Metroplex TOS Departures, Initial Results and Next Steps Input

Breakout Session 8B

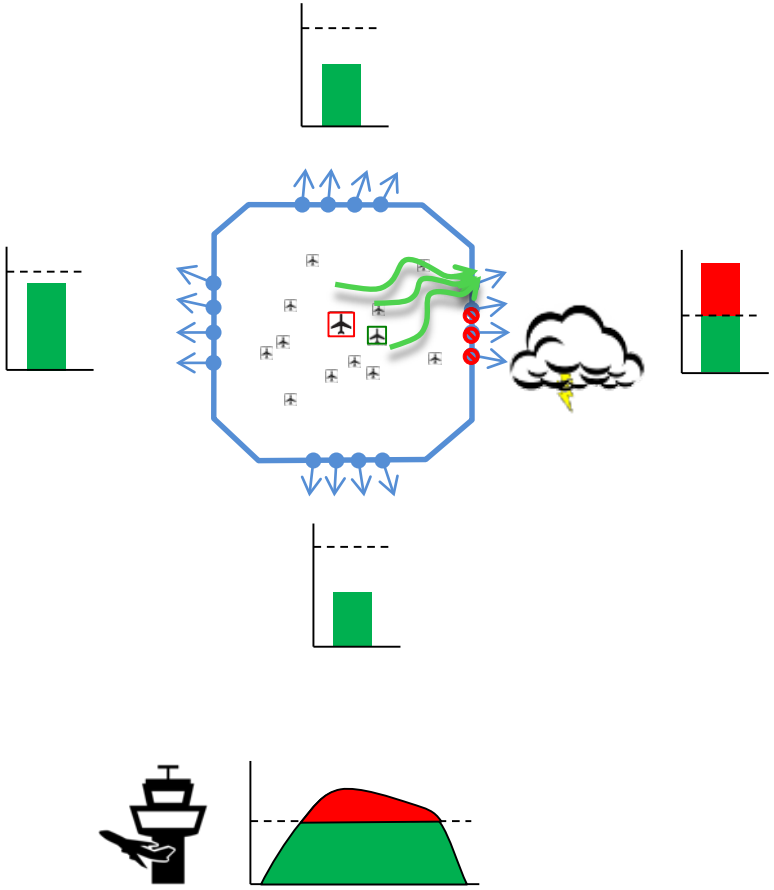
September 5, 2019

Greg Juro and Eric Chevalley

Demand Capacity Imbalances in D10 TRACON Airspace

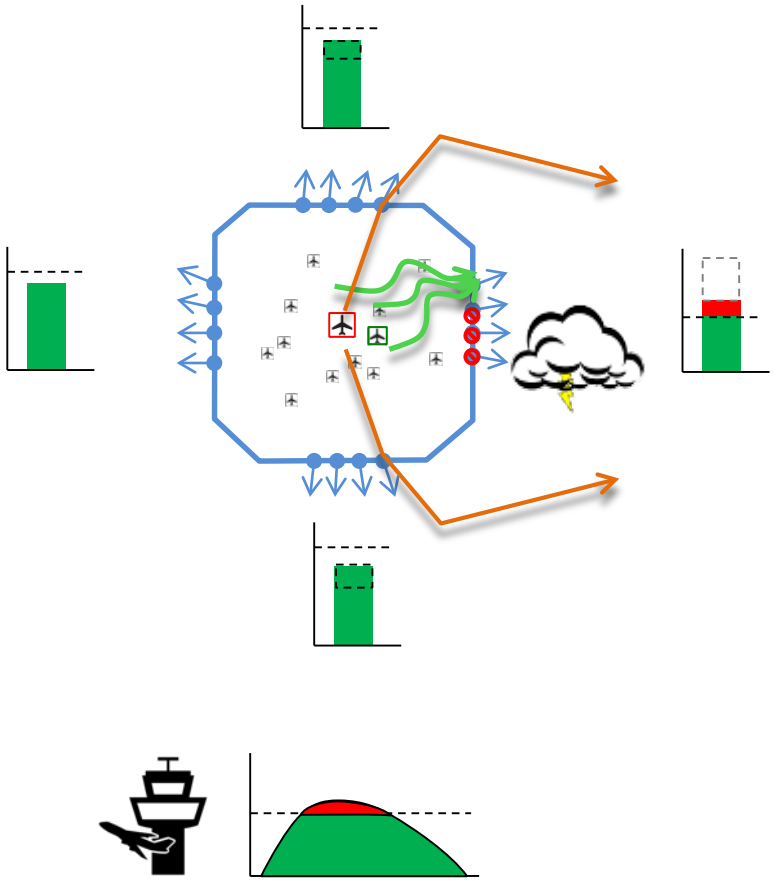
Fix compression caused by weather events near TRACON airspace

Currently



Load Balancing With TOS

(Trajectory Option Set)



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

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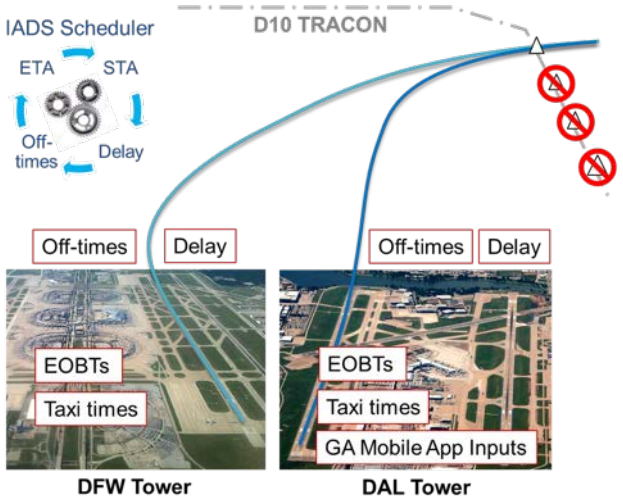
<TRAJ_OPTION_LIST>
  <TRAJ_OPTION>
    <TRAJ_INDEX>1</TRAJ_INDEX>
    <REL_TRAJ_COST>0</REL_TRAJ_COST>
    <ROUTE>DCT IPL J18 GBN DCT PXR J18 SJN DCT TCC J6 PNH
    <ALT>F320</ALT>
    <SPEED>N0380</SPEED>
  </TRAJ_OPTION>
</TRAJ_OPTION_LIST>
```

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 ?

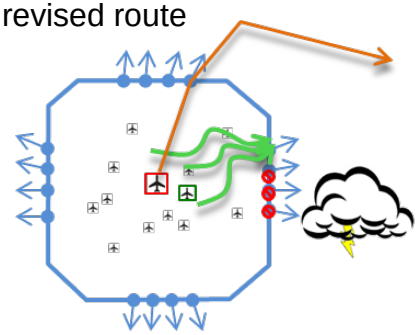
Settings Filter Field Color Alerting **Flight TOS** x

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 CUHAP 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	
AAL1560	MCO	KDFW DARTZ7 TNV IAH LCH J2 SZW OTK PIGLT4 KMCO	DFWMCO1S	998	+118	SOUTH	+30	+2	-16	Potential	Not Submitted	

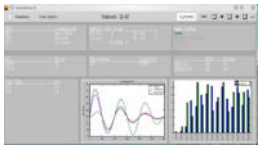
Coordination
Op. Submit
Undo

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

TOS Alternative Routes – Process Flow

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

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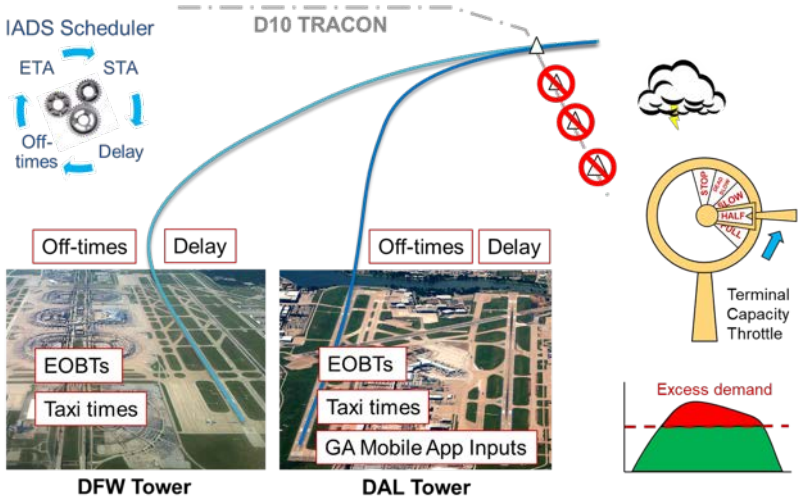
Step 1 - Added Value

- **CDRs used as Static TOS**
- **CDRs are full procedures that are standard, identifiable, and accessible to both operators and ATC**
- **CDRs allow for comparison with filed routes and computation of RTC ahead of time**
- **CDR can be identified as routes that may or may not be available for reroute**
- **CDR code are eventually used to amend filed routes**

TOS Alternative Routes – Process Flow

2 **Terminal Predictive Engine Determines Impact**



Continuous assessment of demand capacity imbalance

Step 2 - Added Value

Demand and delays are computed based off:
- **Surface model**
- **Integrated Surface and terminal schedulers**

Accounting for:
- **EOBTs**
- **TMI restrictions at the terminal boundary and at the runway**
- **Other spacing and sequencing constraints**

Provides:
- **Delays estimates**
- **Basis to compare delays savings on TOS route and RTC**

TOS Alternative Routes – Process Flow

Step 3 - Added Value

- **Candidate TOS are available alternative routes from ATC perspective**
- **Candidate TOS provide an indication to Flight Operators when flights have opportunities to save delays by flying alternative route(s)**
- **ATD-2 Client provides awareness of nm difference and RTC for alternative routes, and delay savings on the surface**

3 ‘Candidate TOS’ are Presented to Operators

- Assess delay savings on alternative routes
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Delay savings > Relative Trajectory Cost ?

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Coordination
Op. Submit
Undo

TOS Alternative Routes – Process Flow

Step 4 - Added Value

- **Submitted TOS provide ATC with ability to balance demand at the runway and effectively reduce surface delay**
- **Approval of reroute is immediately reflected in the scheduler providing feedback about impact of rerouting demand**
- **Clients provide awareness of submitted, approved reroutes as well as when filed routes are revised in ERAM**

4 **Operator Submitted TOS's Presented to ATC**

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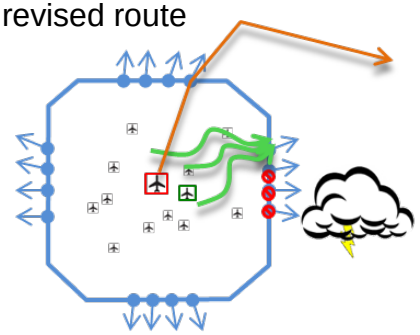


Demonstration of the System with Live Data

Deeper Dive into Stormy 19

- Overview of Field Evaluation
- Main Components of the ATD-2 Graphical User Interface
- Initial Results
- Development and Lessons Learned
  - Handling TMI from NTML entries
  - Modifications to Scheduler and Delay Savings
  - Modifications to Route Distance Computation
  - Global Management of Flights and TOS Route Availability

Stormy 19
Overview of Field Evaluation

ATD-2 Field Demos Partners

Phase 3 Overview

Surface Meets TOS

- A set of Capability that:
  - Leverages IADS Surface predictive and scheduling technology (Phase 1-2)
  - Expands IADS to the terminal boundary
  - Provides Trajectory Option Set (TOS) to identify when alternative routes are available to reduce surface delay for departures out of the North Texas region
  - Leverages CDM products, such as CDR, Playbook
  - Identify potential solutions to bridge 3T technology gaps

Phase 3 Stormy 19 and 20 Objectives

Crawl – Walk – Run

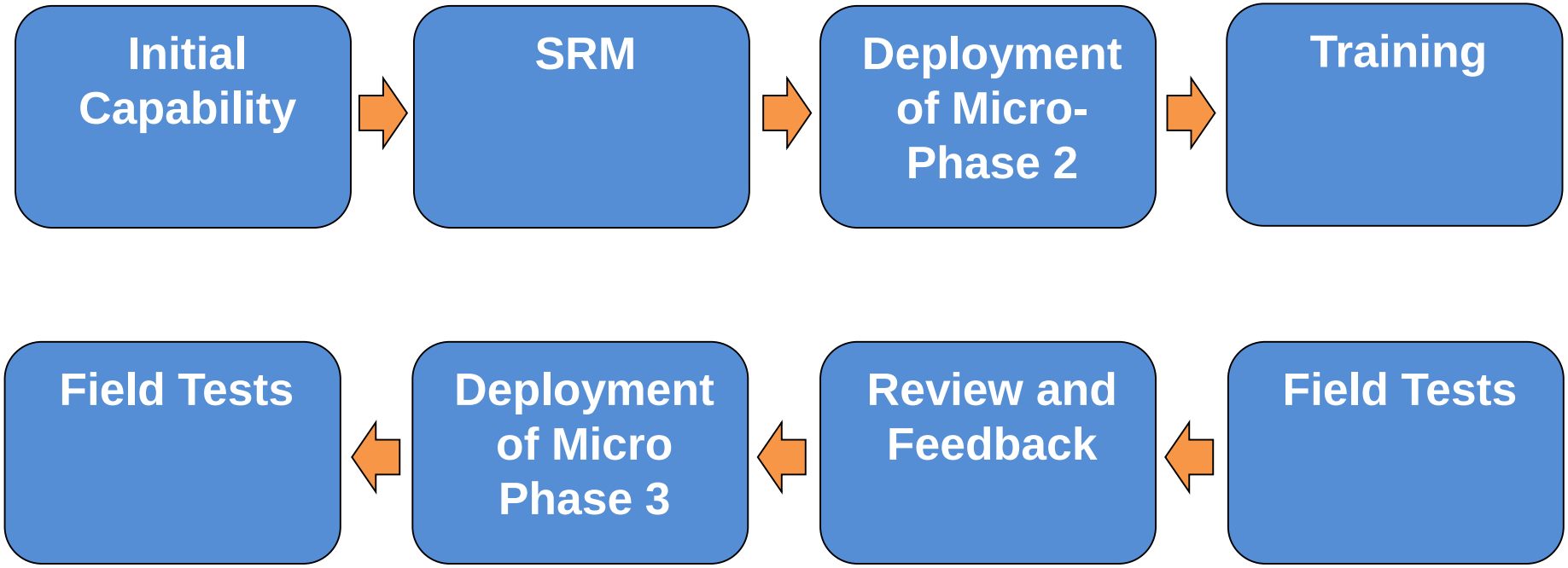
- Stormy 19 (exploratory Research)
  - Identify Requirements through Shadow Sessions
  - Develop an initial capability in an *agile* manner
  - Incremental built of capability (3 micro-phases)
  - Test and use incrementally in operational environment
  - Collect data, observation, feedback
  - Identify monetizable benefits
  - Mature capability
  - Identify goals for Stormy 20

- Stormy 20 (formal test)
  - Implement lessons Learn from Summer 19
  - Identify technology transfer deliverables
  - Develop larger capability leveraging SWIM components
  - Test and Collect data
  - Measure benefits

Stormy 19 Micro-Phased Evaluation

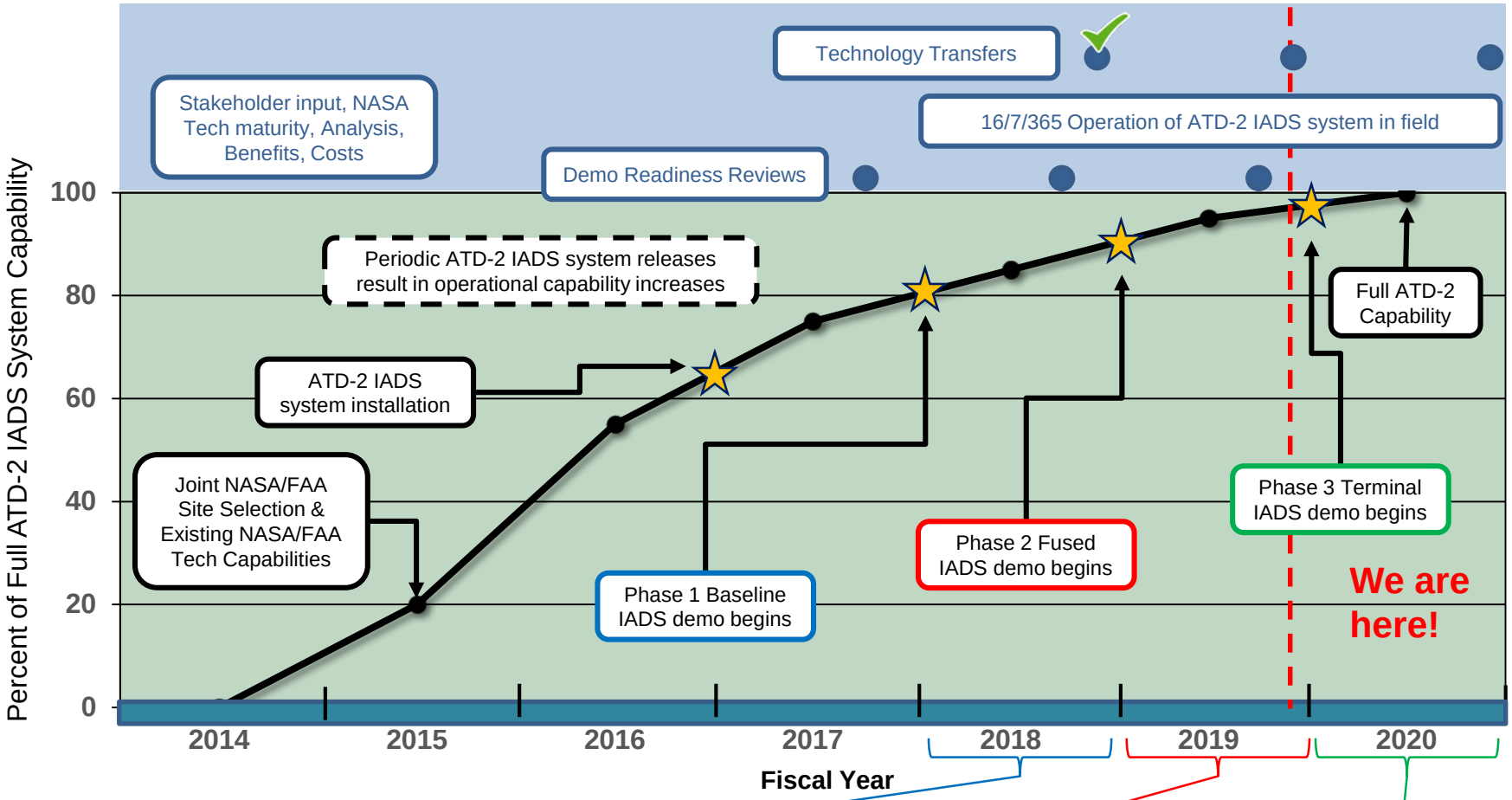
3A - June 10	3B - July 15	3C- August 12
Terminal Data Exchange & Integration	**Departure Fix Load Balancing With TOS**	**Departure Fix Load Balancing with TOS + Data Comm**
New terminal information in operational areas, but not used for operational decisions. Allows ATC restrictions to be available from NTML and SWIM while users orient to new displays.	Core 'Stormy 19' departure fix balancing with TOS concept of operations. Phased in progressively during agreed upon traffic and weather scenarios	Expand upon 3B with Data Comm equipage information to user interfaces. Targets more benefit via use of CPDLC-DCL equipped flights for overall delay reduction.

Stormy 19 – Agile Development And Field Test

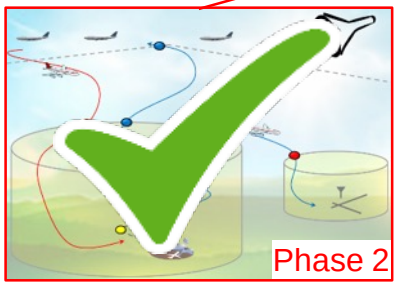


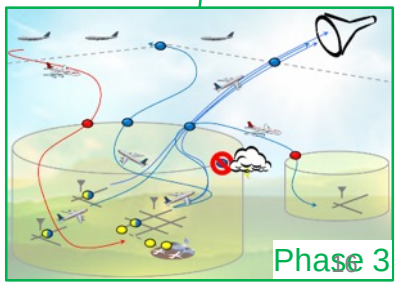
As of Aug 26th, logged 54h during 11days of scheduled operational tests from Mid-July to Mid-August

ATD-2: Progress Indicator Chart



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





Stormy 19
Main Components of Graphical User Interface

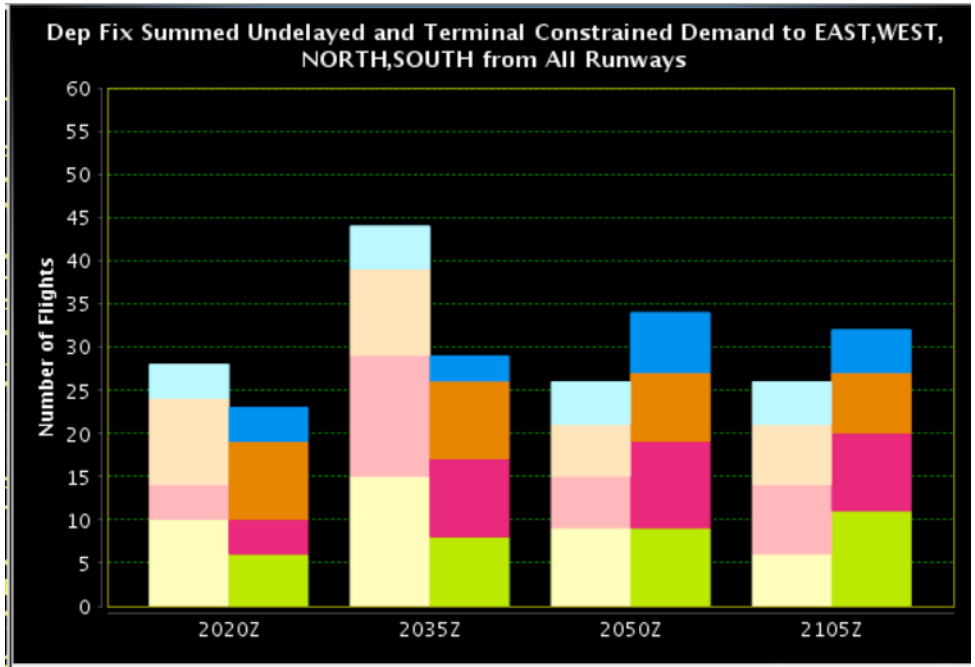
Timeline & Graph

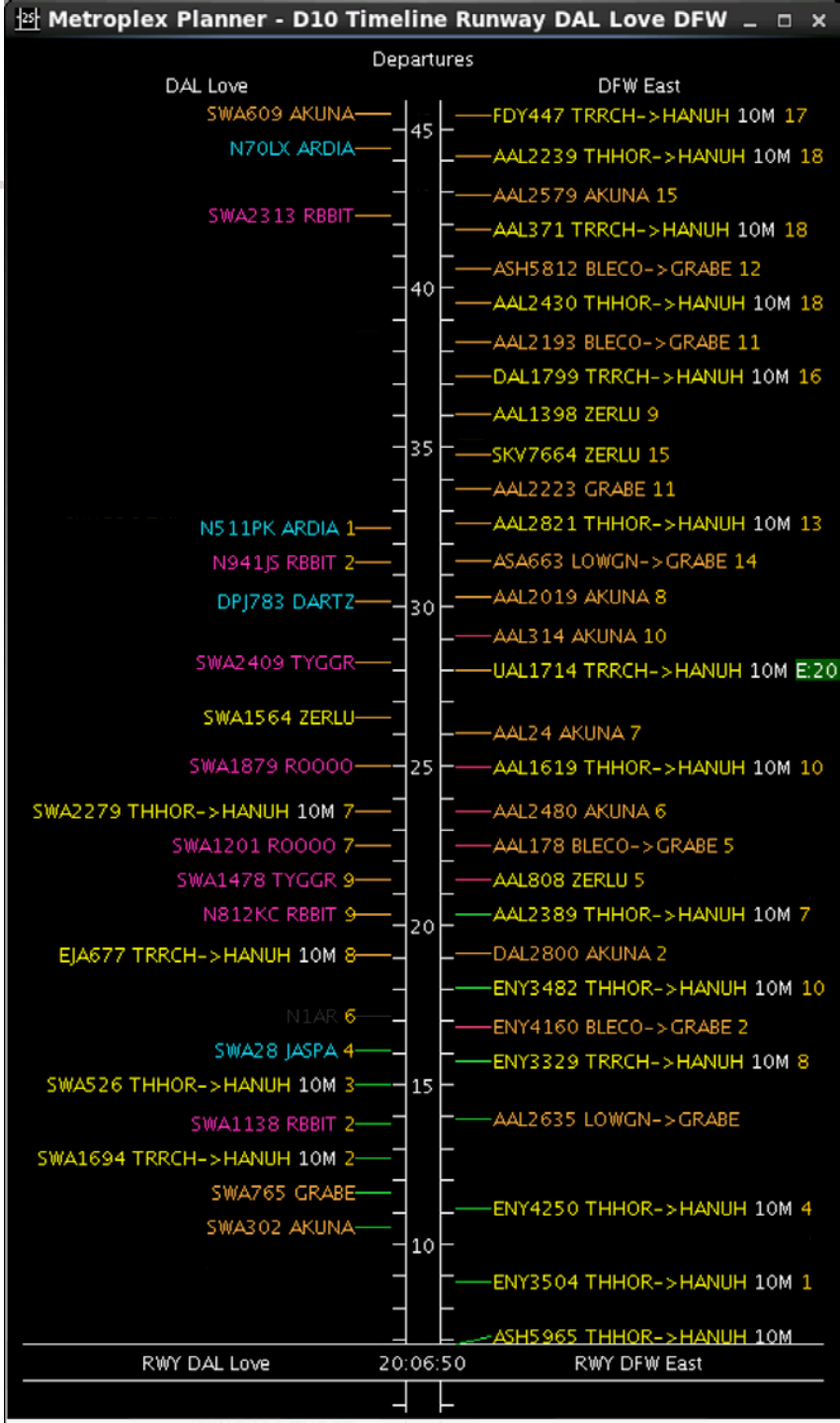
Timelines at Runways or Departure Fixes

- Undelayed and Estimated Times
- Delay
- TMIs
- TOS State
- Flight data

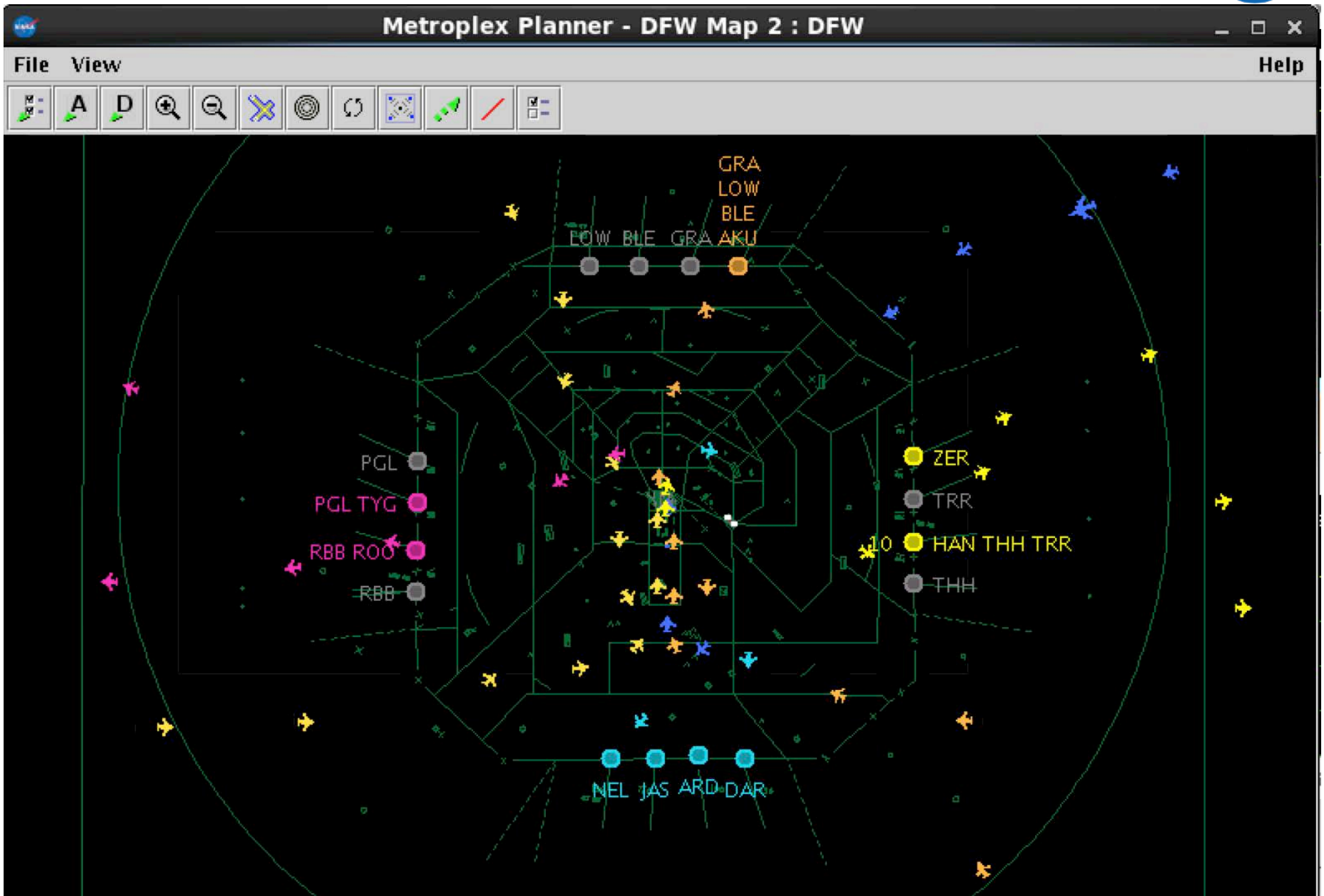
Graph at Runways or Departures Fixes

- Undelayed and Estimated demand





Map


Metroplex Planner - DFW Map 2 : DFW
File
View
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LOW
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PGL
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RBB ROO
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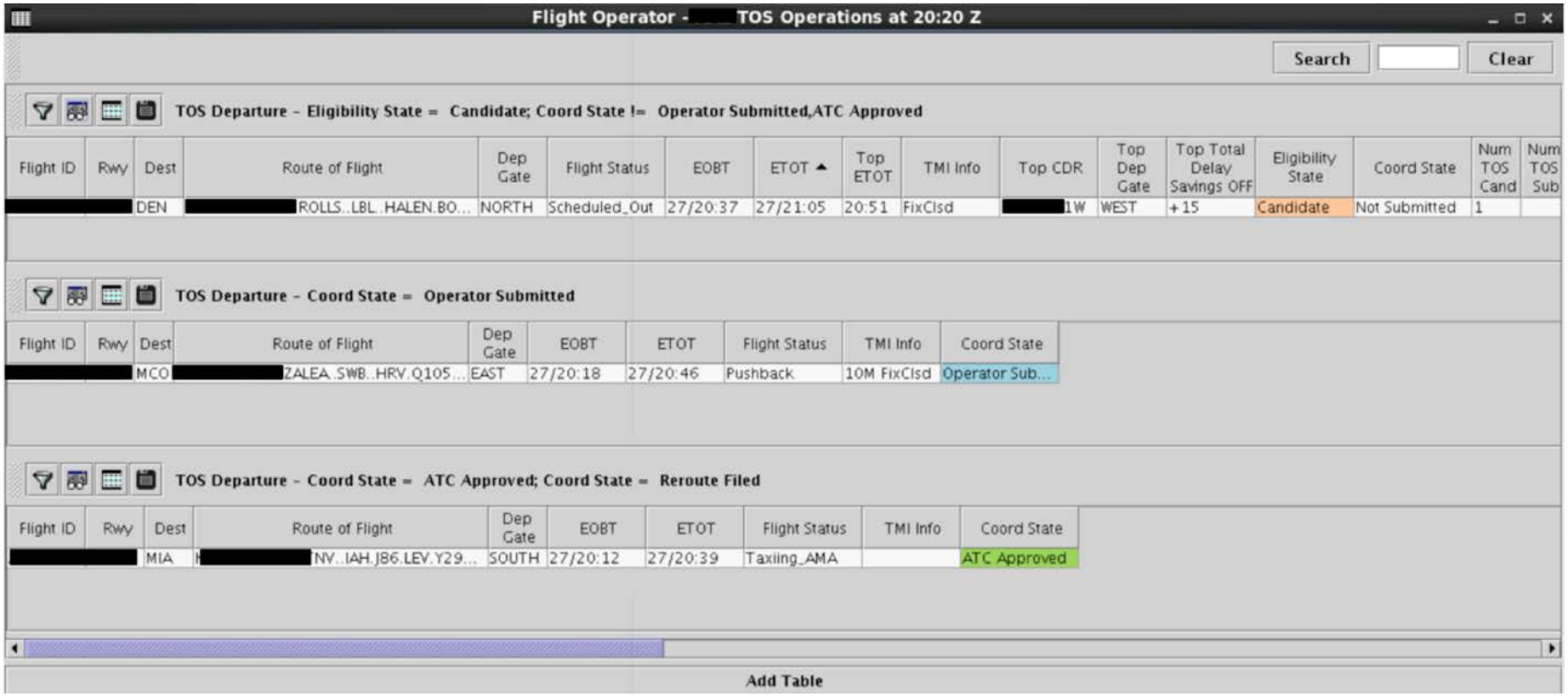
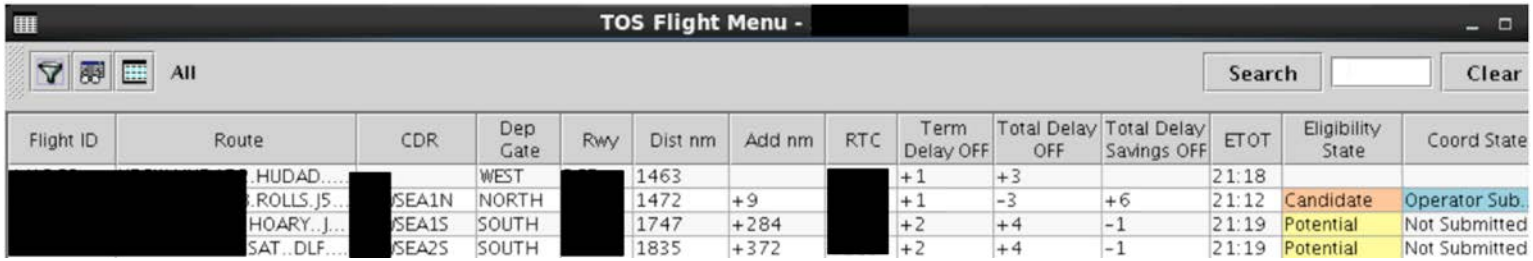
TOS Operation Table & Flight TOS Menu





Stormy 19
Initial Results

Candidate Routes

Since the start of Micro-Phase 3c (8/15 to 8/26)

Candidate State when Flights at OUT vs in Queue

Out \ Queued	Candidate	Potential	Excluded	Total	% Out
Candidate	66	238	5	309	20%
Potential	71	983	6	1,060	70%
Excluded	15	86	49	150	10%
Total	**152**	**1,307**	**60**	**1,519**	100%
% Queued	**10%**	**86%**	**4%**	**100%**	

Note: Candidate flights may be subject to other constraints outside of D10:

- TMIs (EDCT, APREQ)
- AND/OR be already filed to avoid WX
- AND/OR to comply to reroute restrictions

Destinations and TOS Gates for Flights with Candidate routes at OUT

Dest \ Gates	TOS East	TOS North	TOS South	TOS West	Total	% Dest
KLGA	35	16			51	17%
KORD	18	21		1	40	13%
KPHL	8	11			19	6%
KEWR	6	6	1		13	4%
KBOS	8	5			13	4%
KSEA		11			11	4%
KDCA	4	6			10	3%
KMIA			8		8	3%
KJFK	6	2			8	3%
KSNA			4	4	8	3%
KDEN		4		3	7	2%
KMKE	5	2			7	2%
KPIT	4	2			6	2%
KSTL	3	3			6	2%
KPHX			3	2	5	2%
KDTW	4	1			5	2%
KSAN			3	2	5	2%
KLAX			3	2	5	2%
…	…	…	…	…	…	
Total	**117**	**128**	**38**	**26**	**309**	100%
% Gates	**38%**	**41%**	**12%**	**8%**	**100%**	

Submitted Routes

- As of Aug 26th, we logged 54h during 11 days of operational tests from 7/22 to 8/26

- 23 alternative routes for 23 flights were SUBMITTED by Flight Operators
  - 8 times when 10-15 MIT (with and without fix closed)
  - 15 times when no TMI
- 3 routes were then unsubmitted

- 16 alternative routes were APPROVED by ATC
  - 7 times when 10-15 MIT (with or without fix closed)
  - 9 times when no TMI

- 10 reroutes were filed (amended) by ATC

- 8 flights actually flew the alternative routes
  - Total of 49.5min of estimated delay savings (avg 6.1min)
  - 3 times when MITs – total of ***28.5min of estimated delay savings*** (avg 9.5min)
  - 5 times when no TMI – total of ***21.1min of estimated delay savings*** (avg 4.2min)

- 6 procedural tests were conducted without executing any reroute
- 2 flight crew rejected the reroute based on mx and wx issues

Stormy 19 Development And Lessons Learned

Development

- Graphical User Interface: Metroplex Planner
  - Multi-airports system
  - New TOS Table and Demand and Delay Graphics
  - Enhancement of Map with TMI information
  - Enhancement of Timeline information with TOS information

- Data
  - Multi-airport Fuser
  - Ingestion of SWA's EOBT and Gate information
  - Addition of SFDPS data to ingest additional flight plan, in particular CPDLC-DCL information

- Services
  - Creation of TOS Service
    - Handling of CDRs, flights included/excluded, route and RTC distance computation

- Predictive and Scheduler Engine
  - Creation of terminal scheduler
  - Reconciliation between airport surfaces and terminal scheduler

Lessons Learned

- Handling and parsing NTML restrictions
  - Update TMI Service to parse TfmFlow Data from NTML entries
    - Standardization of NTML entries with ZFW partners
      - Fix closures (incl. SWAP) and MIT
    - Handling of cancellations

- Predictive and Scheduler Engine
  - Rules for handling spacing and restrictions at runway and terminal boundary
  - Modification of delay savings computation
  - Exemption of flights that are uncertain to push

- Modification of Route Computation
  - Accounting for flow direction of the airport

- User's Management of Exclusions of flights and TOS routes
  - ATC TMC
    - Global exclusion of TMI flights (EDCT, APREQ, GS)
    - Global exclusions of destinations and CDR
  - Flight Operators
    - Individual exclusion (MX)

Handling TMI From NTML Entries

Terminal Restrictions Handling

- ZFW TMC personnel enters the restriction in NTML
  - ATD-2 system parses the TfmFlow data (SWIM) Looks for restrictions for given requesting and providing facilities
  - ATD-2 system then populates the clients with the restriction information

- When needed, TMC personnel enter or modify the restriction in the NASA ATD-2 client

- Restrictions are an essential input into the schedulers
- Provide Situation Awareness to multiple users

TMI Handled by ATD-2 System

TMI Type	Possible Sources
Runway Utilization	User, Model
APREQs	User, TFM, OIS
Surface Metering Programs	Scheduler
Departure Fix Closures	User, TFM, OIS
Departure Gate Closures	User, TFM, OIS
Ground Delay Programs	TFM
Ground Stops	User, TFM
MITs	User, TFM, OIS
Ramp Closures	User
Runway Closures	User
Scheduled Metering Modes	User
Taxiway Closures	User

Typical Terminal Restrictions

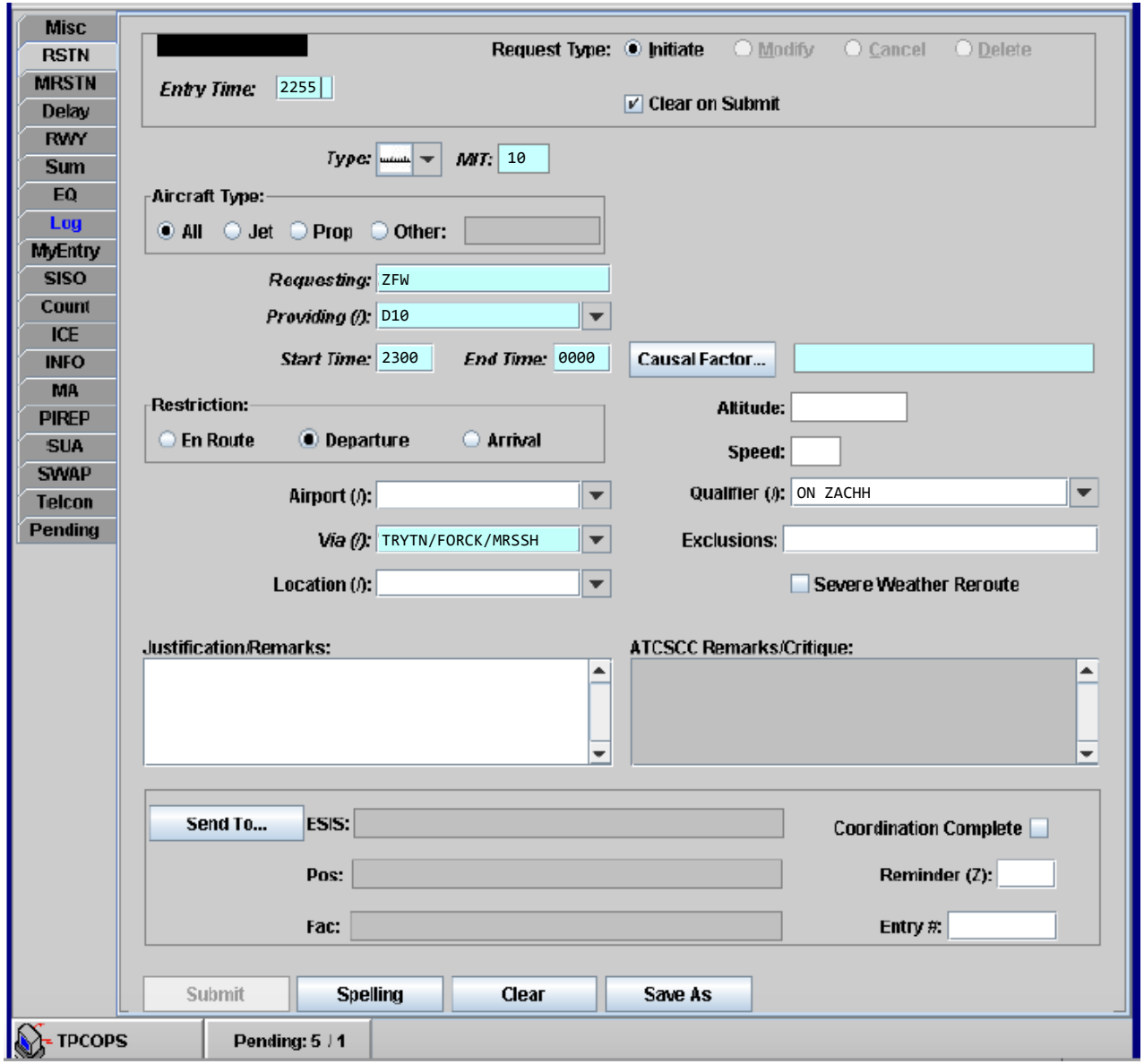
TMI Data Sources

TMI	OIS	TFM Flow	NTML
Airport Information	NO	YES	YES
Airspace Flow Programs	NO	YES	YES
Ground Delay Programs	NO	YES	YES
Ground Stops	NO	YES	YES
Miles/Minutes in Trail	YES	YES	YES
Altitude Restrictions	YES	YES	YES
APREQs	YES	NO	YES
Advisories	NO	YES	YES
Closures (Fixes, etc.)	YES	YES	YES
FADT	NO	YES	NO
RAPT	NO	YES	NO
CTOP	NO	YES	NO
DICE	NO	YES	NO
REROUTEs	NO	YES	NO
TMI FLIGHT LIST	NO	YES	NO

Challenges with Parsing Terminal Restriction in NTML Entries and TFM Data

- Not all NTML restriction entries make to Tfm Flow Data
  - RSTN do
  - SWAP, MISC don't
- Standardization of entries is required to have consistent data parsing
  - Manual entries can be prone to errors
- Requires the use of qualifier and remarks fields to provide additional information
  - Qualifier
    - When fixes are closed they need to be listed under "Via" in NTML client (NasResources in Tfmflow data)
    - While the Alternate/combined fix needs to be indicated in the "Qualifier" field
      - Qualifiers are free text that can be set in an adaptation file
      - Requires syntactic convention to parse correctly (i.e. OTG, SWAP EAST, INNERS ON OUTERS)
  - Remarks have been used to provide inclusion or exclusion information (also requires syntactic convention)

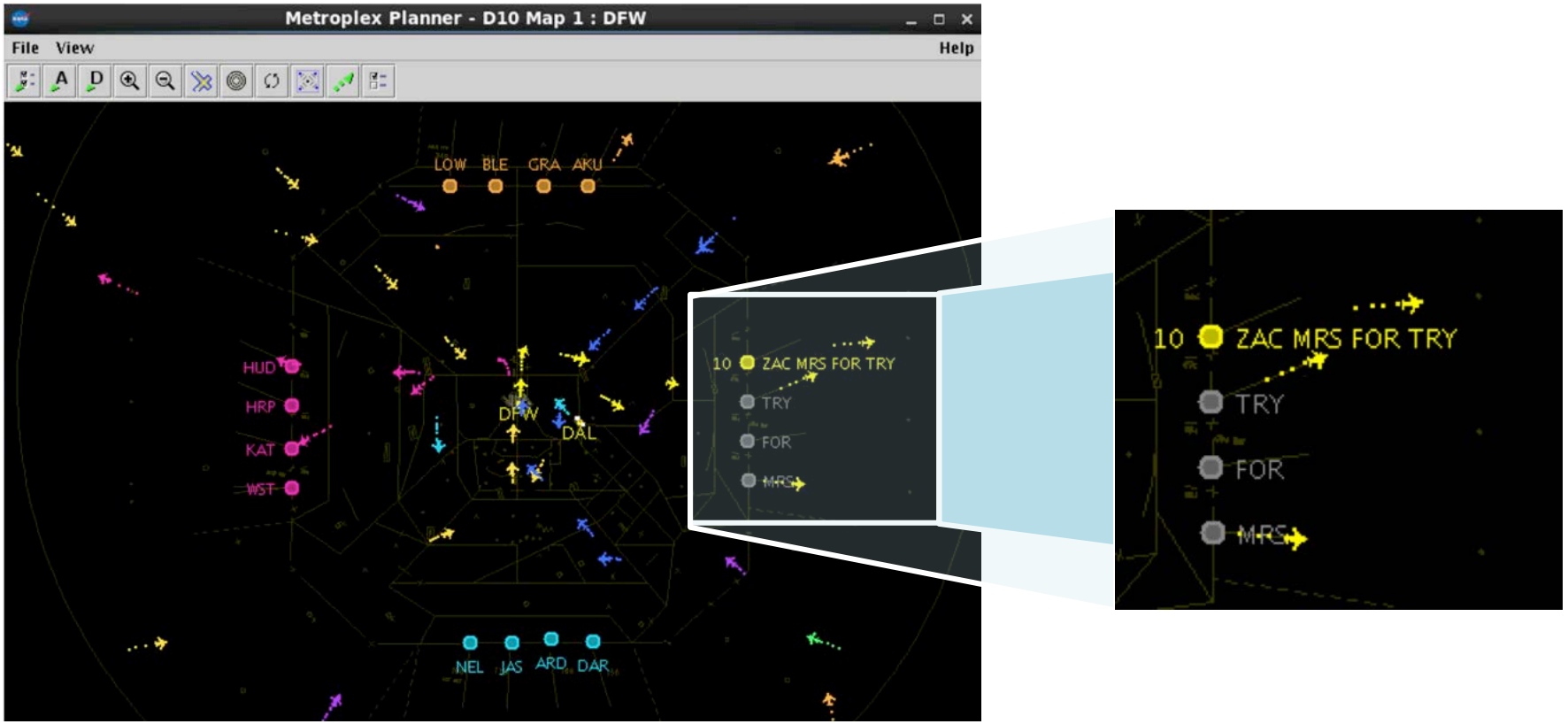
National Traffic Management Log (NTML) Restriction



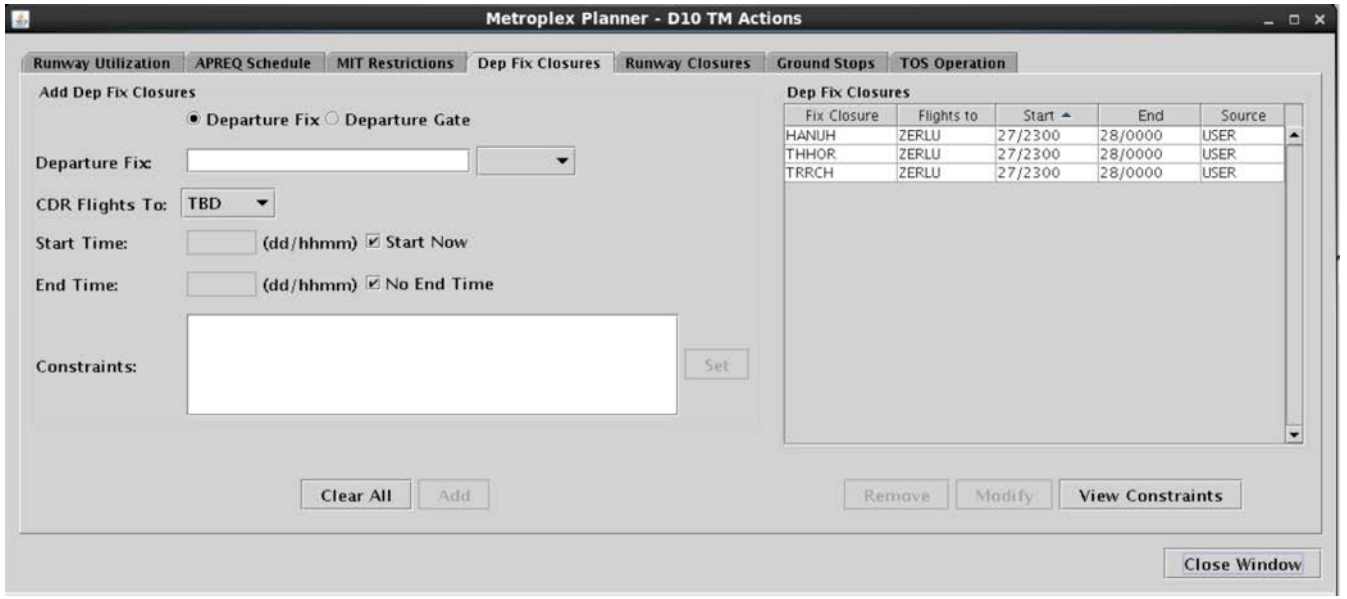
TMIs in the Notification Panel and Map

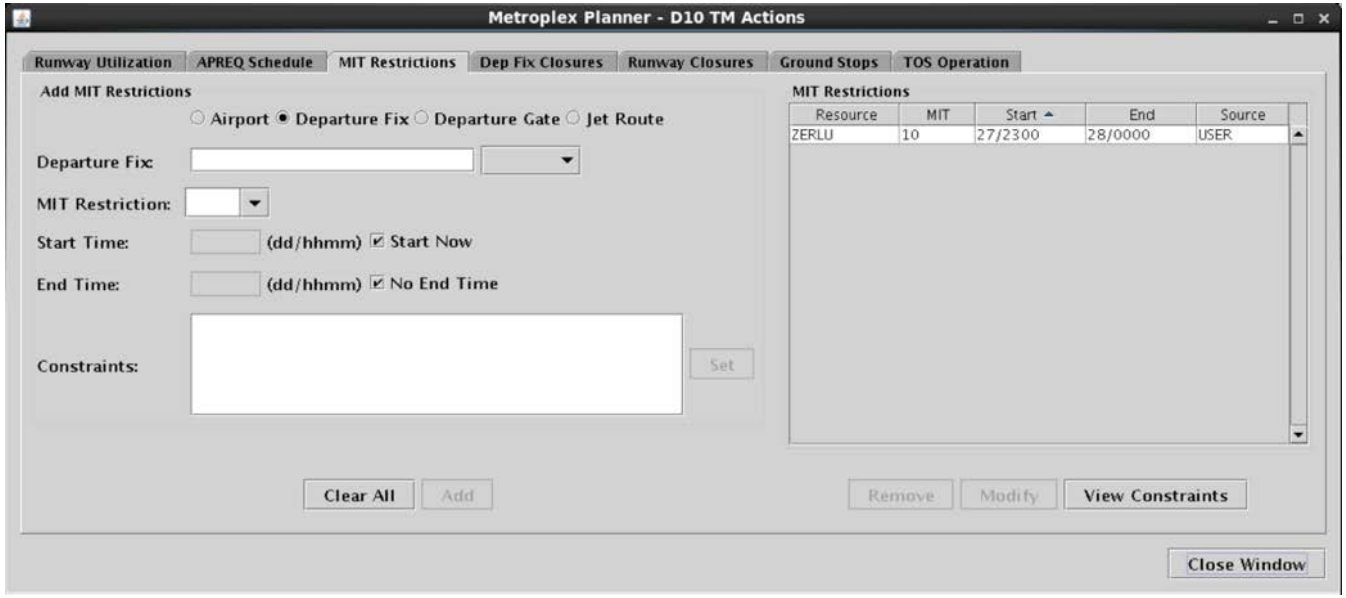
Notifications

Reported	Event Type	Description	Event Start	Event End	Details
8/27/19 2255	Fix	ZERLU 10MIT	8/27/19 2300	8/28/19 0000	
8/27/19 2255	Fix	HANUH CLOSED	8/27/19 2300	8/28/19 0000	TFM / ZFW ON ZERLU
8/27/19 2255	Fix	TRRCH CLOSED	8/27/19 2300	8/28/19 0000	TFM / ZFW ON ZERLU
8/27/19 2255	Fix	THHOR CLOSED	8/27/19 2300	8/28/19 0000	TFM / ZFW ON ZERLU



TMI in the Traffic Management Panel





Modifications to the Scheduler and Delay Savings

Exclude Uncertain flight from the Surface scheduler

Delay Savings Computation with filed route as benchmark

Exclusion of Flights With Uncertain EOBTs

- Surface Scheduler assigns flights in an Uncertain group of flights when the flight passes its EOBT time by pre-determined amount of time.
- What-if scheduler is assessing the ETOT for alternative routes
- The what-if scheduler is agnostic of the surface scheduler handling of the Uncertain flights
- This resulted in TOS route with earlier ETOT than the filed route, and the system falsely detecting candidate routes
- Solution: temporary exclude flights in Uncertain group until AOBT

Computation of Delay and Delay Savings

With Spacing and sequencing at RWY (Surface delay)

With Terminal restriction applied at the runway (Surface + Terminal delay)

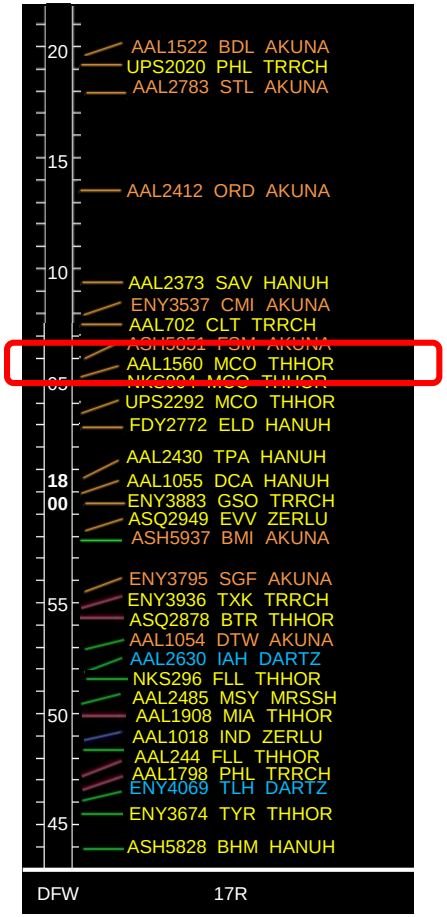
Earlier ETOT for an alternative TOS Route (delay savings)

Delay AAL1560 = 0min

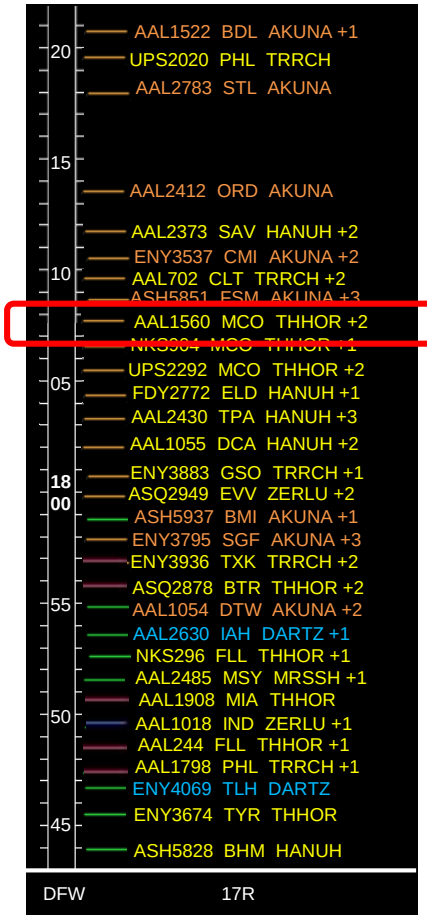
Delay AAL1560 = 2min

Delay AAL1560 = 12min

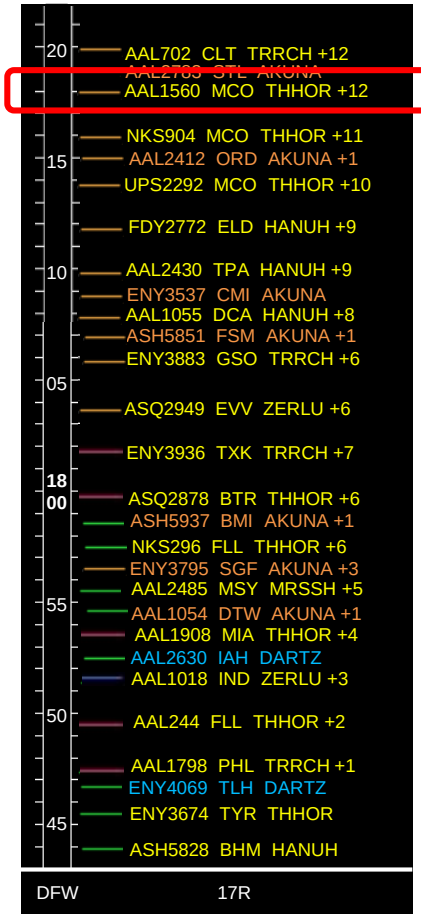
Delay AAL1560 = 0min
Delay Savings = 10min



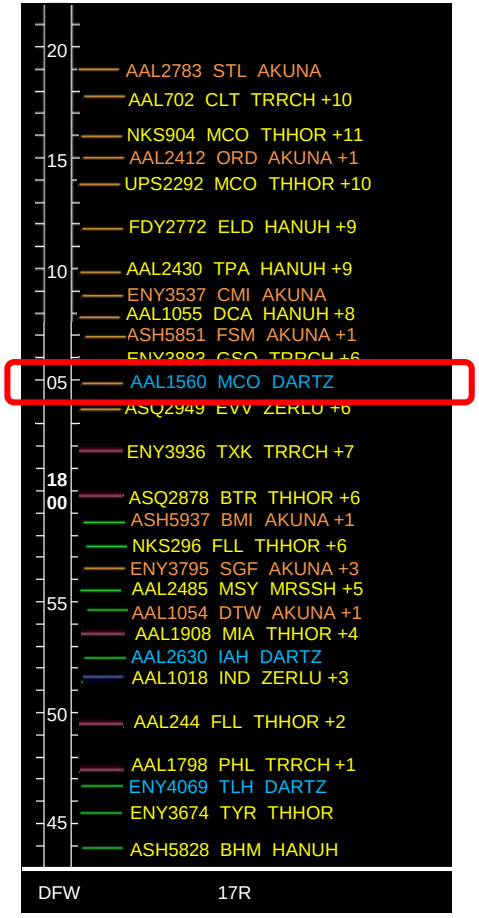
Undelayed TakeOff Times



Target TakeOff Times



Estimated TakeOff Times



TOS Estimated TakeOff Times

Modification of Delay Savings Calculations

- ATD-2 computes delay and delay savings using a delay basis between
  - Delay on filed route = $ETOT_{filed}$ – delay basis
  - Delay on TOS route = $ETOT_{TOS}$ – delay basis
  - Delay savings on TOS route = (delay on filed route) – (delay on TOS route)

- Delay Basis Change
  - From Flight's $UTOT_{TOS}$
  - To Flight's $UTOT_{filed}$

Delay Calculations With UTOT

Route ID	1 (filed)	2	3
Gate	EAST	NORTH	SOUTH
Runway	17R	17R	18L
EOBT	12:30	12:30	12:30
UTOT	12:45	12:45	12:55
ETOT	13:00	12:50	12:55
$Delay_{UTOT}$	15 min	5 min	0 min
$Delay\ Savings_{UTOT}$	-----	10 min	15 min

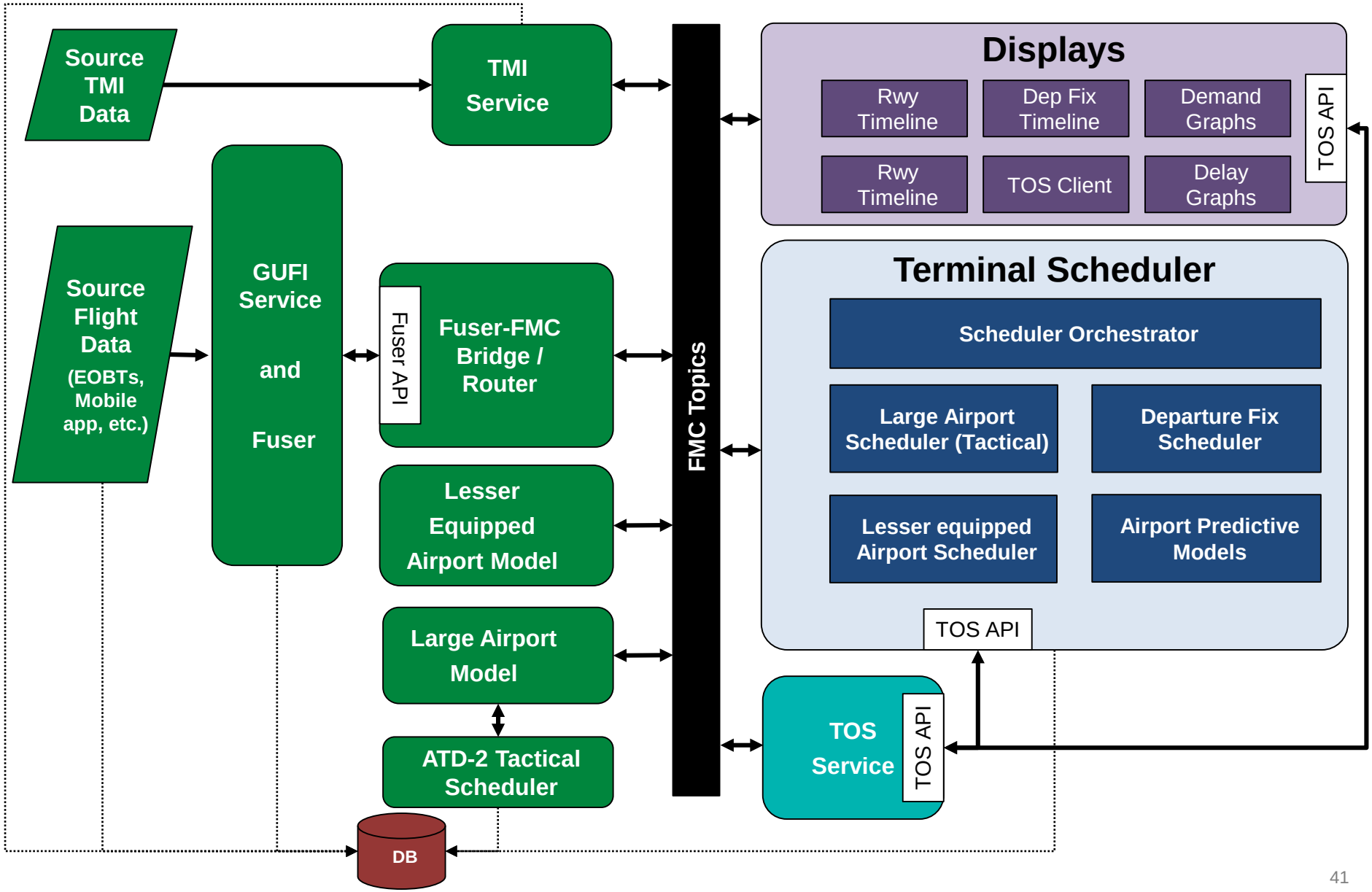
15min of savings?

Delay Calculations with Filed UTOT

Route ID	1 (filed)	2	3
Gate	EAST	NORTH	SOUTH
Runway	17R	17R	18L
EOBT	12:30	12:30	12:30
UTOT	12:45	12:45	12:55
ETOT	13:00	12:50	12:55
$Delay_{UTOT}$	15 min	5 min	0 min
$Delay\ Savings_{UTOT}$	-----	10 min	15 min
$Delay_{filed\ UTOT}$	15 min	5 min	10 min
$Delay\ Savings_{filed\ UTOT}$	-----	10 min	5 min

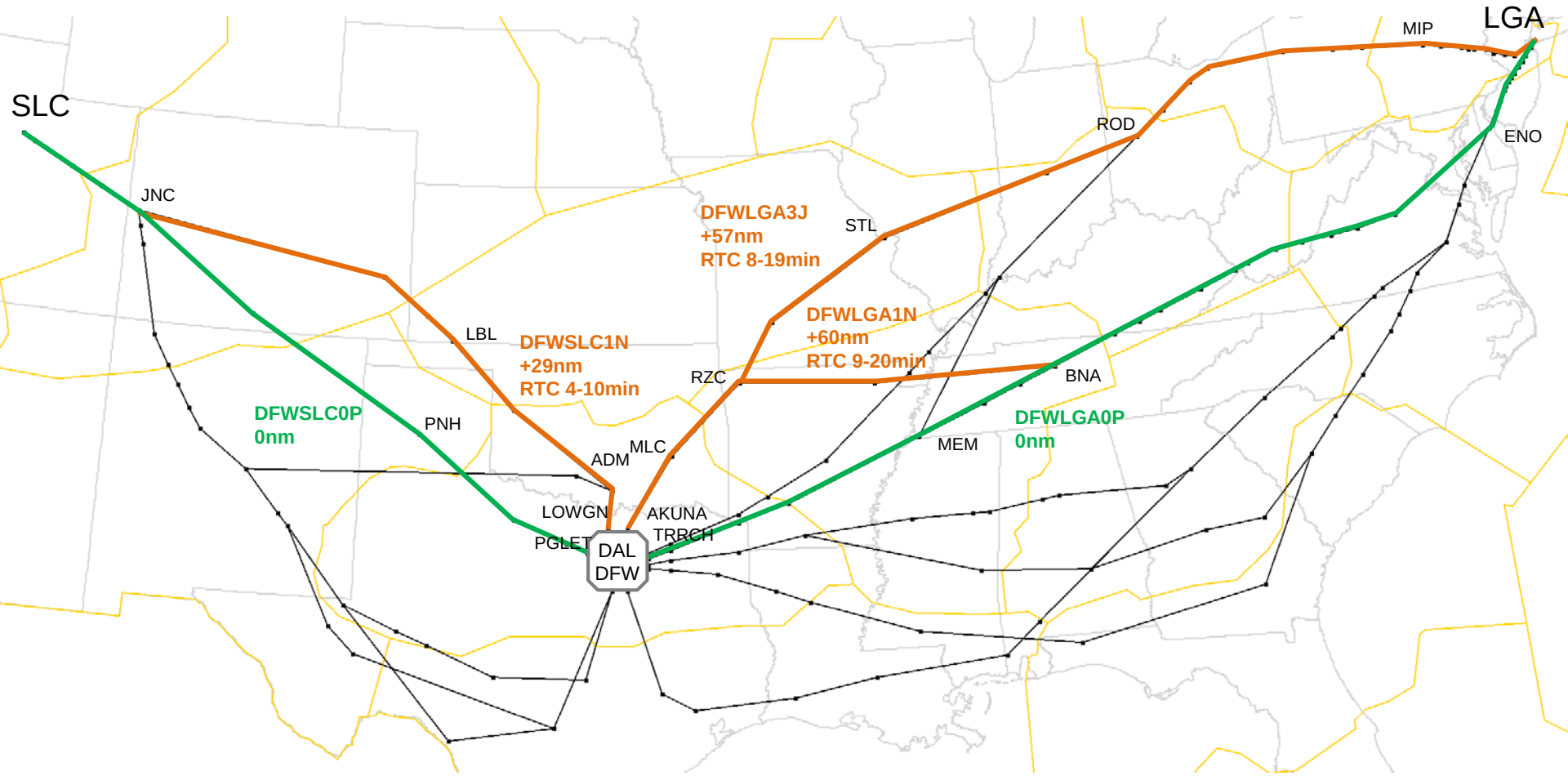
5min of savings?

Terminal Scheduler Software Architecture



Modification to the Route Distance Computation

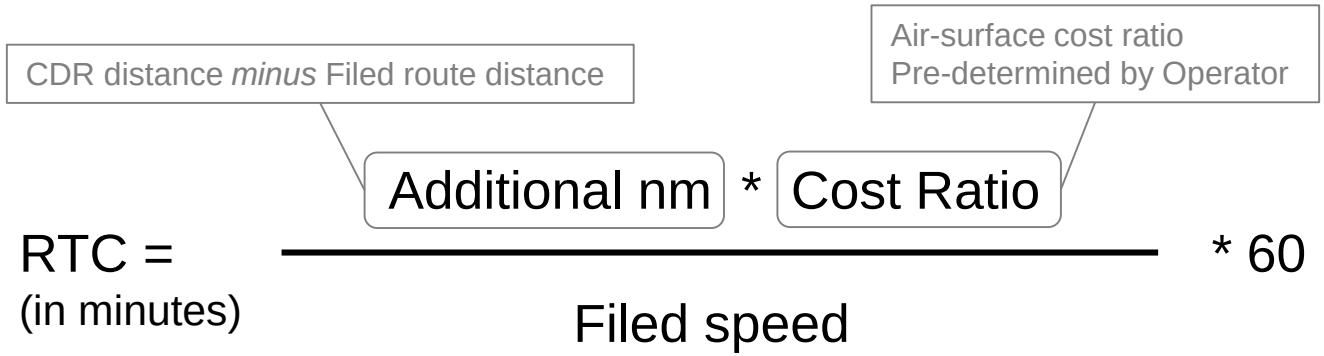
CDRs as TOS alternative routes



Relative Trajectory Cost Computation

- Computed for each operator for their own flights based on agreed upon formula (operator specific)

- Cost (in surface delay minutes) to fly an alternative route, ***relative*** to the filed route



Relative Trajectory Cost

- RTC threshold value is used to determine when an escape route becomes more advantageous to fly than the filed route

  - **RTC is compared to predicted surface delay savings**
  - Surface Delay Savings
    - 20 min surface delay on the filed route via the East Gate
    - 2 min surface delay on the alternative route via the North Gate
    - Delay Savings = 18 min
      = surface delay that the flight will save on the alternative route

  - **When predicted surface delay savings is equal or higher than RTC, Then the escape route becomes a candidate for rerouting the flight**
    - When Delay Savings > RTC = alternative route has lower estimated delay
      - KDEP to KSLC
      - Filed route: 20min surface delay + transit time of 60min = total 80min
      - Alternative route: 2min surface delay + transit time of 64min = total 66min

Route Distance Computation

- Main nm difference between CDRs are driven by the En Route portion of the route

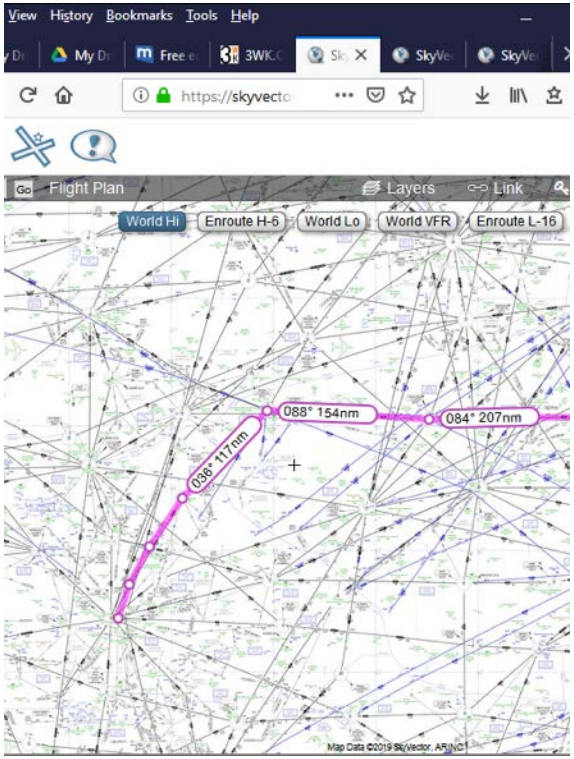
- Initial route computation was from from Center of Airport to Departure Fix
- New route computation accounts for runway utilization at the airport
  - Supports runway balancing strategies

- DFWEWRJ3 (example of reference route)
  - KDFW.AKUNA7.MLC..RZC..STL..VHP..ROD..KLYNE.Q29.DORET.J584.SLT.FQM3.KEWR
  - Default SID : 1,274
  - 18L : 1,304
  - 35L : 1,275

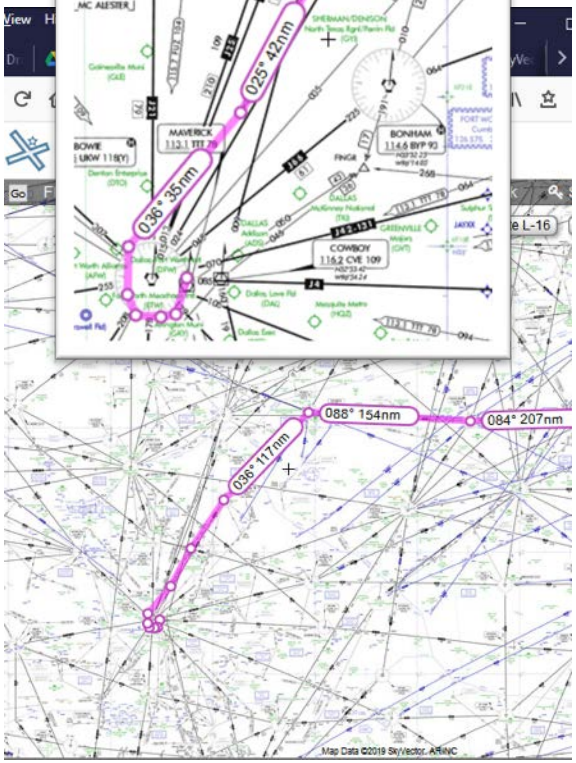
- DFWEWR1N
  - KDFW.AKUNA7.MLC..RZC..ARG..BNA.J42.GVE.PHLBO3.KEWR
  - Default SID : 1,301 | Extra nm = 27 | Minutes longer = 4 (rough approx 7 miles per minute)
  - 18L : 1,331 | Extra nm = 27 | Minutes longer = 4
  - 35L : 1,302 | Extra nm = 27 | Minutes longer = 4

- DFWEWR1S
  - KDFW.DARTZ7.TNV..IAH..LCH.J138.SJI.J37.CATLN.Q22.BEARI..FAK.PHLBO3.KEWR
  - Default SID : 1,509 | Extra nm = 235 | Minutes longer = 34
  - 18L : 1,510 | Extra nm = 206 | Minutes longer = 29
  - 35L : 1,530 | Extra nm = 255 | Minutes longer = 36

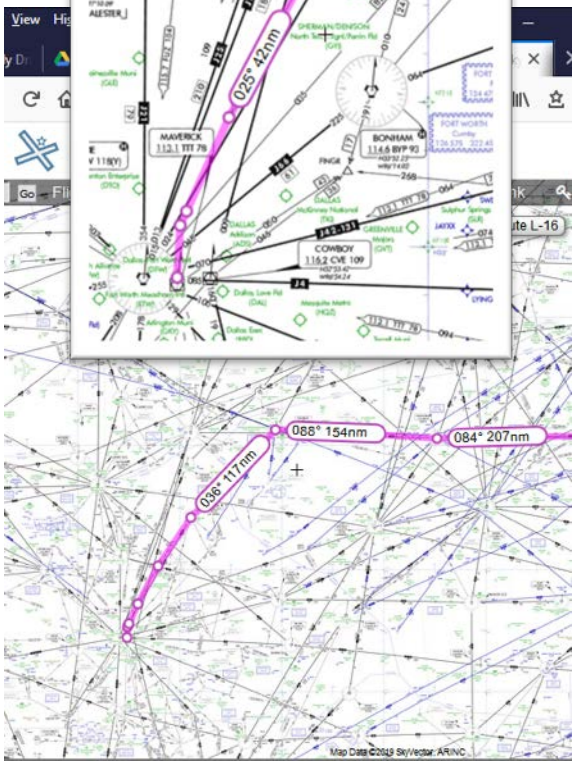
DFWEWR1N via AKUNA



Default

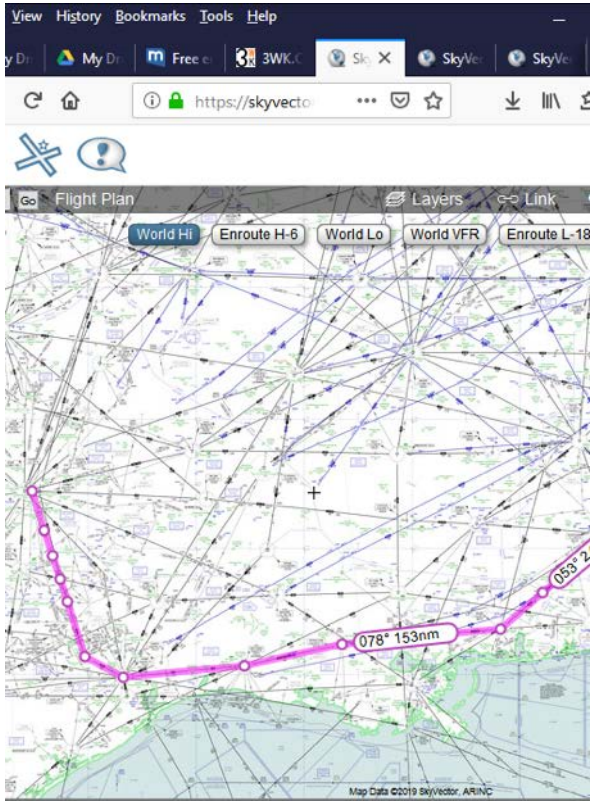


18L



35L

DFWEWR1S via DARTZ



Default

18L

35L

Global Management of Flights and TOS Route Availability

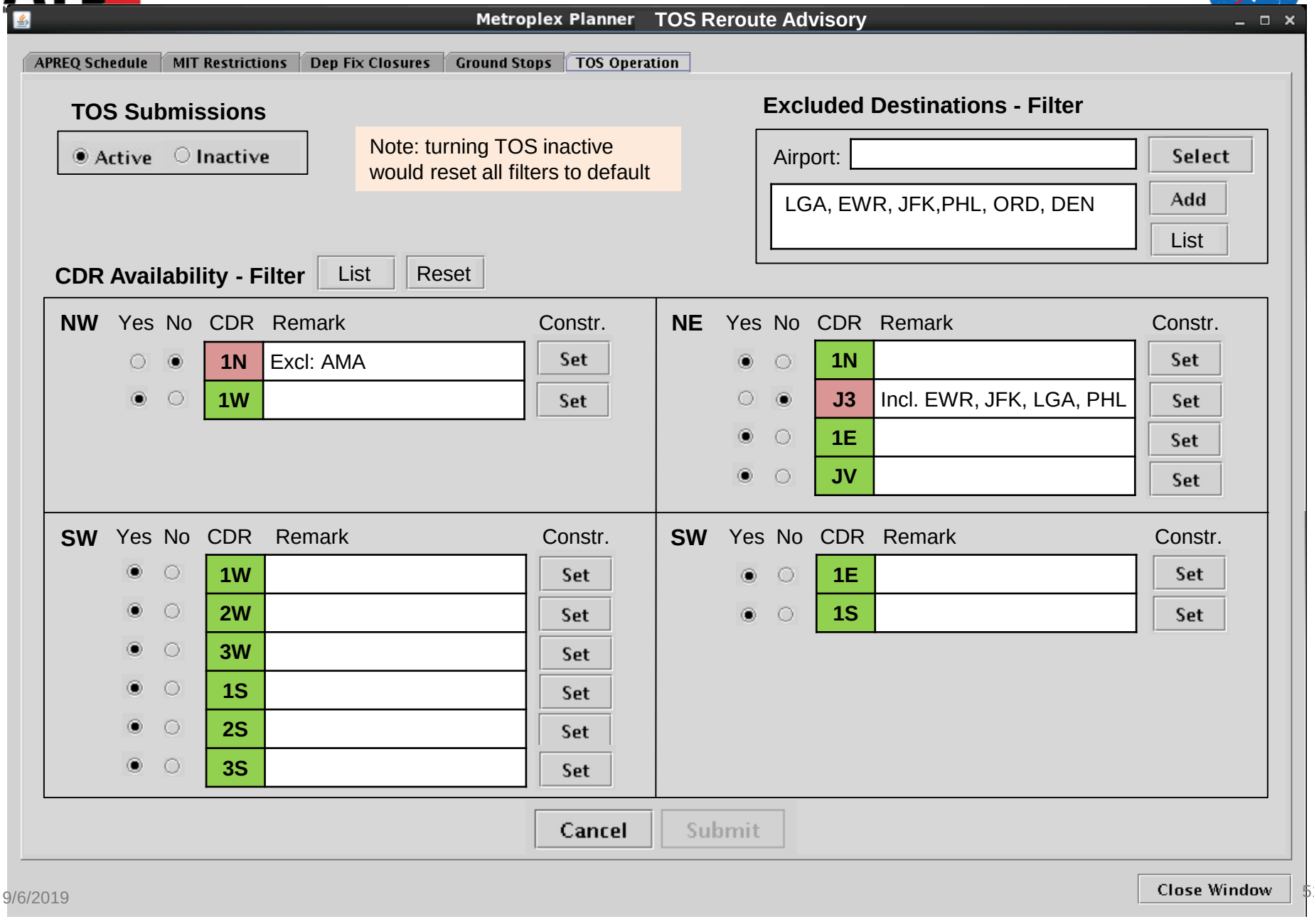
TOS Reroute Advisory

TOS Reroute Advisory

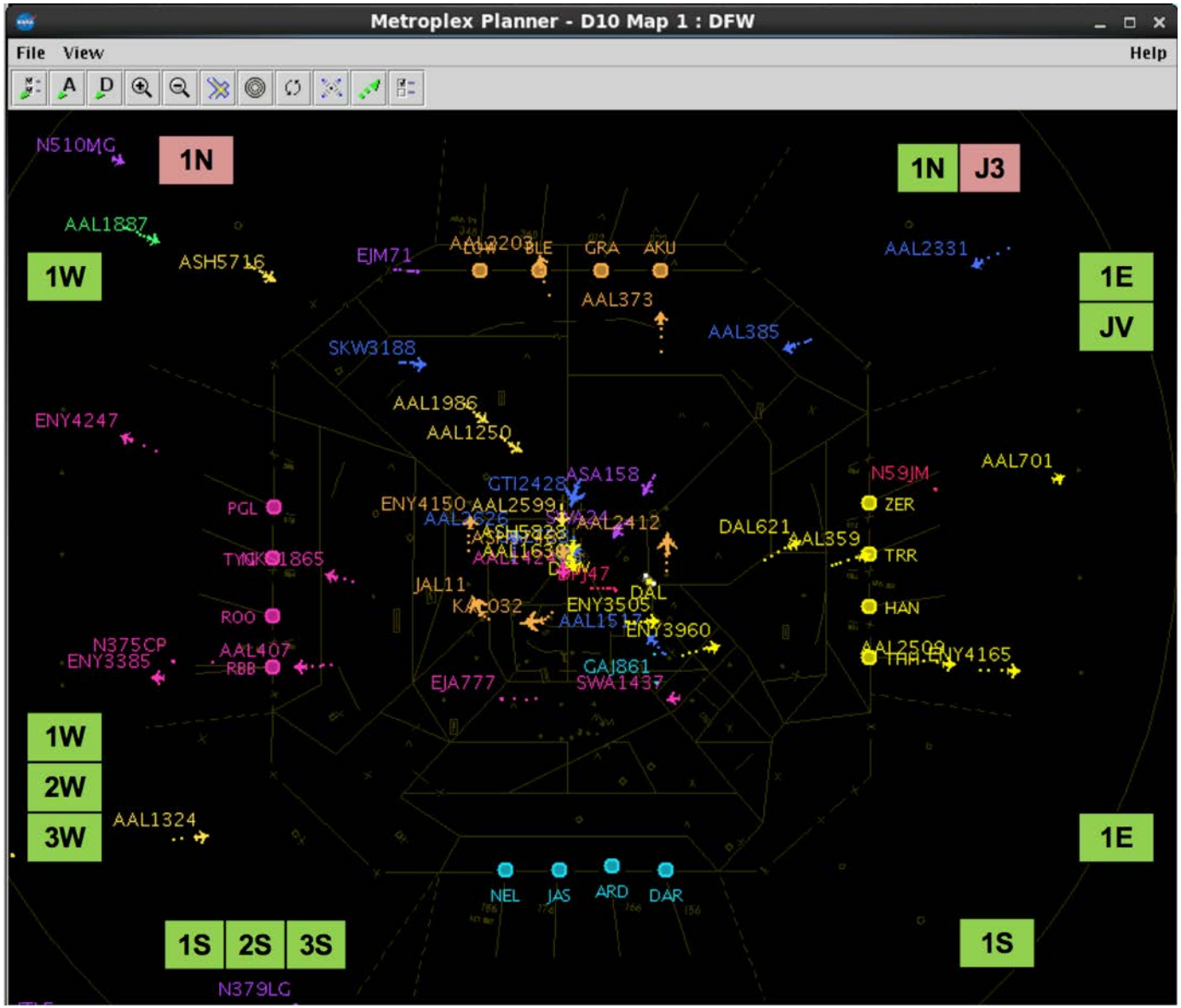
- Provide the Center the ability to communicate and constrain routes and flights that are not eligible for TOS reroute, based on the following Filters:
  - Destinations that that are subject to other TMI restrictions
  - CDR route status
    - Indicate when CDRs are available or not
    - Set inclusions an exclusions for destinations (as needed)

- Provide all users the ability to see
  - Status of TOS Reroute Advisory
  - List of excluded destinations and CDR list in the advisory
  - Show availability of CDRs on the Map

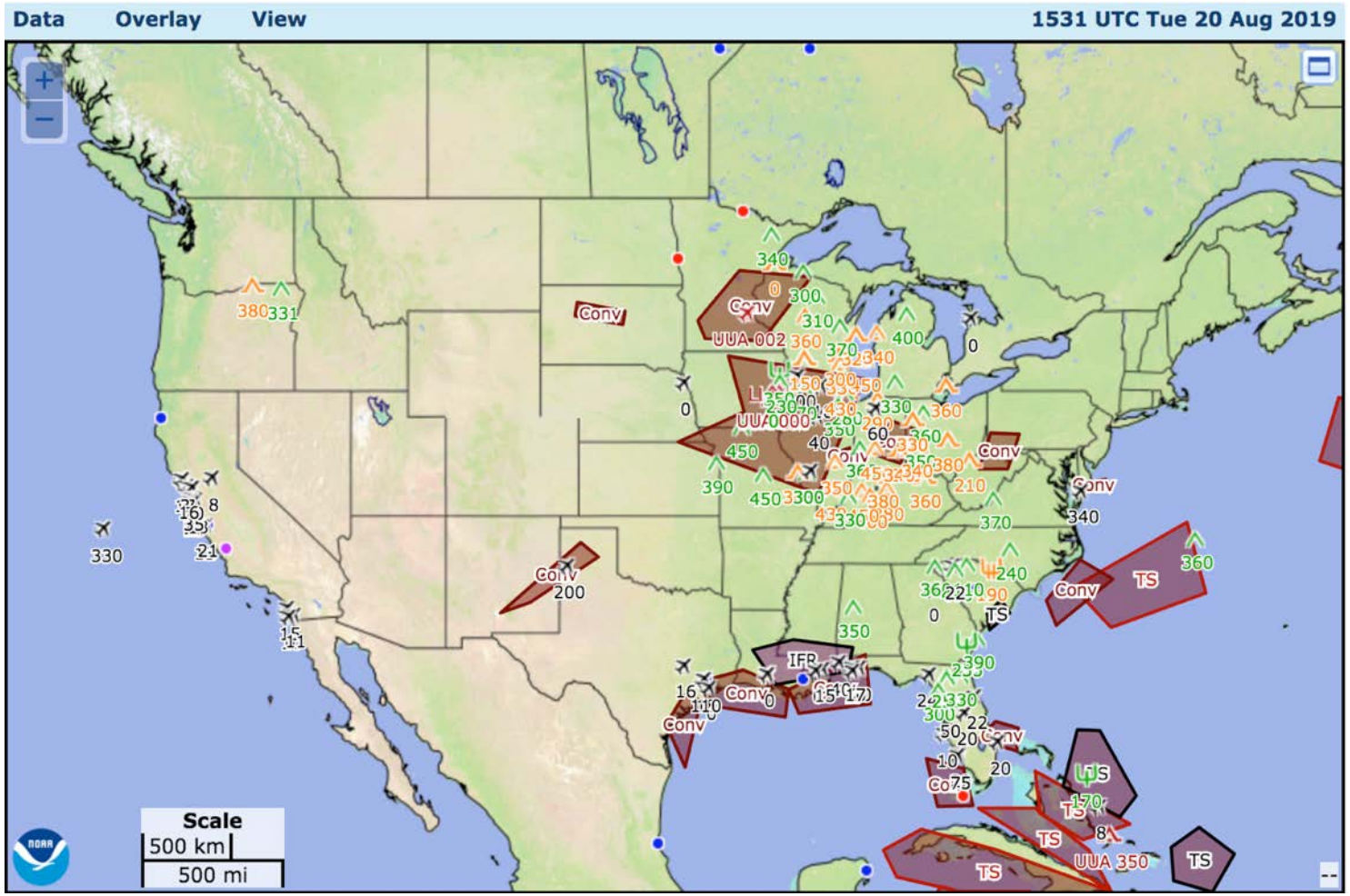
Modification of TOS TM Panel



Restrictions on CDR Displayed on Map (Mock-up)



Example August 20th 2019



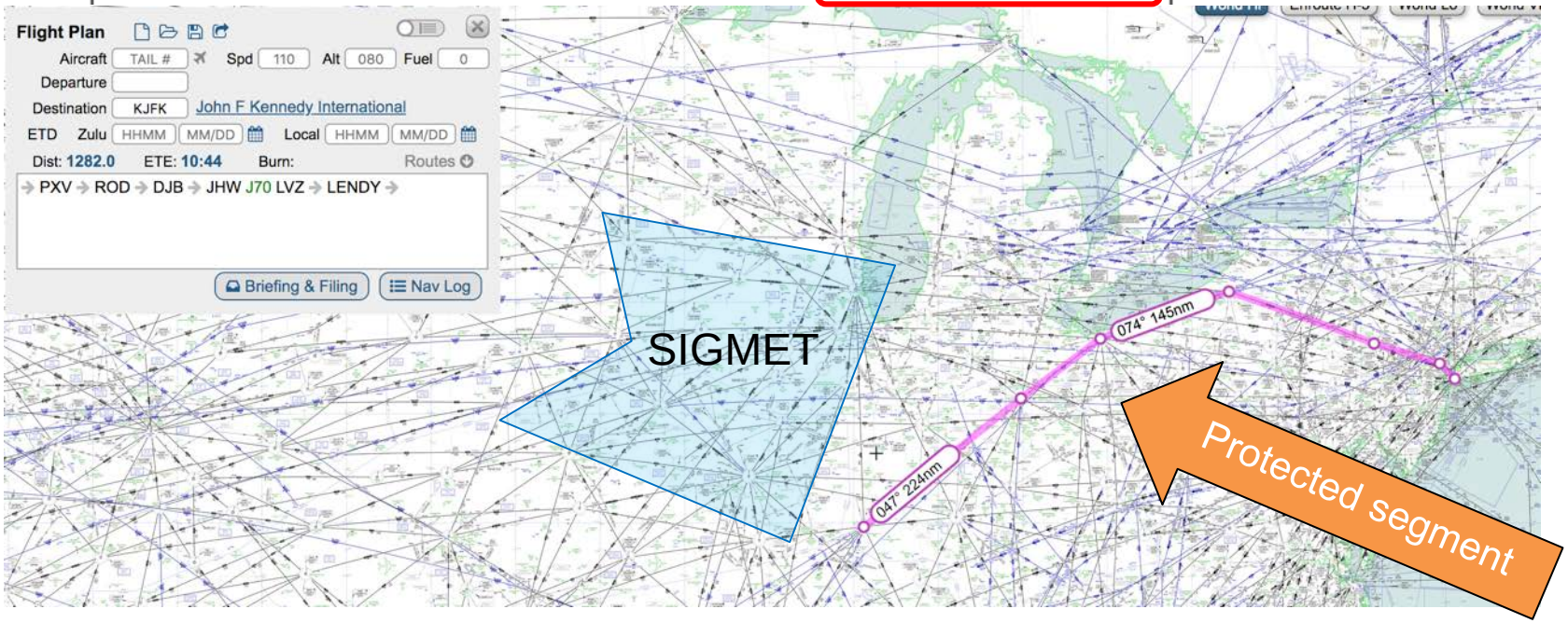
DCC Route Advisory to JFK

ATCSCC Advisory

ATCSCC ADVZY 035 DCC 08/20/2019 FCA RQD

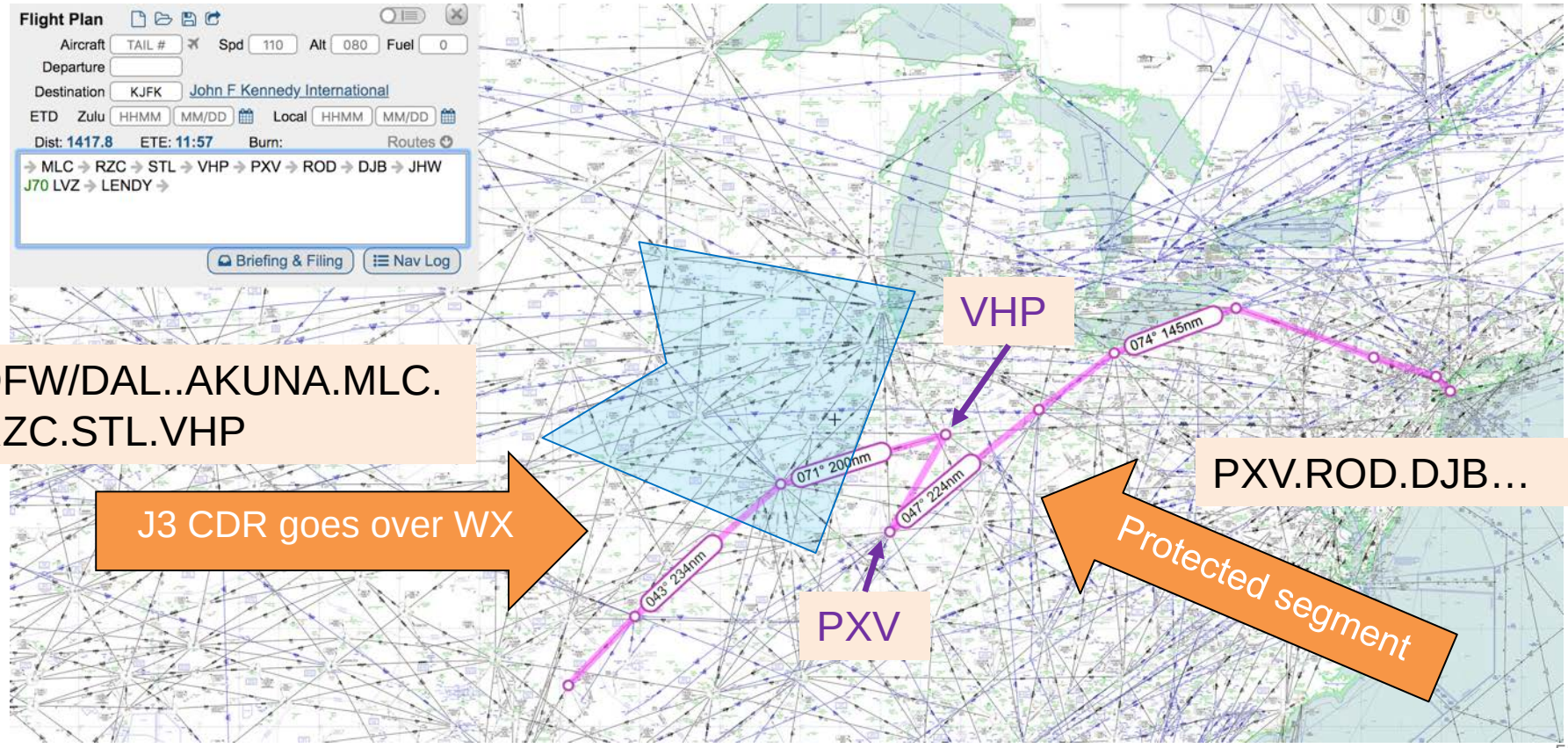
MESSAGE:
NAME: FCAJFK:WIND_ROUTE_JFK_PARTIAL
CONSTRAINED AREA: ZMP ZAU ZID
REASON: WEATHER
INCLUDE TRAFFIC: KMSP/ZKC DEPARTURES TO KJFK
FACILITIES INCLUDED: ZAU/ZID/ZKC/ZMP/ZNY/ZOB
FLIGHT STATUS: ALL_FLIGHTS
VALID: FCA ENTRY TIME FROM 201700 TO 210430
PROBABILITY OF EXTENSION: MODERATE
REMARKS: SEE DYNAMIC LIST FOR UPDATES.
ASSOCIATED RESTRICTIONS:
MODIFICATIONS:
ROUTES:

ORIG	DEST	ROUTE
KMSP	KJFK	>MSP DLL HASTE DAFLU J70 LVZ< LENDY6
ZKC	KJFK	>PXV ROD DJB JHW J70 LVZ< LENDY6



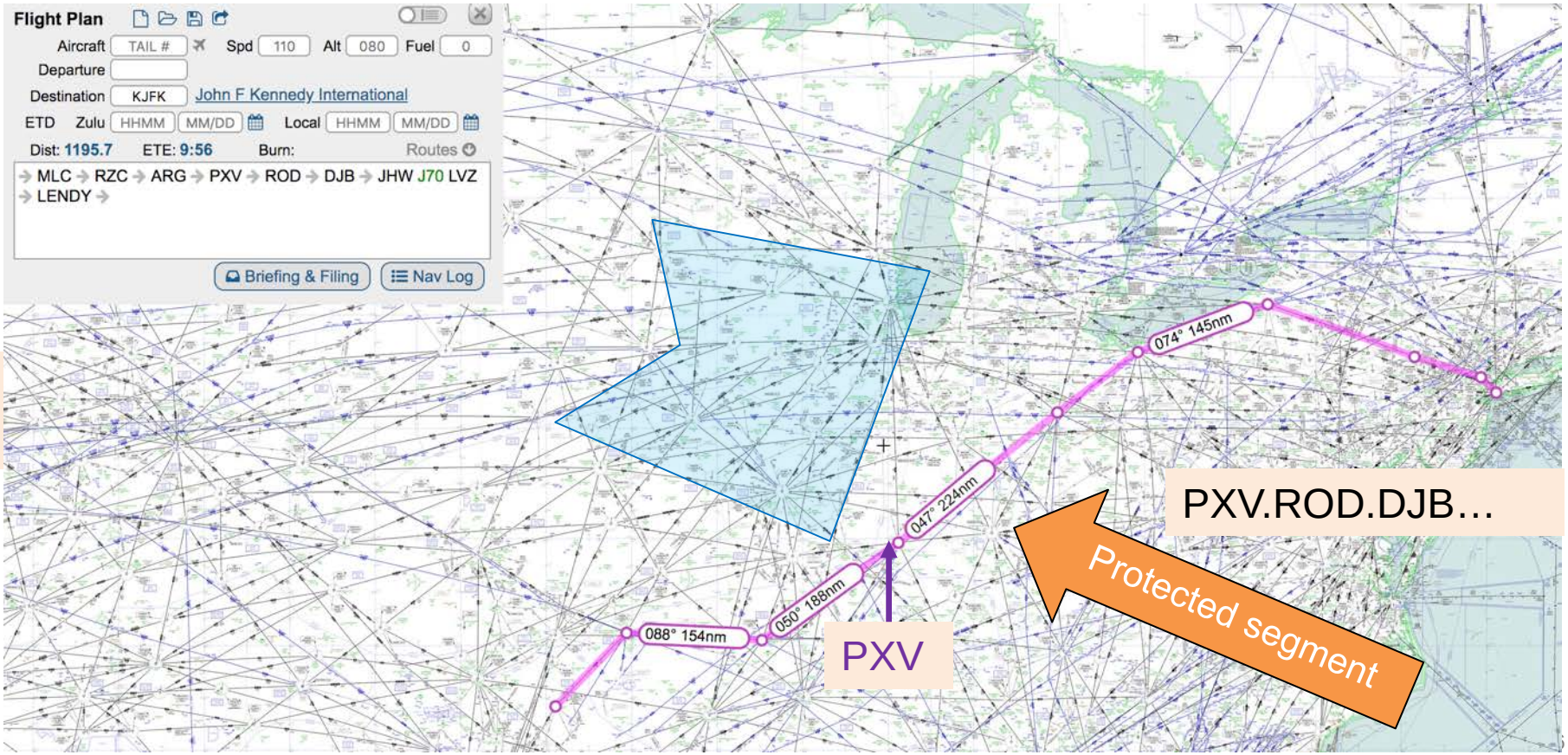
CDR Conflicting with Protected Segment

1	CDR	Orig	Dest	Fix	Procedures
304	DFWJFK0P	KDFW	KJFK	LOOSE	KDFW TRYTN3 LOOSE MEM J42 MOL J24 HCM SAWED J121 SIE CAMRN4 KJFK
305	DFWJFK1N	KDFW	KJFK	MLC	KDFW AKUNA7 MLC ARG BNA J42 MOL J24 HCM SAWED J121 SIE CAMRN4 KJFK
306	DFWJFK1S	KDFW	KJFK	TNV	KDFW DARTZ7 TNV IAH LCH J138 SJI J37 CATLN Q64 TYI ORF J121 SIE CAMRN4 KJFK
307	DFWJFKJ3	KDFW	KJFK	MLC	KDFW AKUNA7 MLC RZC STL VHP ROD KLYNE Q29 JHW J70 LVZ LENDY6 KJFK
308	DFWJFKLT	KDFW	KJFK	BSKAT	KDFW ZACHH3 BSKAT LIT J131 PXV ROD KLYNE Q29 JHW J70 LVZ LENDY6 KJFK
309	DFWJFKM3	KDFW	KJFK	FORCK	KDFW FORCK2 FORCK ELD MEI J4 MGM J40 TWINS PANDY BARTL J121 SIE CAMRN4 KJFK
310	DFWJFKRD	KDFW	KJFK	LOOSE	KDFW TRYTN3 LOOSE MEM Q29 JHW J70 LVZ LENDY6 KJFK
311	DFWJFKVS	KDFW	KJFK	TNV	KDFW DARTZ7 TNV J87 IAH J2 LCH J138 SJI J37 CATLN Q64 TYI ORF J121 SIE CAMRN4 KJFK
312	DFWJFKWC	KDFW	KJFK	ZALEA	KDFW MRSSH2 ZALEA SWB MCB CEW JEFOI TEEEM Q109 PANDY BARTL J121 SIE CAMRN4 KJFK
313	DFWJFKWM	KDFW	KJFK	FORCK	KDFW FORCK2 FORCK ELD MEI J4 MGM FIGEY Q64 TYI ORF J121 SIE CAMRN4 KJFK
314	DFWJFKWV	KDFW	KJFK	FORCK	KDFW FORCK2 FORCK ELD SQS J52 VUZ J14 ATL FIGEY Q64 TYI ORF J121 SIE CAMRN4 KJFK



Modified CDR to Match Protected Segment

1	CDR	Orig	Dest	Fix	Procedures
304	DFWJFK0P	KDFW	KJFK	LOOSE	KDFW TRYTN3 LOOSE MEM J42 MOL J24 HCM SAWED J121 SIE CAMRN4 KJFK
305	DFWJFK1N	KDFW	KJFK	MLC	KDFW AKUNA7 MLC ARG BNA J42 MOL J24 HCM SAWED J121 SIE CAMRN4 KJFK
306	DFWJFK1S	KDFW	KJFK	TNV	KDFW DARTZ7 TNV IAH LCH J138 SJI J37 CATLN Q64 TYI ORF J121 SIE CAMRN4 KJFK
307	DFWJFKJ3	KDFW	KJFK	MLC	KDFW AKUNA7 MLC RZC STL VHP ROD KLYNE Q29 JHW J70 LVZ LENDY6 KJFK
308	DFWJFKLT	KDFW	KJFK	BSKAT	KDFW ZACHH3 BSKAT LIT J131 PXV ROD KLYNE Q29 JHW J70 LVZ LENDY6 KJFK
309	DFWJFKM3	KDFW	KJFK	FORCK	KDFW FORCK2 FORCK ELD MEI J4 MGM J40 TWINS PANDY BARTL J121 SIE CAMRN4 KJFK
310	DFWJFKRD	KDFW	KJFK	LOOSE	KDFW TRYTN3 LOOSE MEM Q29 JHW J70 LVZ LENDY6 KJFK
311	DFWJFKVS	KDFW	KJFK	TNV	KDFW DARTZ7 TNV J87 IAH J2 LCH J138 SJI J37 CATLN Q64 TYI ORF J121 SIE CAMRN4 KJFK
312	DFWJFKWC	KDFW	KJFK	ZALEA	KDFW MRSSH2 ZALEA SWB MCB CEW JEFOI TEEEM Q109 PANDY BARTL J121 SIE CAMRN4 KJFK
313	DFWJFKWM	KDFW	KJFK	FORCK	KDFW FORCK2 FORCK ELD MEI J4 MGM FIGEY Q64 TYI ORF J121 SIE CAMRN4 KJFK
314	DFWJFKWV	KDFW	KJFK	FORCK	KDFW FORCK2 FORCK ELD SQS J52 VUZ J14 ATL FIGEY Q64 TYI ORF J121 SIE CAMRN4 KJFK



DCC Playbook Advisory to DCA

Full or Partial Playbook route restrictions

ATCSCC Advisory

ATCSCC ADVZY 042 DCC 08/20/2019 ROUTE RQD /FL

RAW TEXT:

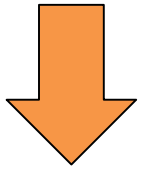
```
NAME: VUZ_PARTIAL
CONSTRAINED AREA: ZAU ZMP ZID ZKC
REASON: WEATHER
INCLUDE TRAFFIC: KBUR/KLAS/KLAX/KLGB/KONT/KSAN/KSNA/ZAB/ZFW/ZHU/ZME
                 DEPARTURES TO KBWI/KDCA/KIAD/KPHL
FACILITIES INCLUDED: ZAB/ZDC/ZFW/ZHU/ZLA/ZME/ZNY/ZTL
FLIGHT STATUS: ALL_FLIGHTS
VALID: ETD 201400 TO 201900
PROBABILITY OF EXTENSION: MODERATE
REMARKS: REPLACES ADVZY 37
ASSOCIATED RESTRICTIONS:
MODIFICATIONS: ROUTE SHOULD INCLUDE DC METS + PHL FOR DEST.
ROUTES:

FROM:
ORIG                                ROUTE - ORIGIN SEGMENTS
----                                ----------------------
KLAS                                >INW J86 ELP J50 ABI J4 FUZ UIM
                                    ELD SQS VUZ
KLAX KBUR KSNA KLGB KONT            >BLH J169 TFD J50 SSO J4 EWM
                                    J66 ABI J4 FUZ UIM ELD SQS VUZ
KSAN                                >IPL J2 GBN J50 SSO J4 EWM J66
                                    ABI J4 FUZ UIM ELD SQS VUZ
ZAB                                 >EWM J66 ABI J4 FUZ UIM ELD SQS
                                    VUZ
ZFW                                 >ELD SQS J52 VUZ
ZFW                                 >TNV J87 IAH J2 LCH J138 SJI
ZHU                                 >SJI
ZME(-BNA)                           >VUZ


TO:
DEST                                ROUTE - DESTINATION SEGMENTS
----                                ---------------------------
KBWI                                VUZ ATL KBLER Q56 KELLN Q58
                                    PEETT THHMP< RAVNN6
KBWI                                SJI J37 CATLN Q56 KELLN Q58
                                    PEETT THHMP< RAVNN6
KDCA                                VUZ ATL KBLER Q56 KIWII WAVES<
                                    CAPSS3
KDCA                                JI J37 CATLN Q56 KIWII WAVES<
                                    CAPSS3
```

Playbook Route Matching Portions of CDR

Origin Route



Restricted route

```
ZFW                                   >ELD SQS J52 VUZ
ZFW                                   >TNV J87 IAH J2 LCH J138 SJI
ZHU                                   >SJI
ZME(-BNA)                             >VUZ


TO:
DEST                                  ROUTE - DESTINATION SEGMENTS
----                                  ----------------------------
KBWI                                  VUZ ATL KBLER Q56 KELLN Q58
                                      PEETT THHMP< RAVNN6
KBWI                                  SJI J37 CATLN Q56 KELLN Q58
                                      PEETT THHMP< RAVNN6
KDCA                                  VUZ ATL KBLER Q56 KIWII WAVES<
                                      CAPSS3
```

CDR	Origin	Dest	Fix	Procedures
DALDCA0P	KDAL	KDCA	LOOSE	KDAL LNDRE4 LOOSE MEM J42 BKW TRUPS4 KDCA
DALDCALT	KDAL	KDCA	BSKAT	KDAL LNDRE4 BSKAT LIT J131 PXV ROD APE J30 BUCKO FRDMM4 KDCA
DALDCAM3	KDAL	KDCA	FORCK	KDAL LNDRE4 FORCK ELD MEI J4 MGM J40 TWINS BLAAN Q99 POLYY TUBAS J52 RDU FUUFF WAVES CAPSS3 KDCA
DALDCARD	KDAL	KDCA	LOOSE	KDAL LNDRE4 LOOSE MEM Q29 CREEP OTMAN J30 BUCKO FRDMM4 KDCA
DALDCAVS	KDAL	KDCA	TNV	KDAL CURLO4 TNV J87 IAH J2 LCH J138 SJI J37 CATLN Q56 KIWII WAVES CAPSS3 KDCA
DALDCAWB	KDAL	KDCA	LOOSE	KDAL LNDRE4 LOOSE MEM J42 BNA J42 BKW TRUPS4 KDCA
DALDCAWC	KDAL	KDCA	ZALEA	KDAL LNDRE4 ZALEA SWB MCB CEW JEFOI TEEEM Q99 POLYY TUBAS J52 RDU FUUFF WAVES CAPSS3 KDCA
DALDCAWM	KDAL	KDCA	FORCK	KDAL LNDRE4 FORCK ELD MEI J4 MGM KBLER Q56 KIWII WAVES CAPSS3 KDCA
DALDCAWV	KDAL	KDCA	FORCK	KDAL LNDRE4 FORCK ELD SQS J52 VUZ ATL KBLER Q56 KIWII WAVES CAPSS3 KDCA

This advisory matches the CDR DALDCAWV

Phase 3 Stormy 20 Objectives

Crawl – Walk – Run

- Stormy 19 (Exploratory Research)
  - Identify Requirements through Shadow Sessions
  - Develop an initial capability in an *agile* manner
  - Incremental built of capability (3 micro-phases)
  - Test and use incrementally in operational environment
  - Collect data, observation, feedback
  - Identify monetizable benefits
  - Mature capability
  - Identify goals for Stormy 20

- Stormy 20 (Formal Evaluation)
  - Implement lessons Learn from Summer 19
  - Identify technology transfer deliverables
  - Develop larger capability leveraging SWIM components
  - Test and Collect data
  - Measure benefits

Stay Tuned for More…

Thank You

Questions or comments, please contact:

Field Demo Lead - Greg Juro - greg.juro@cavansolutions.com

Research Lead - Eric Chevalley - eric.chevalley@nasa.gov