Airspace Technology Demonstration II (ATD-2) Update for the National Customer Forum (NCF)

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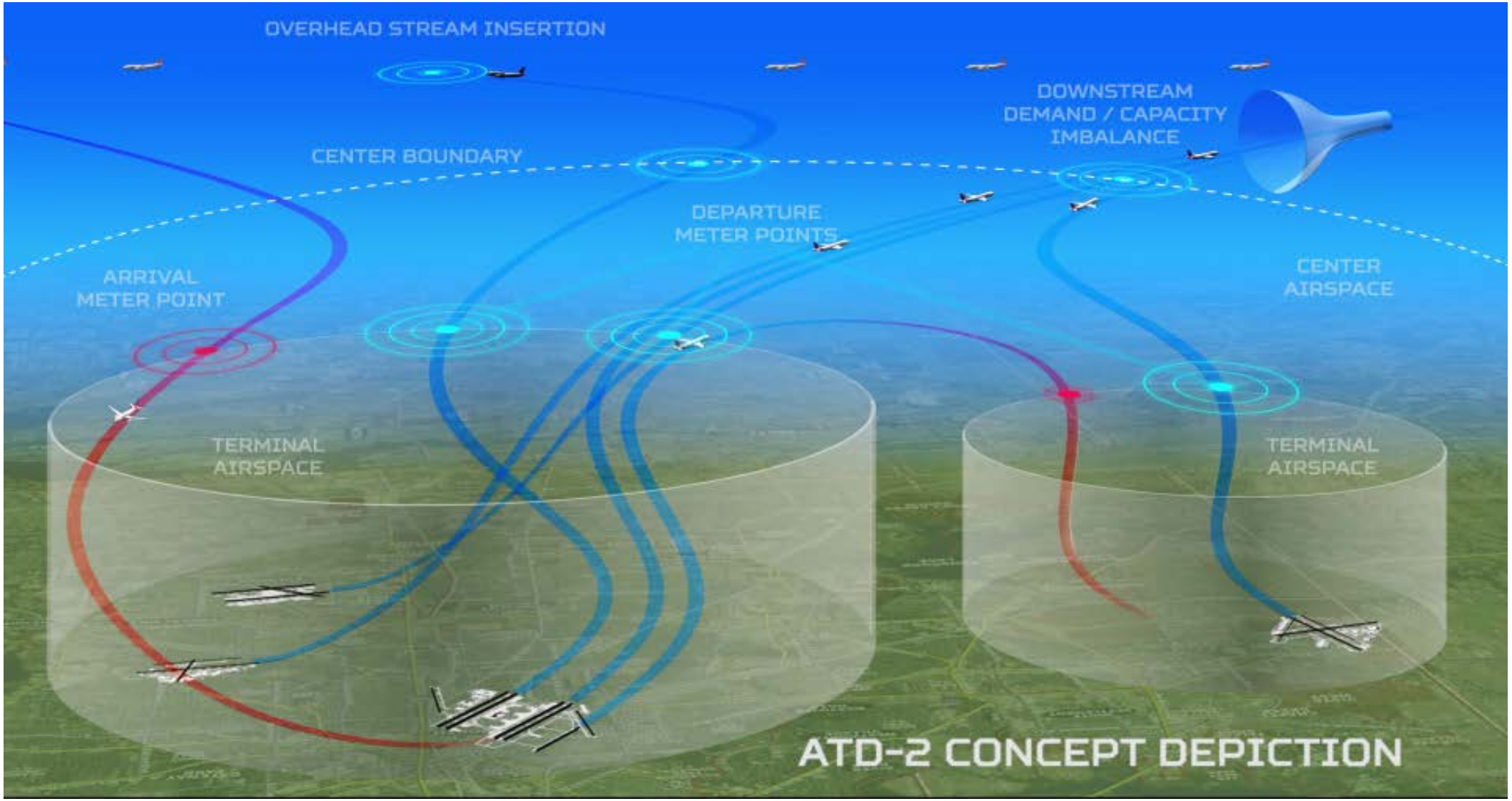
ATD-2 Concept Overview



Video available online at: http://aviationsystemsdivision.arc.nasa.gov/research/tactical/atd2.shtml

ATD-2 Project Background and Timeline

Plan vs. Actual Notes

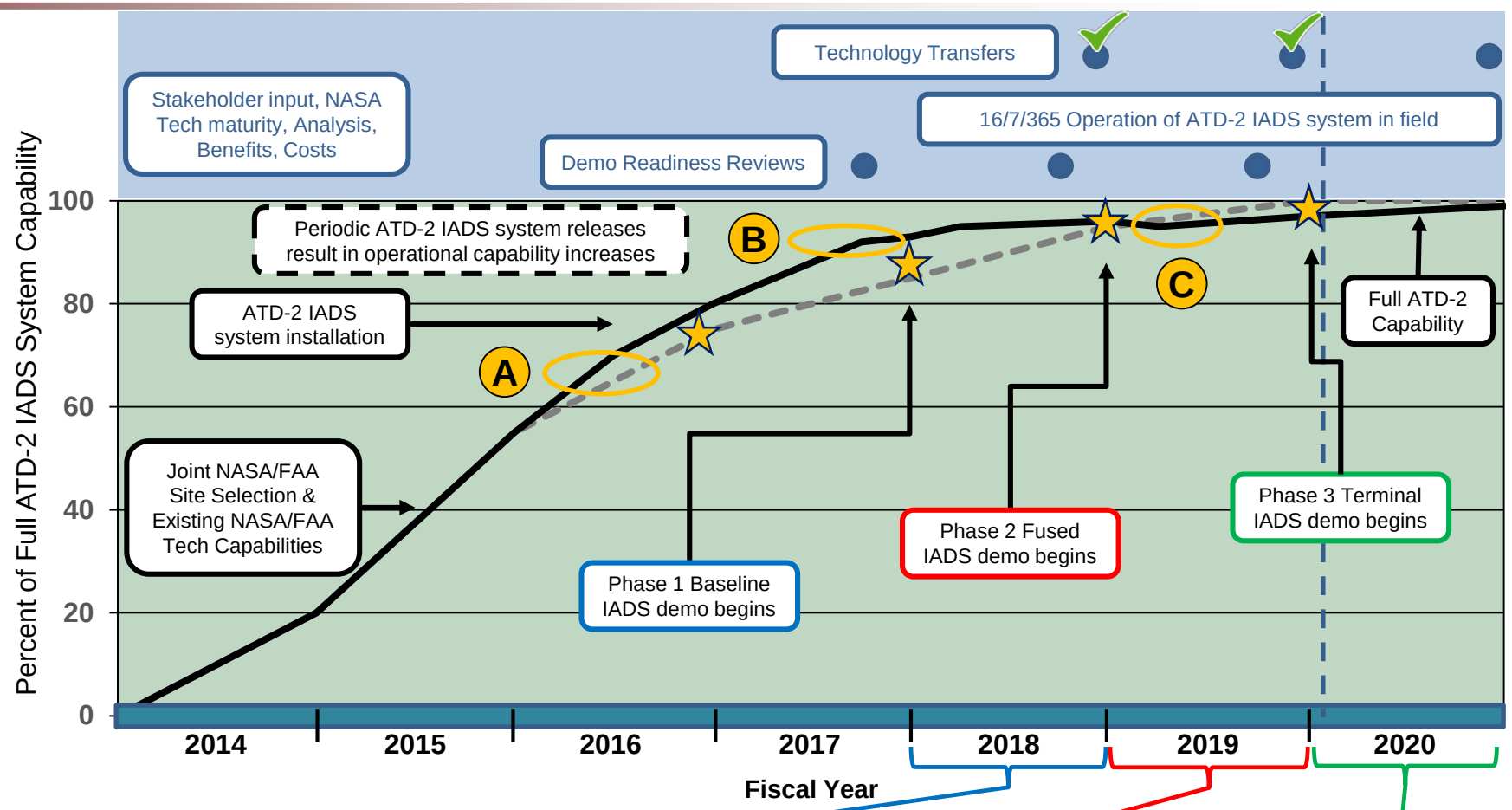
Plan = - - - -

Actual = ———

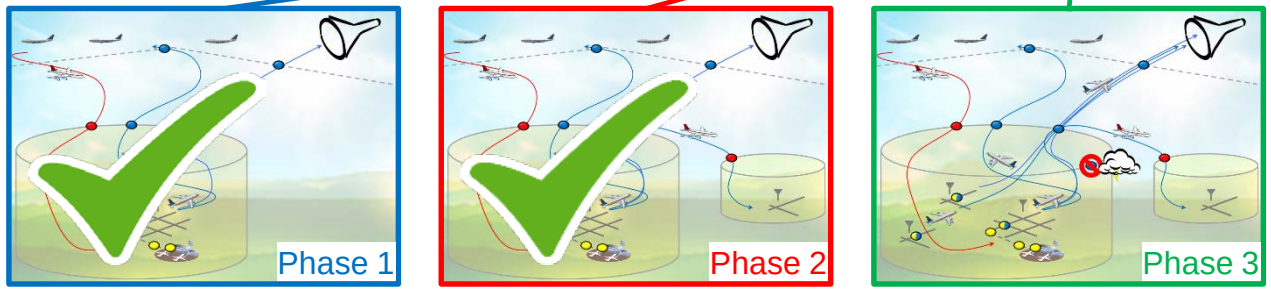
A Decision to interface IADS system with FAA AEFS and TBFM systems substantially increased impact of ATD-2 Field Demo

B Decision to collaborate on prototype TTP feed increased ATD-2 Field Demo relevance to broader flight operator community

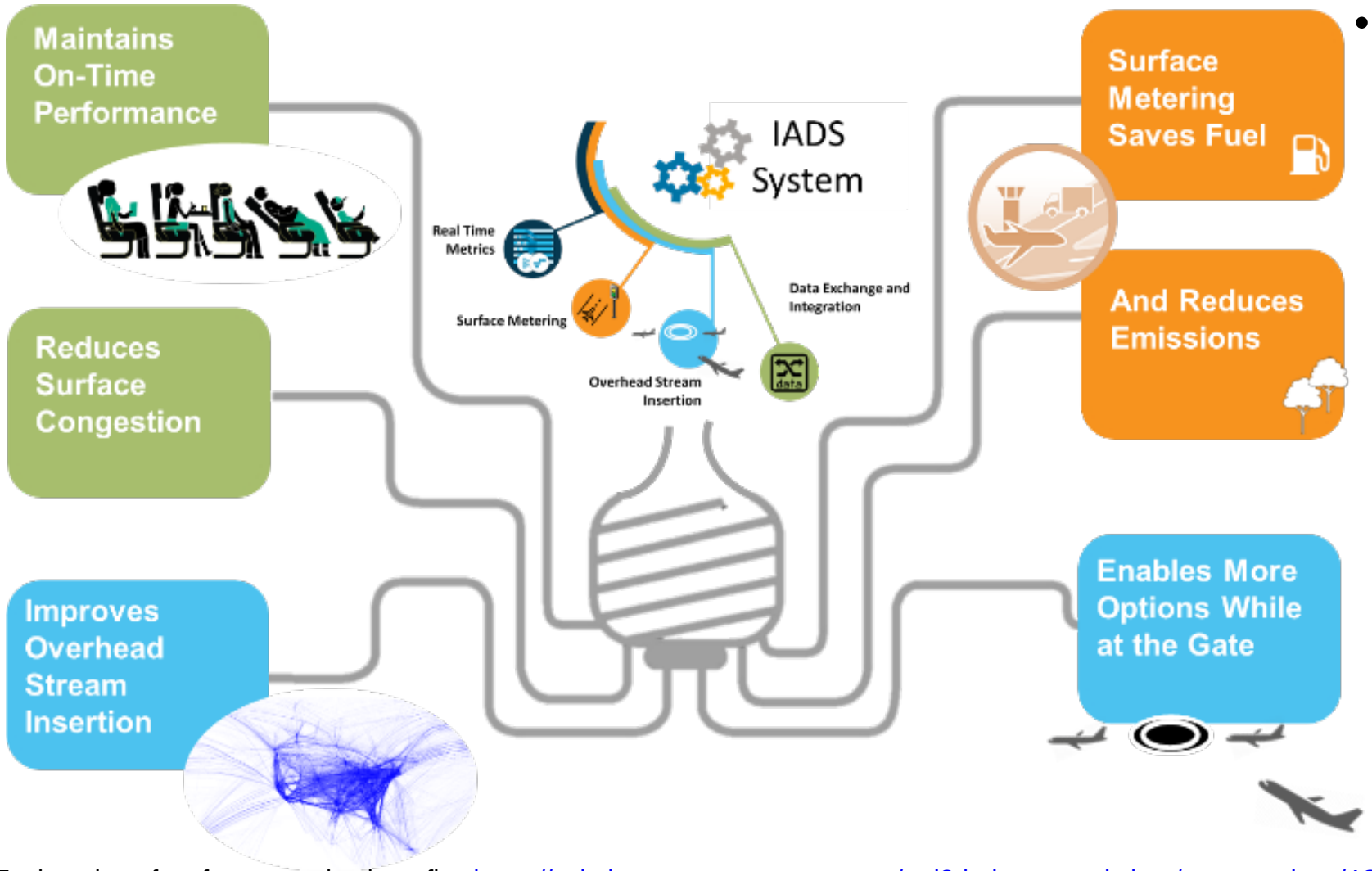
C Government shutdown results in reduced capability for Phase 3 system



Field Demo structured in 3 year-long phases with increasing IADS system capabilities.



ATD-2 is a TFDM Precursor
Benefits Demonstrated at CLT



- Multiple benefits mechanisms (benefits through 2020-01-31)
  - 4,379,031 lbs. of fuel saved
  - CO_2 savings equivalent to 100,292 urban trees
  - 557.0 hours of surface delay saved
    - $2,673,697 passenger value of time
    - $757,627 flight crew costs
  - 3,317 hours of reduced runtime on engines

Explanation of surface metering benefits: https://aviationsystems.arc.nasa.gov/atd2-industry-workshop/presentations/4C_ATD2_Benefits_Industry_Day_FINAL.pdf
Explanation of overhead stream benefits (analytical): https://aviationsystems.arc.nasa.gov/atd2-industry-workshop/presentations/3C_ATD2_APREQ_Industry_Day_FINAL.pdf
Explanation of overhead stream benefits (operational): https://aviationsystems.arc.nasa.gov/atd2-industry-workshop/presentations/4B_Prescheduling_with_EOBTs_90519v1.pdf
How compliance helps stream insertion: https://aviationsystems.arc.nasa.gov/atd2-industry-workshop/presentations/7B_ATD-2_IndustryWkshp_ApreqCompl_StreamInsertion_v2.pdf

EOBT Pre-Scheduling Compliance Improvements

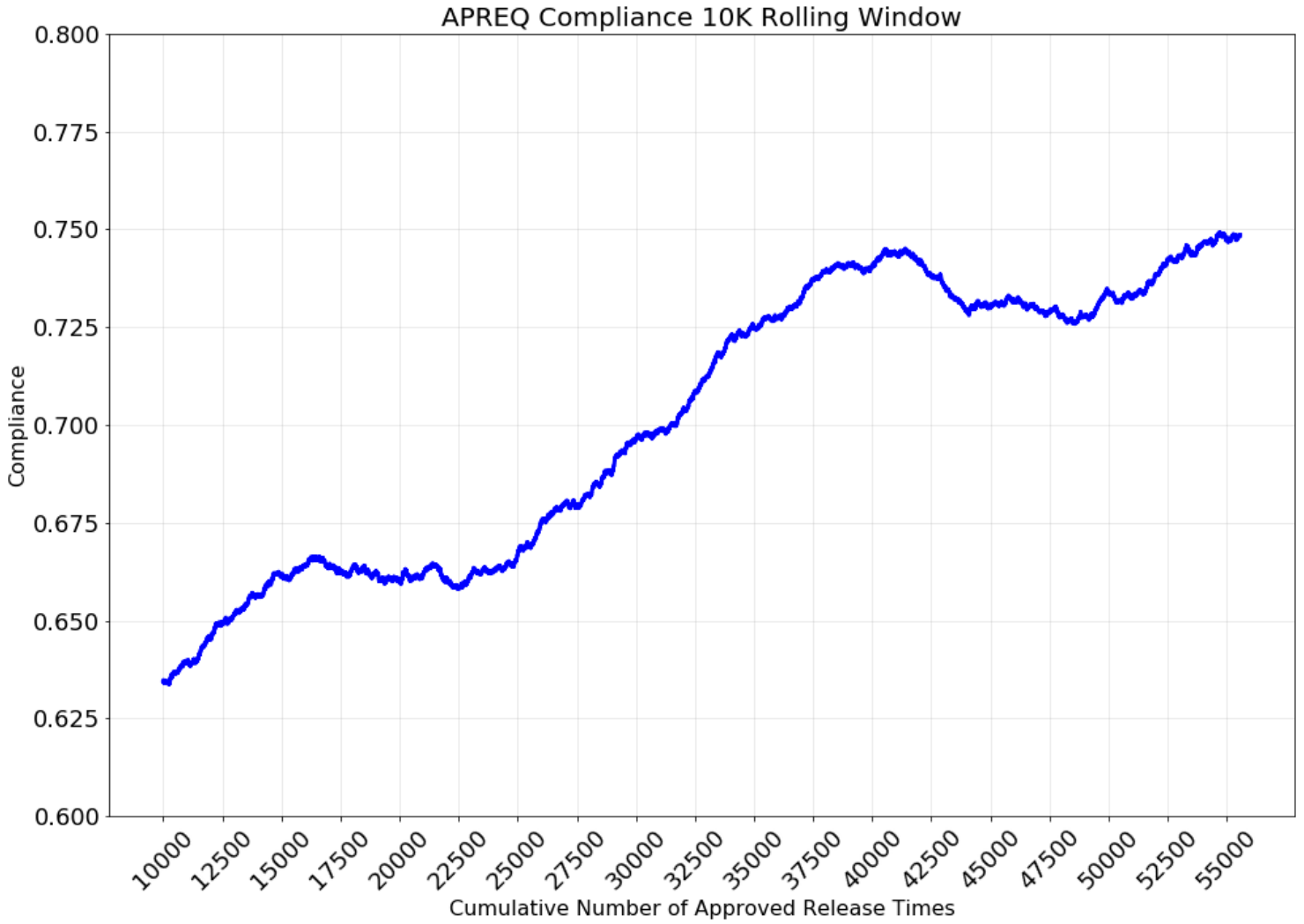
Destination Airport	Before Pre-scheduling	After Pre-scheduling
KATL	68.2%	75.5%
KORD	71.6%	74.0%
KEWR	70.6%	72.8%
KLGA	71.4%	74.6%

Destination Airport	Pre-scheduling Start Date	Analysis Date Range
KATL	Dec 2018	Dec 2017 – Feb 2020
KORD	Jun 2019	Jun 2018 - Feb 2020
KEWR	Nov 2019	Nov 2018 – Feb 2020
KLGA	Nov 2019	Nov 2018 – Feb 2020

APREQ (TBFM time) departure compliance has improved across the board with pre-scheduling.

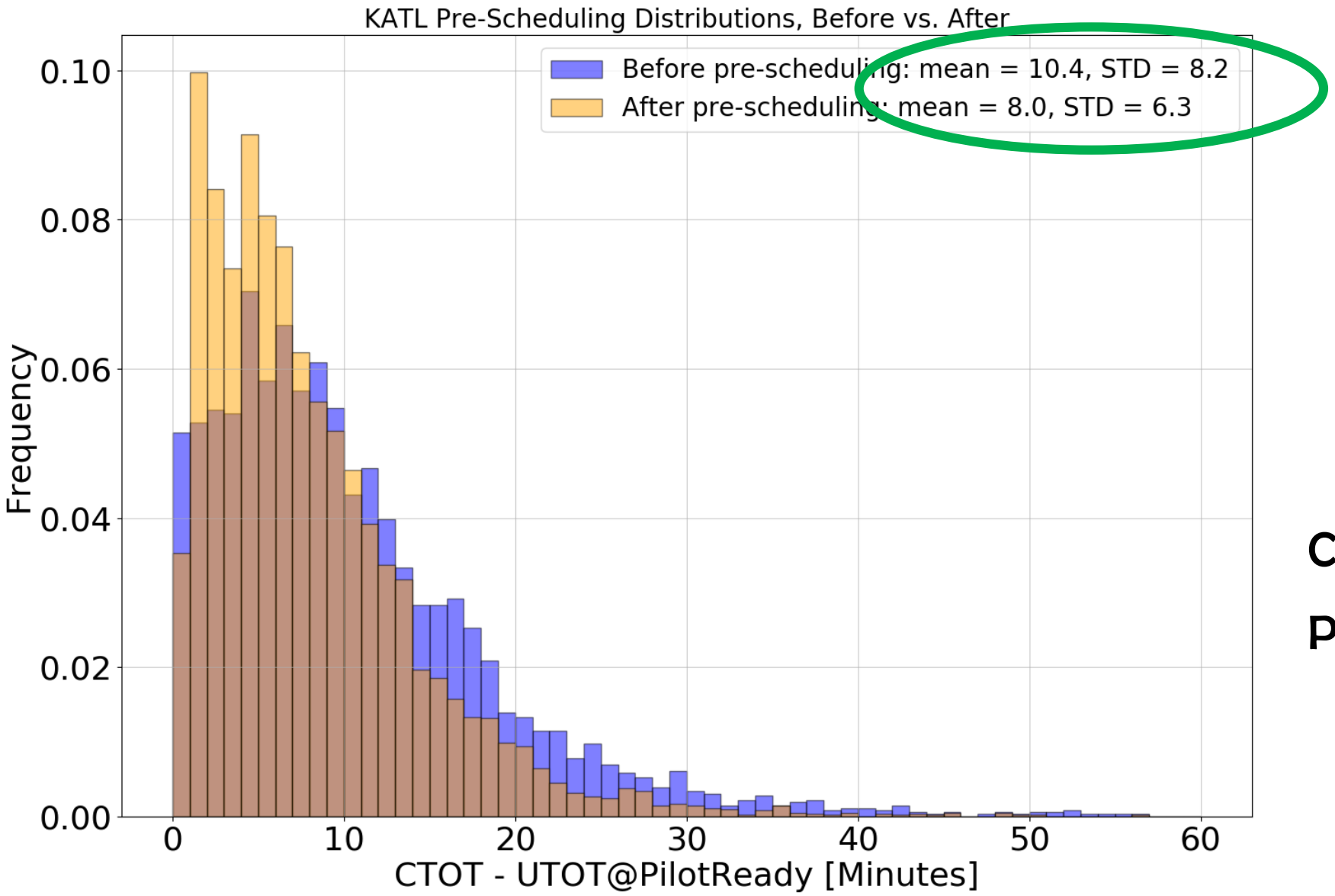
This helps the downline airports being served with higher schedule integrity (better planning).

KCLT APREQ Daily Compliance
10k Rolling Window



Compliance out of CLT has improved dramatically during ATD-2. Now well above average for NAS.

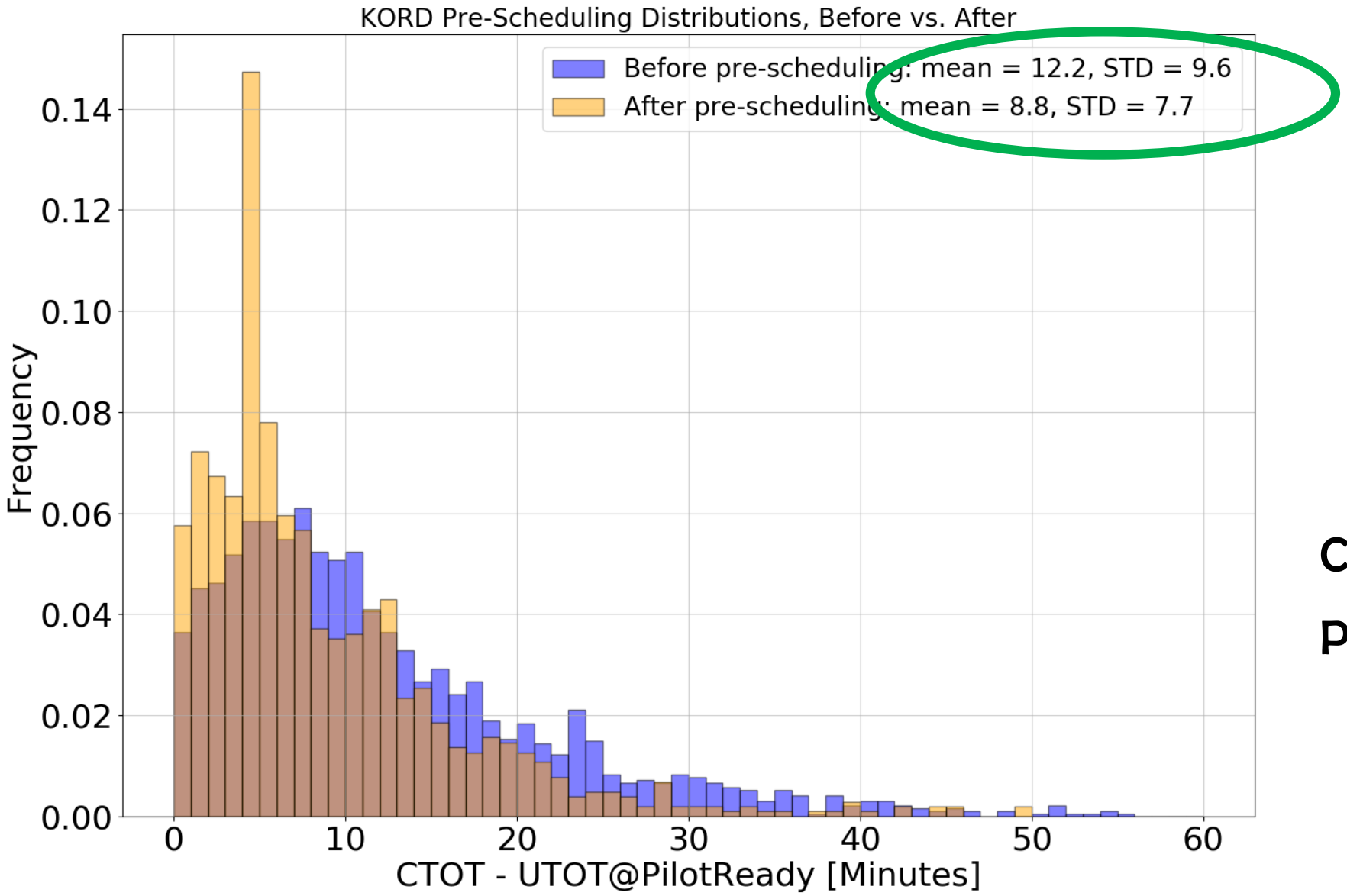
KATL Before and After Pre-scheduling



Compliance ↑

Predictability ↑

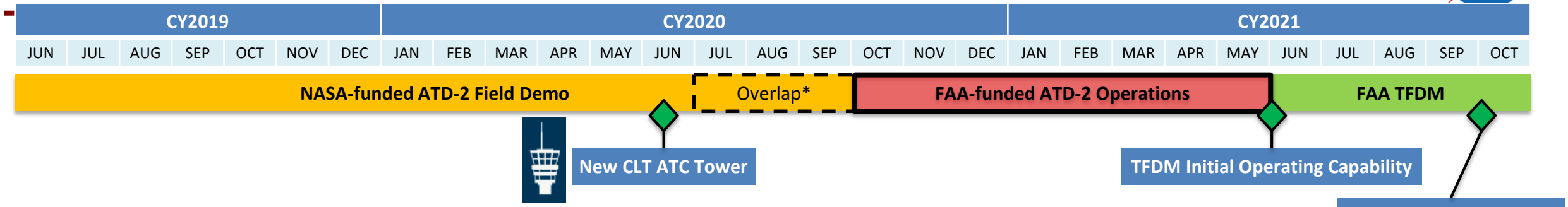
KORD Before and After Pre-scheduling



Compliance ↑

Predictability ↑

ATD-2 to TFDM Transition Plan at CLT



NASA's ATD-2 Field Demo is a pathfinder for Terminal Flight Data Manager (TFDM) capabilities that the FAA will implement at 27 airports.

Executive Summary

- CLT was chosen as a TFDM key site specifically because of the ATD-2 Field Demo
- FAA and Industry stakeholders desire to continue ATD-2 operations at CLT to smooth transition to TFDM
- ATD-2 team developed a transition plan in collaboration with FAA partners (i.e. TFDM and NextGen) via IADS RTT
- FAA senior leadership in ATO and ANG have committed resources to fund transition operations
- NASA senior leadership has concurred with plan
- Commitments will be documented via written agreement

Motivation for Continuing ATD-2 Operations

- Leverage NASA ATD-2 investment to reduce risk for FAA TFDM key site deployment to CLT
  - Continue refining Processes, Procedure, and Policy (P3) for surface metering
  - Continue providing prototype TFDM Terminal Publication (TTP) SWIM feed to facilitate flight operator on ramping
- Minimize disruptions for CLT operational facilities (ATC, flight operators, airport authority)
- Continue providing benefits to flight operators and the flying public

ATD-2's Engagement in "Surface meets TOS"

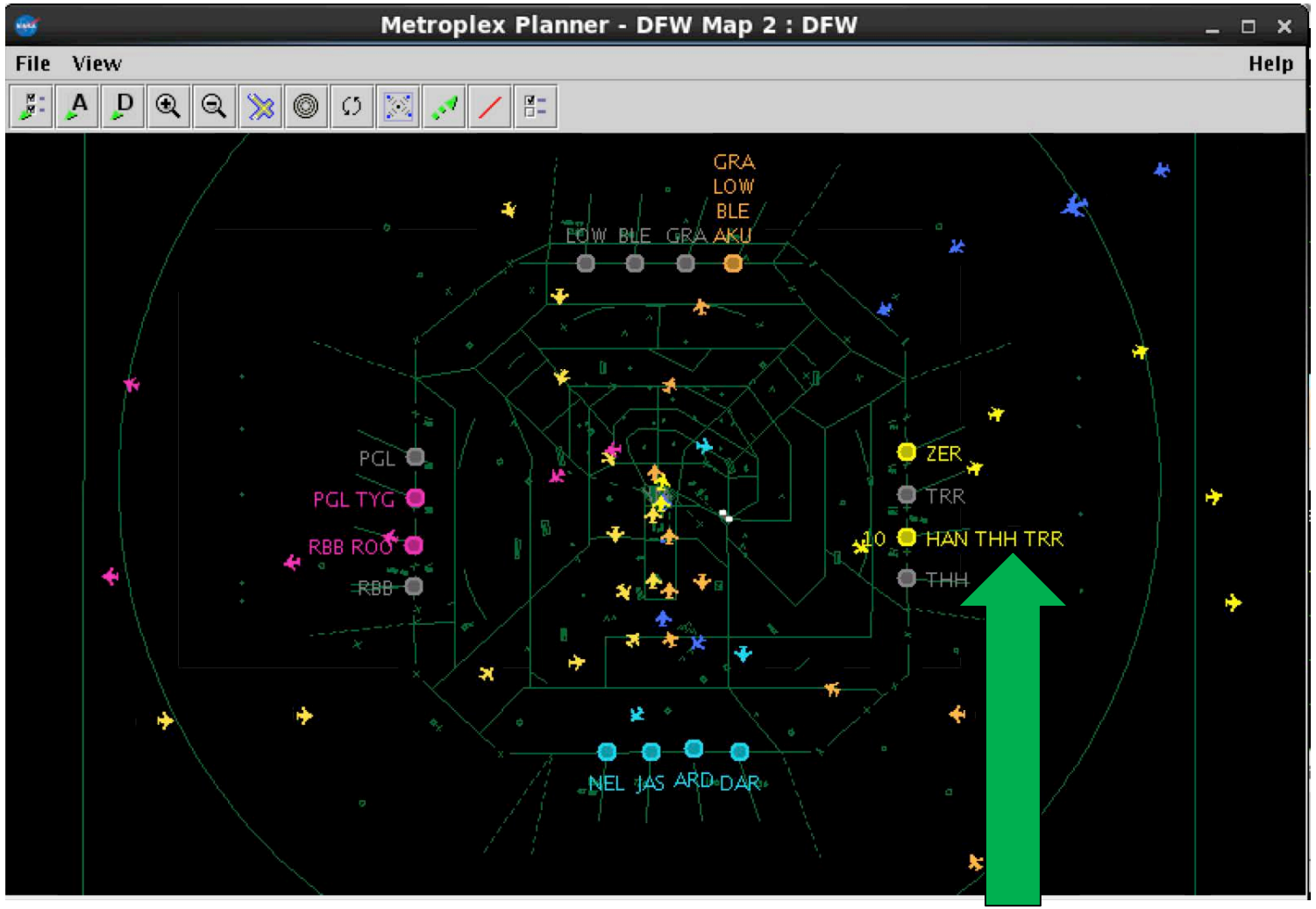
- 2016 – Metroplex demo in NTX for agreed to in original project plan
- Input from community during 2018 Spring CDM in Memphis to look into "Surface meets TOS"
- Numerous meetings with FET/SCT, joint tasking. Engagement with CAT on NTML/TFM Flow.
- 'Stormy 19' pathfinder, data collection, lessons learned and sharing with the community in Oct 2019
- Next week, FET/SCT meet at NASA NTX for detailed discussion
- Partners are working toward this summer's evaluation (Stormy 20)
- Sep 30, 2020 - ATD-2 project ends. NASA ***proposed*** follow on work includes continued TOS evolution consistent with FAA/Industry plans

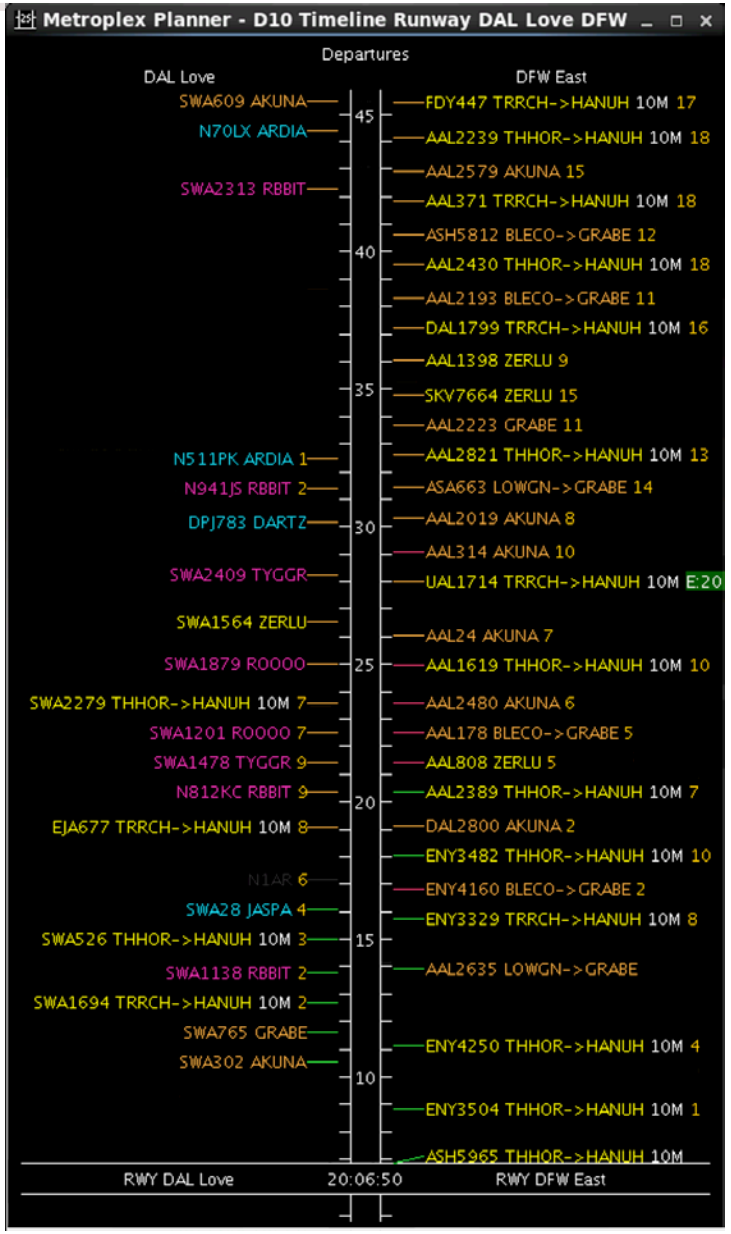
2018 Spring CDM Forum calls for "TOS meets Surface"

2018/2019 Meetings with FET, SCT, CAT

Oct 2019 Workshop Panel Discussing Stormy 19

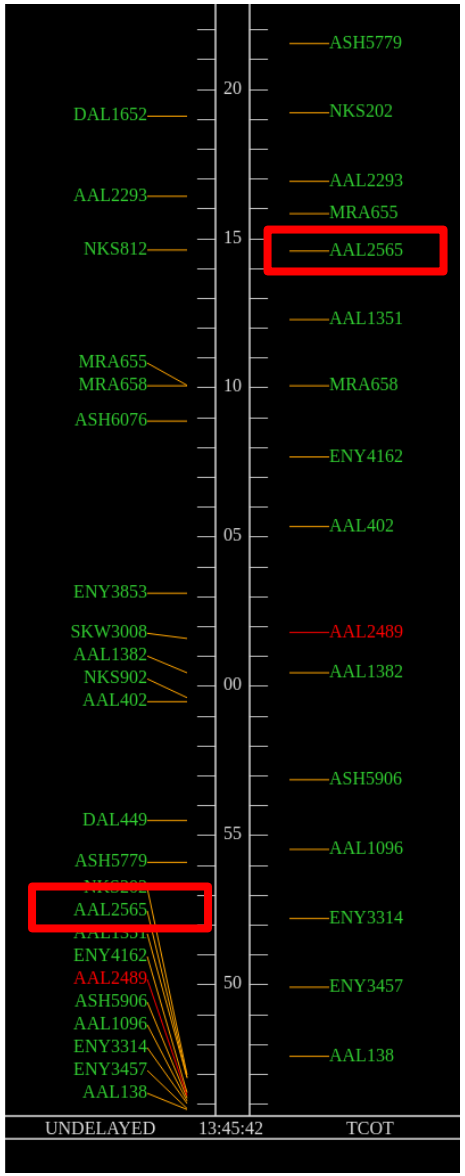
D10 ATD-2 Airspace Map With Departure Fix Restrictions

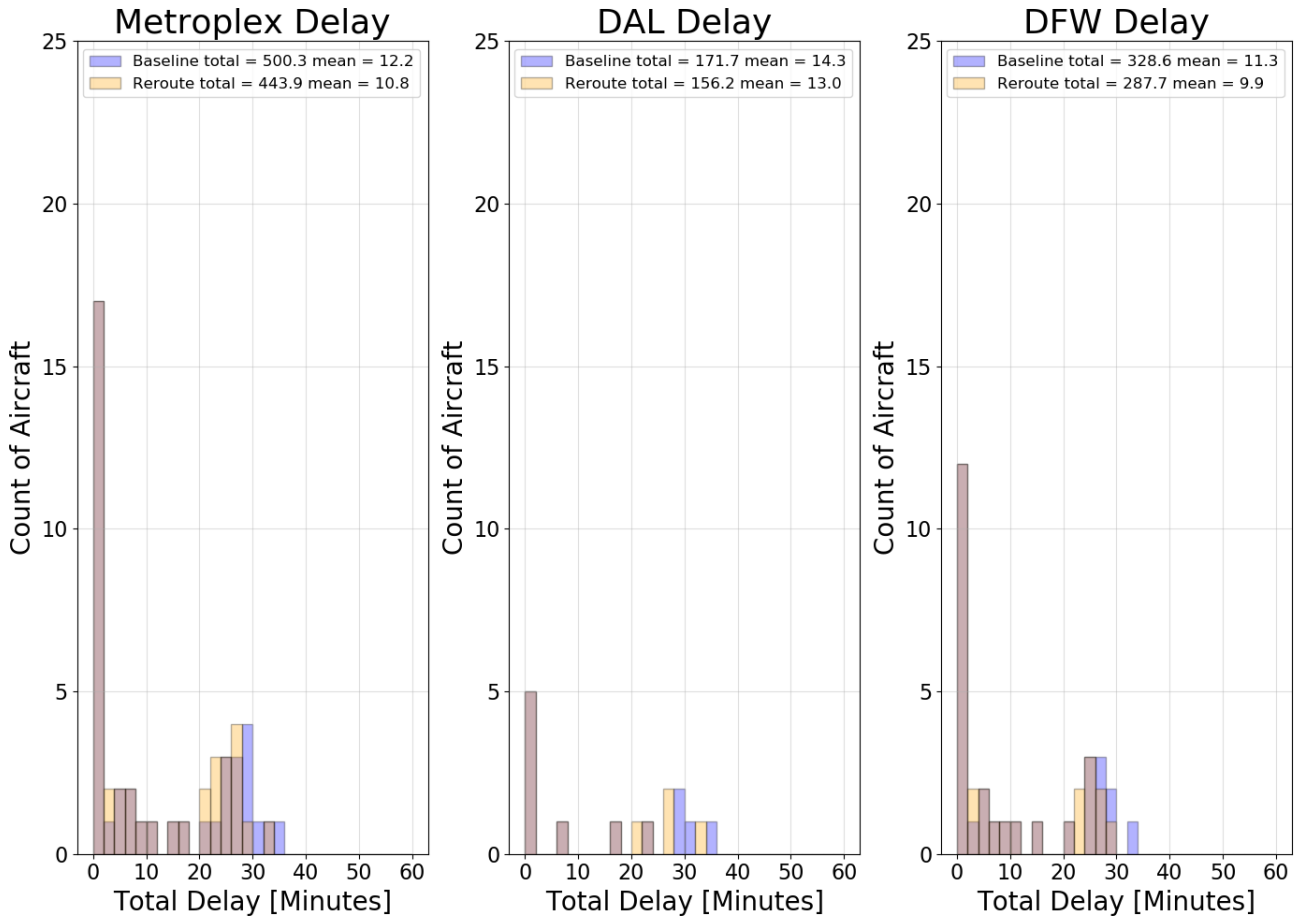




THH and TRR departure fixes are closed, and their demand is added to departure fix HAN with 10 MIT added.

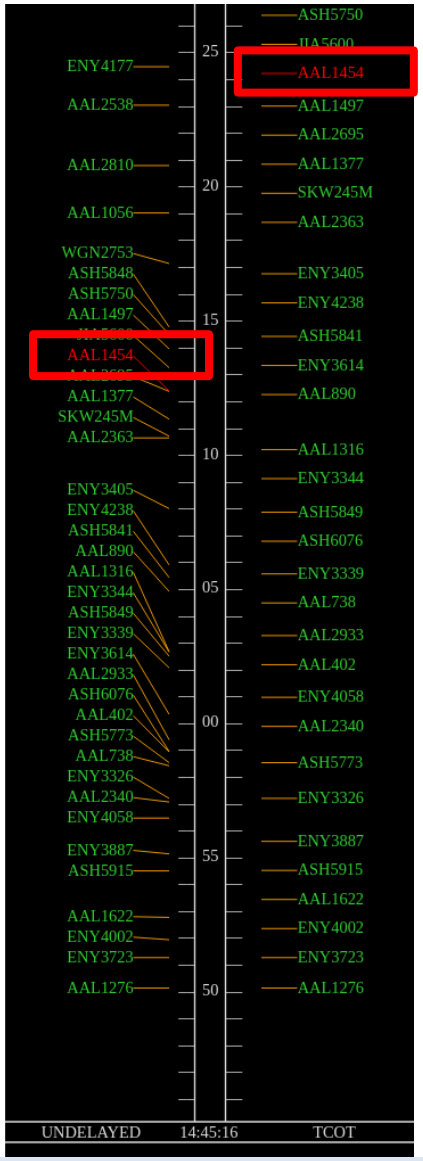
New Metric - System-Wide Benefit of Single Reroute AAL2565 at 2019-12-16 13:45:42

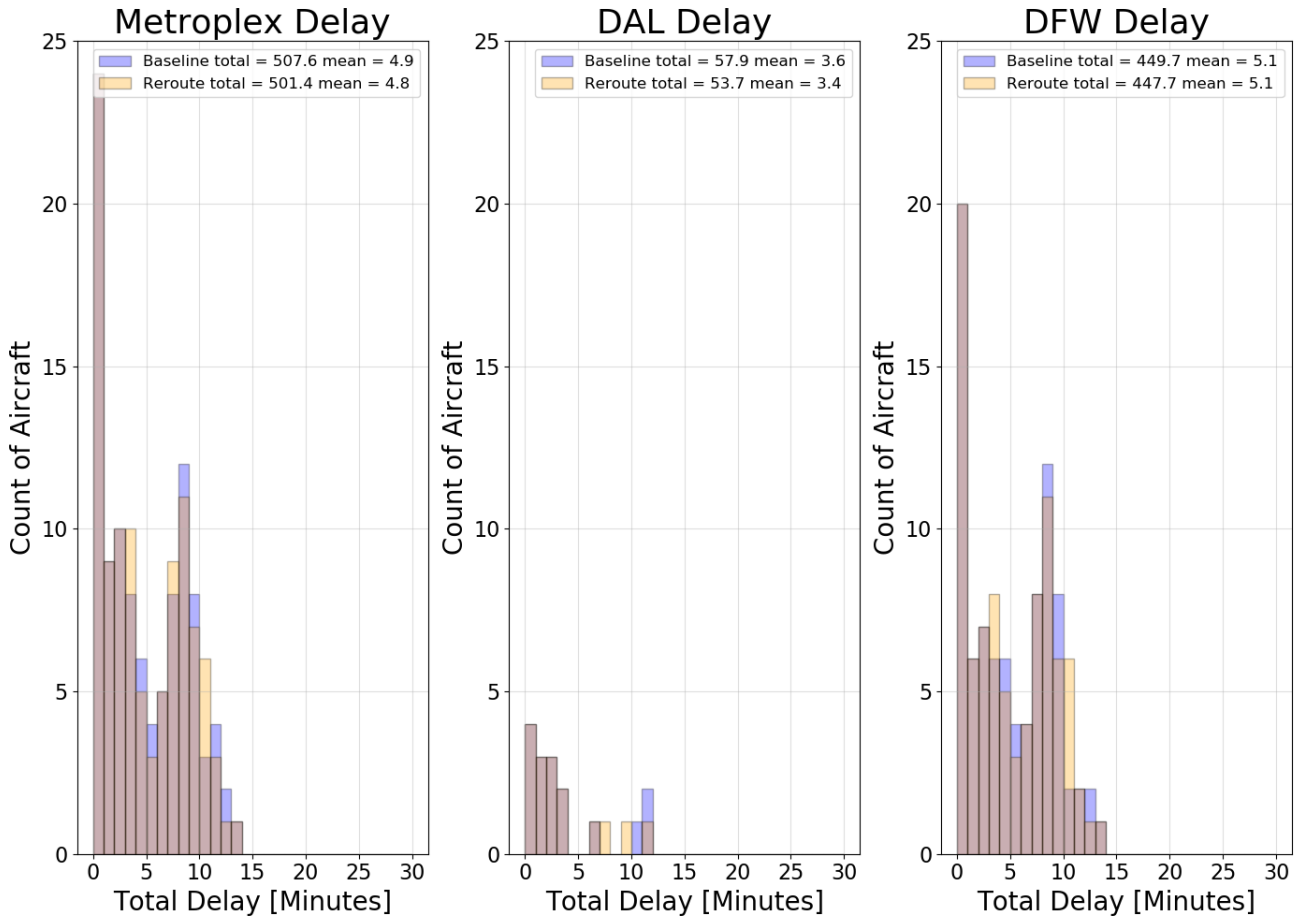




	D10	DAL	DFW	AAL2565
Total Savings	56.4	15.5	40.9	27.7
Average Savings	1.4	1.3	1.4	

New Metric - System-Wide Benefit of Single Reroute AAL1454 at 2019-12-16 14:45:16

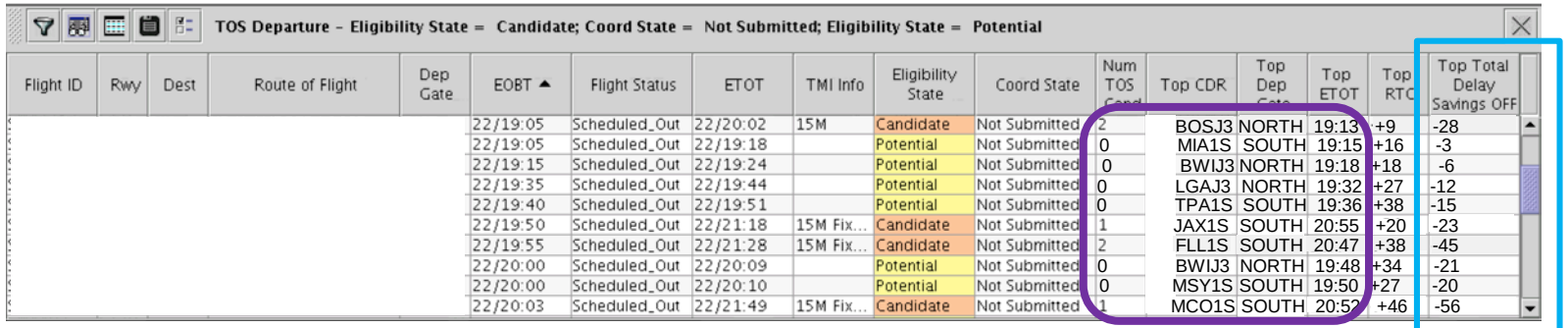


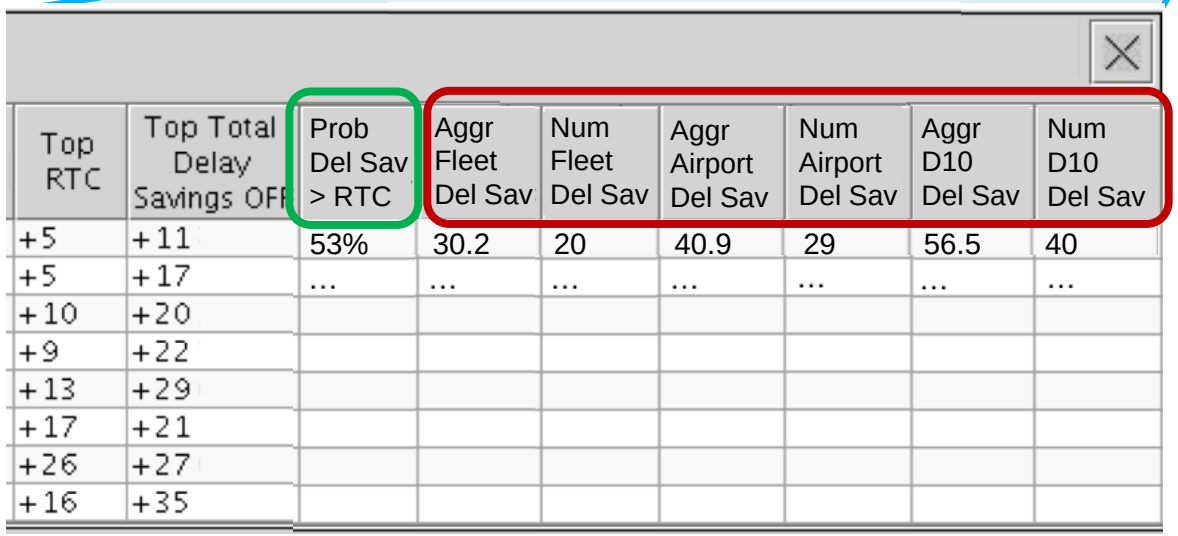


	D10	DAL	DFW	AAL1454
Total Savings	6.2	4.2	2.0	1.2
Average Savings	0.1	0.2	0.0	

In this example, the runway (not departure fix) is the biggest bottleneck. Thus, lower benefits for terminal reroute.

New Metric Fields In The TOS Table





Probability of Delay Savings above Relative Trajectory Cost (RTC) threshold

Aggregate delay savings are indicated at the Fleet, Airport and D10 levels

ATD-2 is Powered by System Wide Information Management (SWIM)

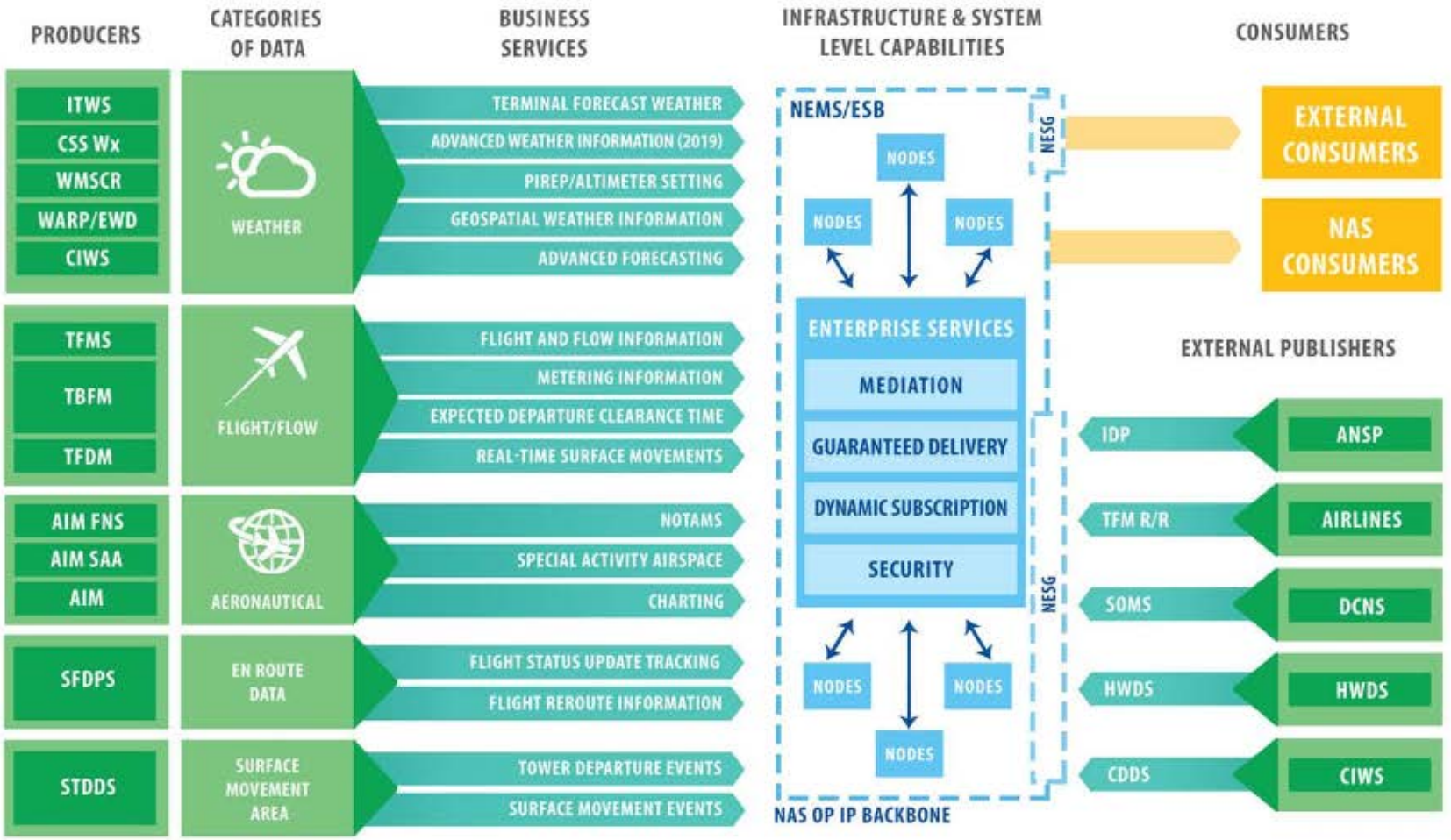


Image above from FAA website: https://www.faa.gov/air_traffic/technology/swim/swift/media/SwimArchitecture.png
Examples of how ATD-2 uses SWIM: http://connect.lstechllc.com/files/SWIFT_ATD2_Consolidated_20190521v2.pptx
Examples of data mappings: https://aviationsystems.arc.nasa.gov/atd2-industry-workshop/fuser/TFMS-Flight-Data-Mapping_85328230.html
Examples of data products: https://aviationsystems.arc.nasa.gov/atd2-industry-workshop/presentations/1C_consistent_reporting_1.pdf

Help Needed

- Assess CDM-Sensitive data access rights of key elements
  - In TFDM feed, EOBT may be the only truly sensitive data element
  - Are operator ‘gate assignments’ CDM-sensitive? Can be obtained via others sources ($).
- Data access support for solutions providers
  - Support for CDM-Sensitive access so folks can innovate and prepare for TFDM
- Ideas and engagement for data-driven services
  - Join the SWIFT revolution
  - More innovation that leverages SWIM, rather than requiring changes to 3T systems
- Support for continued NASA collaboration (through CDM groups, NAC groups, etc.)

Backup

- Backup

TOS Alternative Routes – Process Flow

1 Before Day-Of Ops. Formulate 'Static TOS'

- ATC and operators identify acceptable alternative routes to be notified on
- Routes codified in ATD-2 static adaptation
- NASA and operators agree on Relative Trajectory Cost algorithm

```
<TRAJ_OPTION_LIST>
  <TRAJ_OPTION>
    <TRAJ_INDEX>1</TRAJ_INDEX>
    <REL_TRAJ_COST>0</REL_TRAJ_COST>
    <ROUTE>DCT IPL J18 GBN DCT PXR J18 SJN DCT TCC J6 PNH
    <ALT>F320</ALT>
    <SPEED>N0380</SPEED>
  </TRAJ_OPTION>
</TRAJ_OPTION_LIST>
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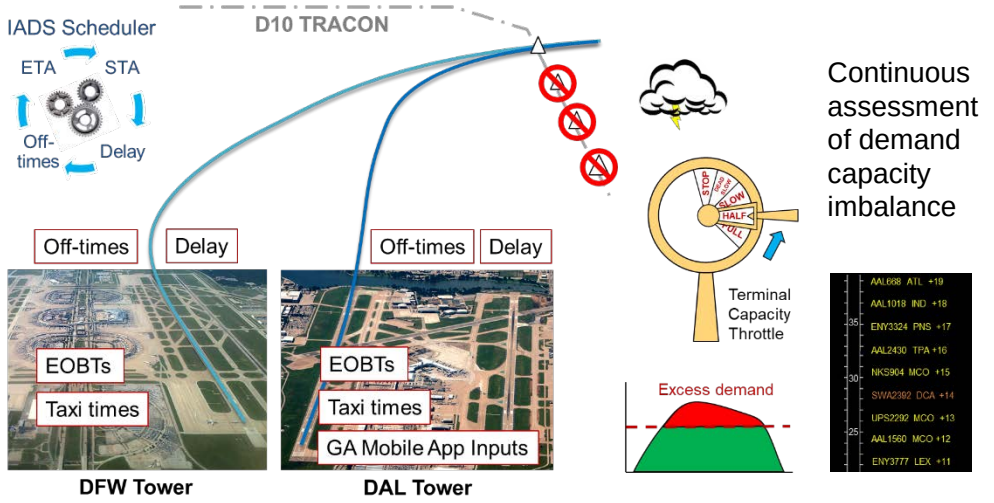
2 Terminal Predictive Engine Determines Impact



Continuous assessment of demand capacity imbalance

3 'Candidate TOS' are Presented to Operators

- Assess delay savings on alternative routes
- When the RTC thresholds are met, the operator is informed of 'candidate TOS routes"
- Operators can then submit an acceptable TOS

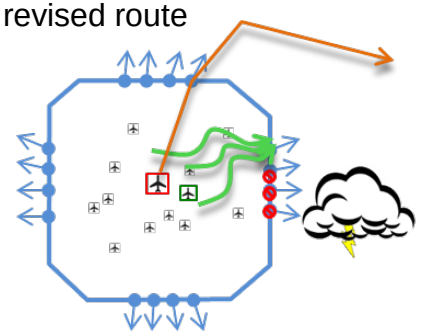
Delay savings > Relative Trajectory Cost ?

Settings Filter Field Color Alerting — **Flight TOS**

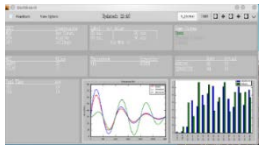
Callsign	Dest	Route	CDR	Dist	+nm	Terminal Gate	RTC	Delay	Delay Savings	Eligibility State	Coordination State	Scratch pad
AAL1560	MCO	KDFW MRSSH2 ZALEA CREEM CEW J2 OJHAP OTK PIGLT4 KMCO	--	880	--	EAST	--	+18	0	N/A	Filed Route	Crew time out 18:10
AAL1560	MCO	KDFW FORCK2 FORCK ELD MEI OTK PIGLT4 KMCO	DFWMCO0P	885	+5	EAST	+1	+18	0	Potential	Not Submitted	
AAL1560	MCO	KDFW AKUNA7 MLC RZC ARG MEM J41 SZW OTK PIGLT4 KMCO	DFWMCO1N	1112	+232	NORTH	+15	+0	-18	Candidate	Not Submitted	Coordination
AAL1560	MCO	KDFW DARTZ7 TNV IAH LCH J2 SZW OTK PIGLT4 KMCO	DFWMCO1S	998	+118	SOUTH	+30	+2	-16	Potential	Not Submitted	Op. Submit / Undo

4 Operator Submitted TOS's Presented to ATC

- ATC is notified of the Operator approved TOS route
- ATC evaluates the TOS routes for operational feasibility. If approved, all users are notified, the filed route is amended, and pilots are cleared on the revised route



5 Post Ops Eval

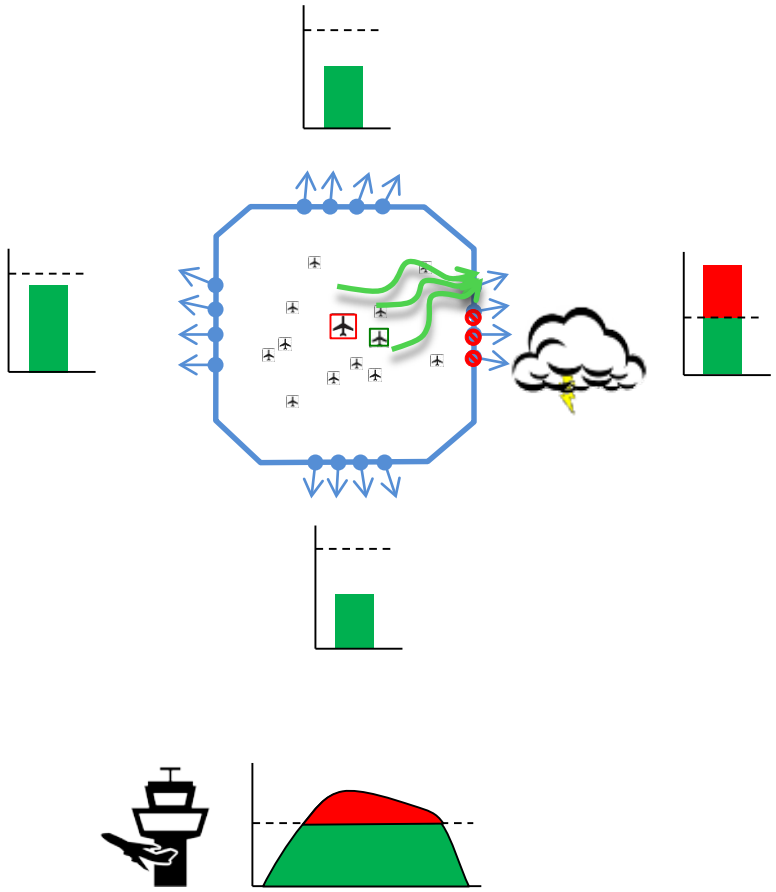


- Benefits
- Lessons
- Refinements
- Data
- Reports

Demand Capacity Imbalances in D10 TRACON Airspace

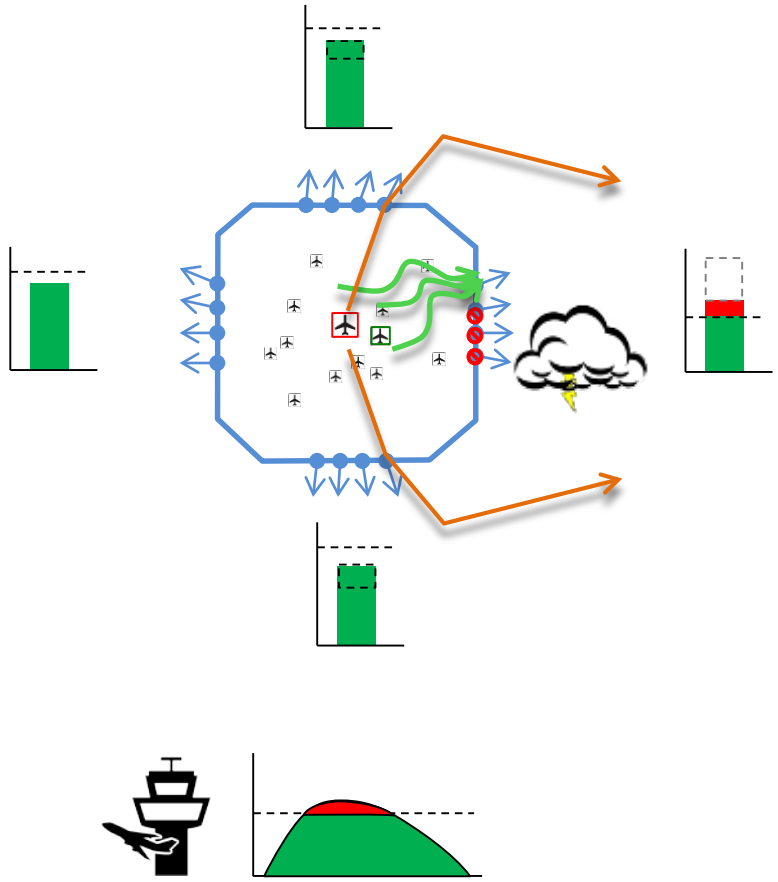
Fix compression caused by weather events near TRACON airspace

Currently

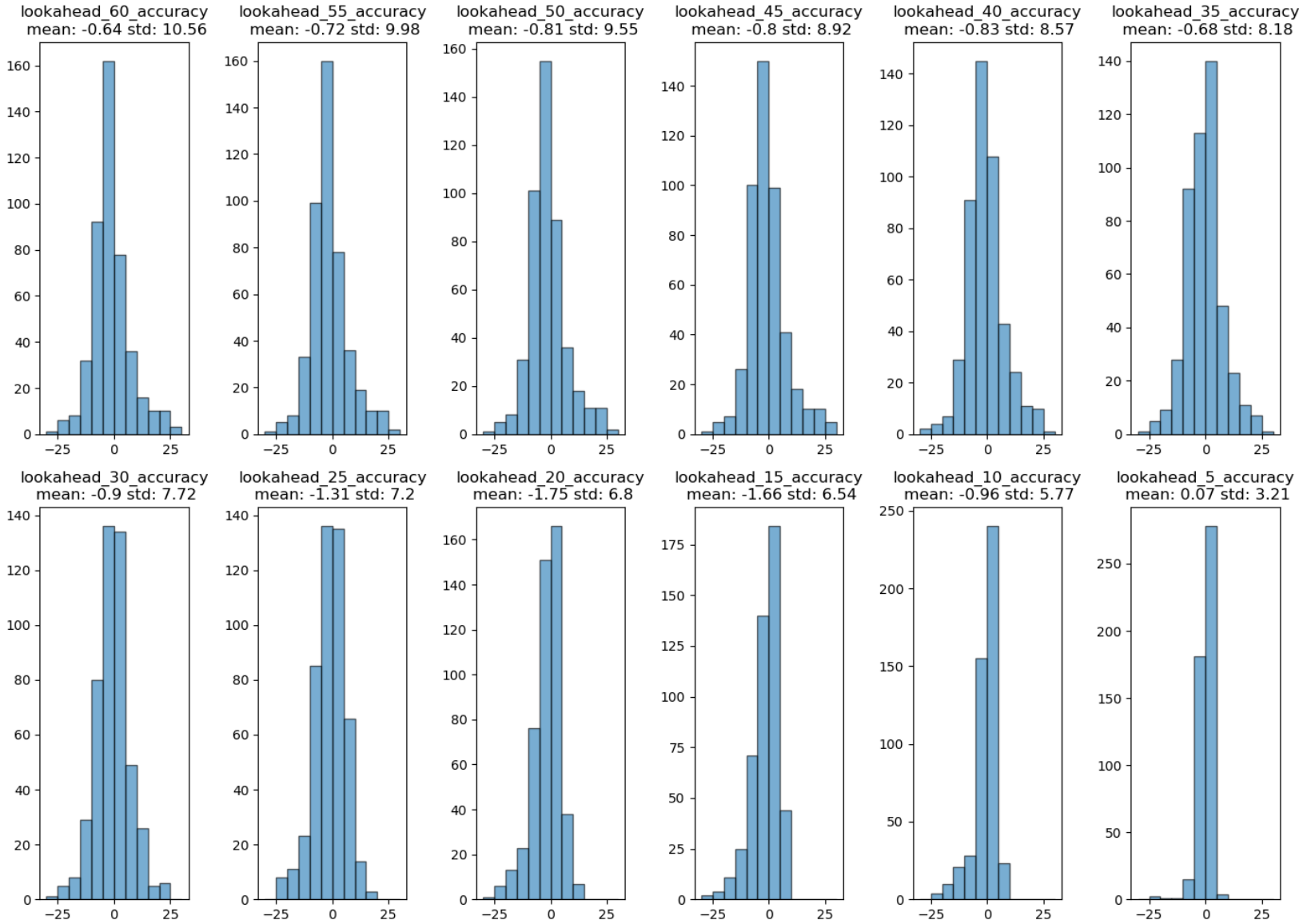


Load Balancing With TOS

(Trajectory Option Set)



ETOT Accuracy on 2019-12-15



Delay Savings Distribution Based on ETOT Accuracy from 2019-12-15