entrants** to promote **cohesive decision making**

Formulation Input

From Sep-Nov 2019, NASA collected substantial formulative input from airline operators, airport operators, NBAA, FAA and vendor groups.

- Establish an **environment to rapidly innovate** toward wholesale upgrades to NAS efficiency and safety
- Create an **architecture that allows high reuse of solutions** and serves as a building block for advanced capabilities
- Align NAS data assets to **leverage the explosion in data science technologies** to create an oasis of innovation (i.e. – create clean datasets for training)
- Change the solution evaluation paradigm from large-scale field-based testing requirements to **smaller footprint cloud-based demonstrations**
- Pave the way for a **commercialization methodology for digital services** to be more quickly obtained from the cloud via trusted sources
- Evolve the use of cloud-based computing within the aviation system while increasing the ability to **rapidly collaborate across aviation development teams**

High Interest Data Assets

Getting key data out of ATC's and Operators brain

Important information from ATC and Operators is emerging in digital form such as the System Wide Information Management (SWIM) system.

Additional effort is required to fully extract and utilize this information for greater benefit to the aviation community.

- Specific examples of high interest digital assets (from community interviews)
  - Provide a capability that integrates key flight information from multiple sources for an accurate and reliable nation-wide stream of data in the cloud
  - Create objective measures of data quality that are shared with the community
  - Reduce data access right limitations that prevent broader community innovation

Digital assets are the building blocks of future game changing services

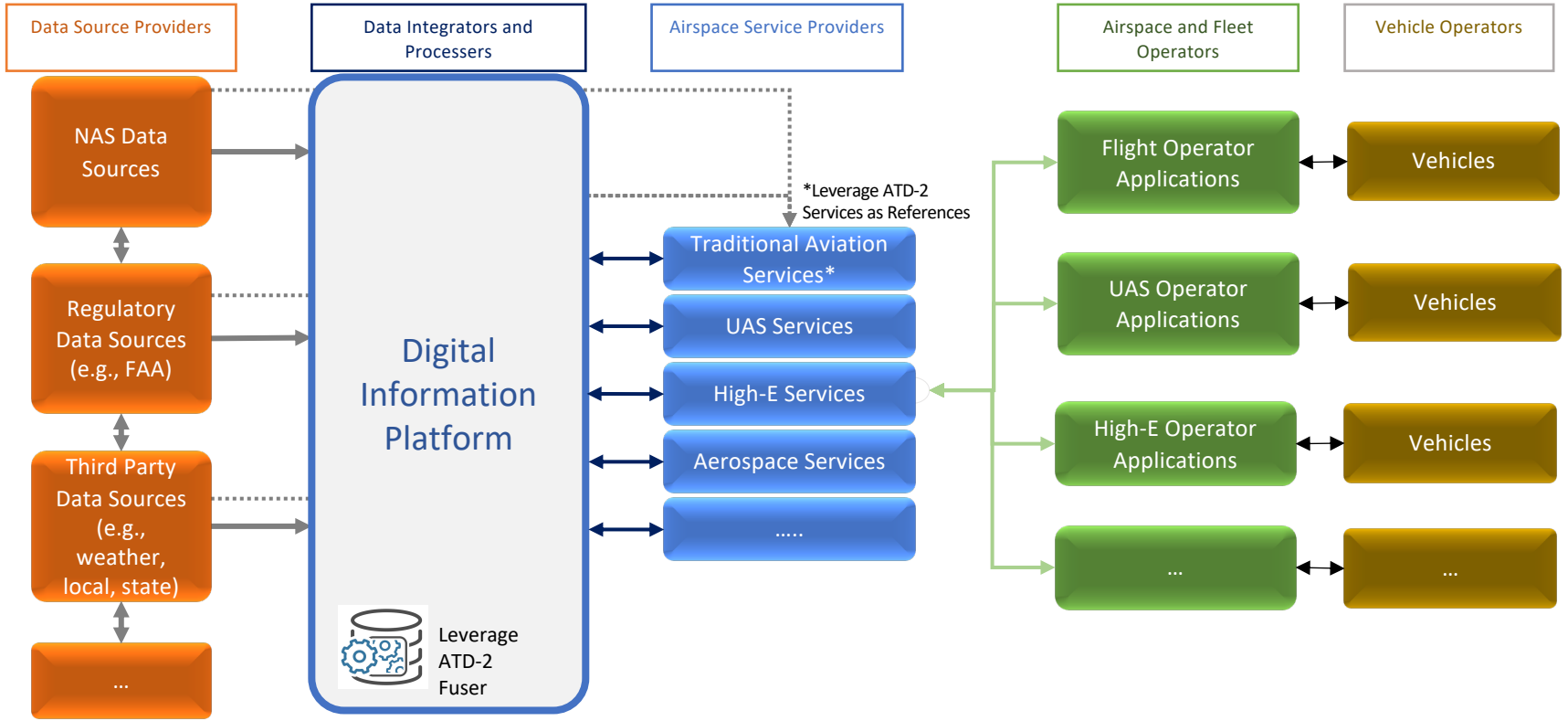
High Interest Services*

*listed services are subject to change based on stakeholder input

- From Sep-Nov 2019, identified highly reusable services that can be leveraged as building blocks for more advanced capabilities for both traditional and new entrants:
  - **Digitize the re-routing process (TOS)** to make better use of existing capacity
  - Provide a multi-system, multi-domain view of **impacts to their flights from gate-to-gate**
  - Create services **that promote system-wide safety (SWS)** related to new entrants
  - Provide services to help **reduce impact of space launch** (current day problem)
  - Create **disruption management services**. Faster recovery to nominal operations
  - NAS-wide **wind miles prediction** service
- Opportunities to apply Machine Learning and develop core data sets

Continue Partnership Input to prioritize services to enable for innovation

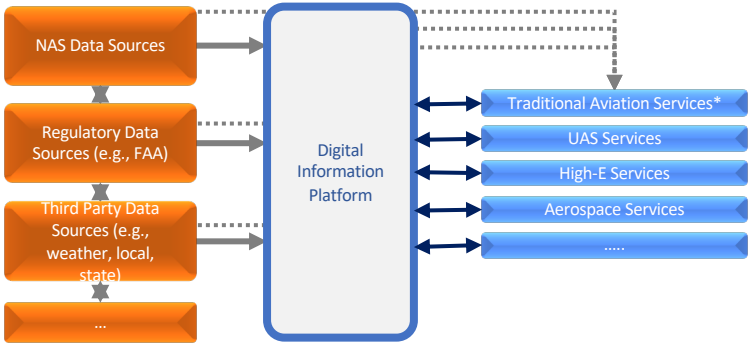
Notional Digital Information Platform



Common, simplified interface to integrated, processed information of high-interest

Benefits of Digital Information Platform

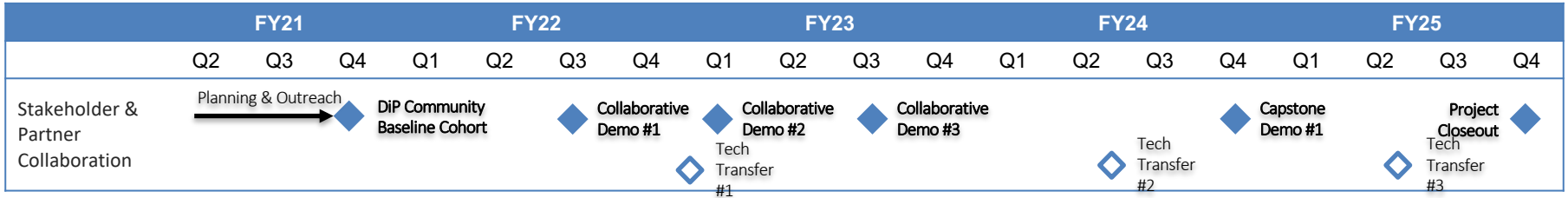
- Enable more and new types of operations by creating a scalable and resilient airspace system
  - Market place of digital services ecosystem open to all
- Increase the use of NAS Information powered by Advanced Technology
  - Integrated and fused data from FAA, airlines and other sources
  - Common, simplified API to access the fused information
- Improve Operational Flexibility with the development of user-informed Airspace Management Services
  - NAS-wide available services using high quality information from DIP
  - Establish new partnerships with solution providers with the goal of industry building the technologies
- Leverage Third Party Services and continue progress towards a service-oriented architecture



DIP Sub-Project Objectives

- **Stakeholder-Informed Platform:** Create a stakeholder informed requirements for a digital data platform to improve the deployment and access of services.
- **Validated Reference Implementation:** Develop a reference implementation of DIP to validate stakeholder-informed requirements
- **Data Needs for Services:** Evaluate a variety of services to identify data needs for the DIP architecture.
- **Demos with Partner Collaboration:** Coordinate demonstration with stakeholders of reference technologies, new service(s) and DIP framework
- **Recommend Processes:** Share best practices for sharing data and data handling among stakeholders in the DIP community

Collaborative Approach*



- Currently, DIP is under project planning, team formulation and initial concept development
- Minimal Viable Products - quicker turnaround, quicker feedback, increasing capability
- Stakeholder outreach to create a DIP community to participate in architecture feedback and standardized interface requirements between data sources, DIP, and services
- Partnerships to contribute and participate in multiple collaborative demonstrations to validate concept and mature requirements
- Next Steps: Community Input to reassess highly desired data assets and services

*schedule is subject to change

Seeking Information and Feedback

- Challenges and Pain Points:
  - Problems, challenges, benefits, priorities, scenarios, and use cases related to data feed usage, data availability and accuracy, types of services.
  - Identify things to consider when further defining the notional architecture (previous figure).
- Operational Concept:
  - Partner's operational view regarding the integration and use of DIP framework
  - If known, identify and define metrics that would be valuable to measure effectiveness and performance.
- Concept Adoption Feedback:
  - Information outlining opportunities and anticipated obstacles (business and technical) to adopting DIP, other considerations for investing and prioritizing DIP or related services
- Data and Services Needs:
  - Data sources that would be beneficial to fuse and mediate. Services that are of high priority that face data integration challenges and would be of high value to traditional and emerging fleet operators to build more advanced services.

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