4th TBO Industry Day

Sep 7. 2022

Reminders

TBO website:
https://www.faa.gov/air_traffic/technology/tbo/

- Please mute your microphones

- There are multiple ways to ask a question:
  - Submit your questions via email 9-AJT-TBO@faa.gov
  - Submit your questions via chat
  - Raise your hand to alert the moderator

Agenda

8 AM	**Doors open for in-person attendees**
8:30 AM	**Doors open for virtual attendees** *(TBO: Right Tool, Right Place, Right Time video will play at 8:45am and will broadcast again during the break)*
9 AM	**Executive Welcome** *Jeffrey Vincent (AJT), Alyce Hood-Fleming (AJR), Mark DeNicuolo (AJM), Michele Merkle (AJV), and Dan Hamilton (NATCA)*
9:30 AM	**Opening Remarks,** *Wendy O'Connor (AJT) and Lakisha Price (AJR)*
9:45 AM	**TBO Deployment Status Update** *Aaron Wilkins (AJM) and Dan Hamilton (NATCA)*
10 AM	**TBO Integration Status Update** *Patrick Blaser (AJT) and Phil Hargarten (NATCA)*
10:15 AM	**TBO Opportunities to Improve Performance in the NAS** *Almira Ramadani (AJT), Curt Rademaker (AJR), and Dave Knorr (ANG)*
11 AM	*Break*
11:15 AM	**Measuring Progress: TBO Analytics Demo** *Almira Ramadani (AJT), Brandon Smith (TBFM Ops Team/NATCA), Dave Raymond (AJR), and Curt Rademaker (AJR)*
12 PM	**Airspace Modernization Roadmap Update** *Jim Arrighi (AJV)*
12:30 PM	**Q&A and Wrap Up**

******Note: The facility will remain open for attendees until 3:00pm**

Opening Remarks

Jeffrey Vincent, *Air Traffic Services*

Alyce Hood-Fleming, *System Operations Services*

Mark DeNicuolo, *Program Management Organization*

Michele Merkle, *Mission Support Services*

Dan Hamilton, *NATCA*

Opening Remarks

Wendy O'Connor
Air Traffic Services

Lakisha Price
System Operations Services

TBO Deployment Status Update

Aaron Wilkins, *Program Management Organization*

Dan Hamilton, *National Air Traffic Controllers Association*

Program Management Office Focus

Infrastructure	Integrated Arrivals	Integrated Departures	Advanced Trajectory Management
✓ ERAM ✓ TAMR ✓ SWIM ✓ AIMM ✓ Data Comm ✓ TBFM ✓ TFMS O TFDM	**TBFM** ✓ Arrival metering ✓ Extended metering ~~o Terminal metering~~	**TBFM Automation** ✓ Time based departure management **TFMS** ✓ Pre-departure reroutes o Surface Viewer **TFDM** o Automated surface management including surface metering **Data Comm** ✓ Tower Services	**TFMS** ✓ Route Availability Planning ✓ Airborne Reroutes **Data Comm** ✓ Initial En Route Services o Full En Route Services

o = In Development

✓= Operationally Available in at least one location

All implementation dates subject to change due to budget, sustainment needs, workforce training, and other constraints

iTBO Implementation Going Forward

Despite challenges … we are still moving forward

- Budget constraints will moderate the pace of implementation
- Prioritization of activities is data-driven with input from facilities and industry
- More agile and targeted deployments

- **Data Comm En Route Services**
- **TFDM Deployment**
  - Build 1 CLE IOC: October 2022
  - Build 2 CLT IOC: March 2024
- **TBFM Expansion**
  - Extended Metering Designs: LAX & LAS
  - IDAC Implementation: South Florida (MIA, FLL, TPA, RSW, PBI, FXE)

Lessons Learned

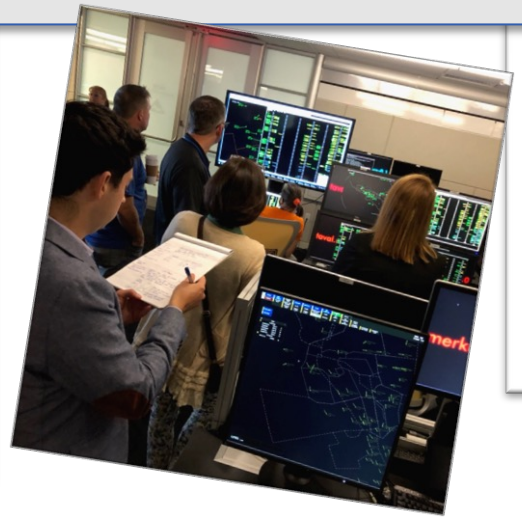
- What's different? What's the same?
- Innovation
  - Remote testing
  - Virtual training
  - Virtual site surveys

- Operationalizing TBO
- Transparency with Industry
- Risk Mitigation

Interoperability Assessments

Primary Goals of Interoperability Evaluation

- A critical component of the FAA's Risk Management and Mitigation processes
- An opportunity to verify key assumptions and change expectations
- A time to engage, inform, and collaborate on iTBO with the specific facilities and operational personnel targeted to undergo change



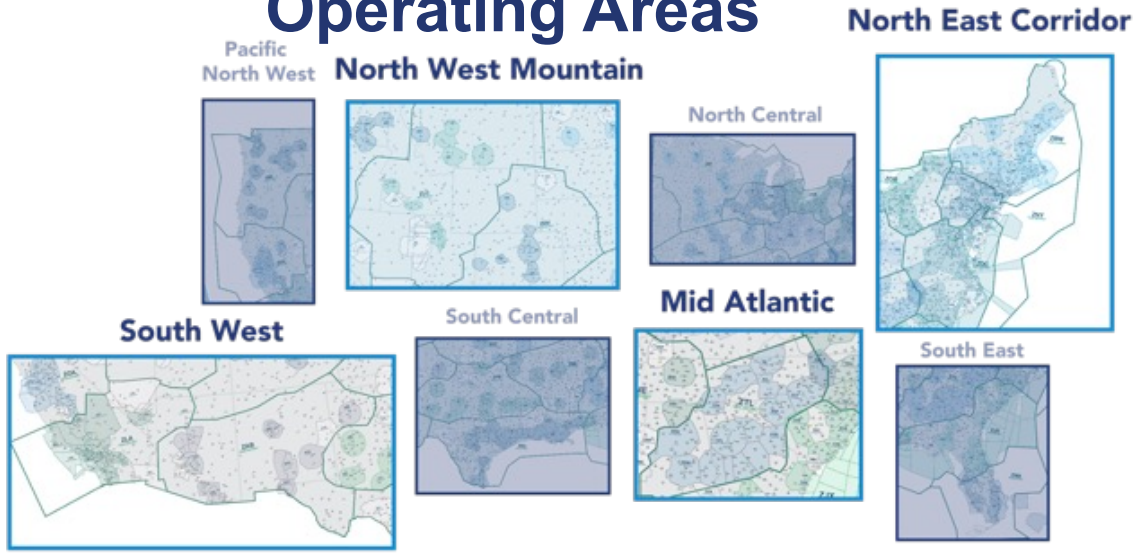
TBO Integration Status Update

Patrick Blaser, *Air Traffic Services*

Phil Hargarten, *National Air Traffic Controllers Association*

Key iTBO Implementation Milestones

Operating Areas



Northwest Mountain
- ✓ DEN Metroplex
- ✓ XM for DEN
- ✓ IDAC
- • *TSAS (On hold)*

Southwest
- ✓ LAS Metroplex
- ✓ EoR at LAX
- ✓ IDAC
- • XM for LAS & LAX (2022)
- • *TSAS (On hold)*

NAS-Wide
- ✓ En Route Departure Capability (EDC)
- ✓ PDRR & ABRR (except ZNY)
- ✓ Data Comm Tower Data Services – 64 Towers
- ✓ Data Comm Initial En Route Services – ZKC, ZID, ZDC, ZMP, ZOA
- • Data Comm Initial En Route Services – ZMA (2022)
- • Data Comm Full En Route Services (starting 2022)
- • Reroute Impact Assessment/TFMS R15 (2022)
- • IDAC at all ARTCCs (2023)
- • TFDM initial 10 sites (2024)

Northeast Corridor
- ✓ IDAC
- • PDRR/ABRR Enhancements (2022)
- • TFDM at CLE Build 1 (2022)
- • Surface Viewer for CLE (2022)
- • Atlantic Coast Routes (2023)
- • XM for PHL & EWR (2024)

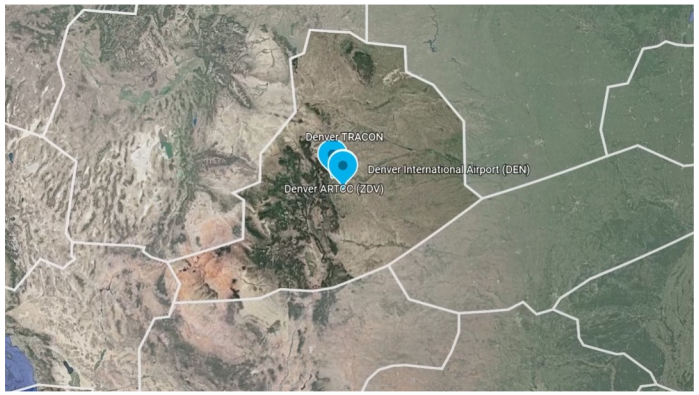
Mid Atlantic
- ✓ ACM for ATL & CLT
- ✓ IDAC
- • TFDM at CLT Build 2 (2024)

All implementation dates subject to change due to budget, sustainment needs, workforce training, and other constraints

Acronyms
- ABRR: Airborne Re-Route
- ACM: Adjacent Center Metering
- EoR: Established on RNP
- IDAC: Integrated Departure Arrival Capability
- PDRR: Pre-Departure Reroute
- TBM: Time-based Management
- TSAS: Terminal Sequencing and Spacing
- XM: Extended Metering

Legend
- ✓ Completed
- • In progress (Expected completion)
- • *On hold*

Accomplishments and on-going work



NWM/DEN

- Extended and Arrival system; metroplex; IDAC at DEN, COS, ASE, APA; Procedural updates to manage speed into D01

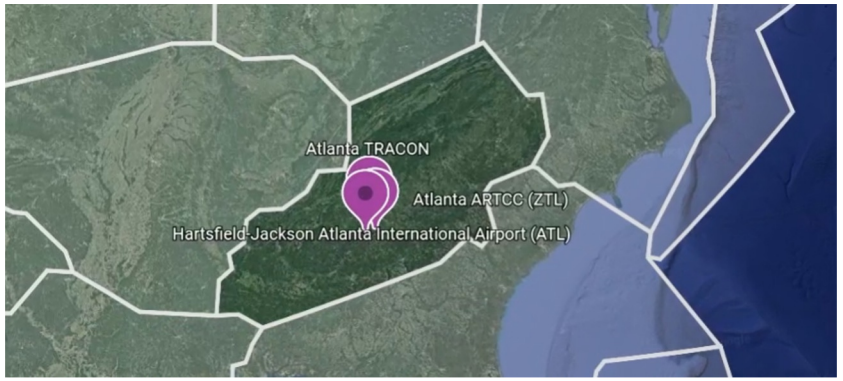
SW/LAX & LAS

- LAX RNP ARs, CRDA, EoR; LAS metroplex;
- T2T connectivity enables ZOA to schedule into ZLA systems;
- XM to LAX has been in use for a while; planning is underway to implement ZOA XM for LAX arrivals
- XM for LAS (ongoing work): all surrounding ARTCCs/ZAB, ZDV, ZLC, ZOA, ZLA;
- EDC dep scheduling system for SDL (display and schedule deps into EDC system; not a full arrival system, no times on the glass, just scheduling into an EDC arc(s) to improve flow management)

Accomplishments and on-going work (cont'd)

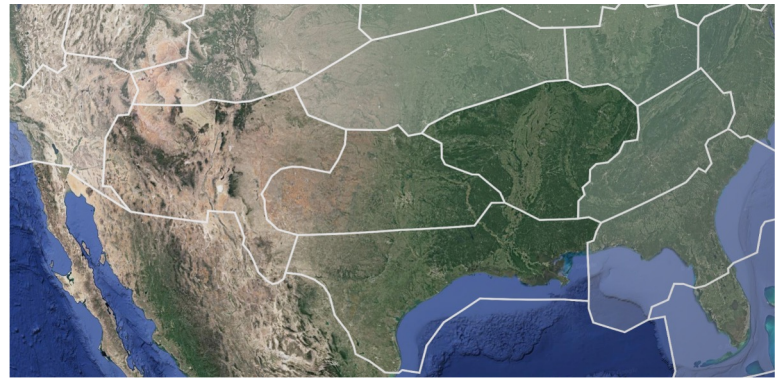
NEC

- PHL/EWR collocation introduced delays in delivering our commitments; IDAC at ABE, ACY, ISP, MDT
- T2T connectivity enables all IDAC Towers in the NEC to schedule into ATL's and CLT's arrival systems
- ACR (Jun 2023)



Mid-Atlantic and Southeast

- EDC system for OPF;
- IDAC at MIA, FLL, RSW, PBI, TPA, FXE
- EDC dep scheduling from ZMA up to ZAU for ORD (each facility will be aware of others' departures; rather than four separate systems scheduling to ORD—ZID, ZTL, ZJX, and ZMA—we are developing a single system with integrated information)

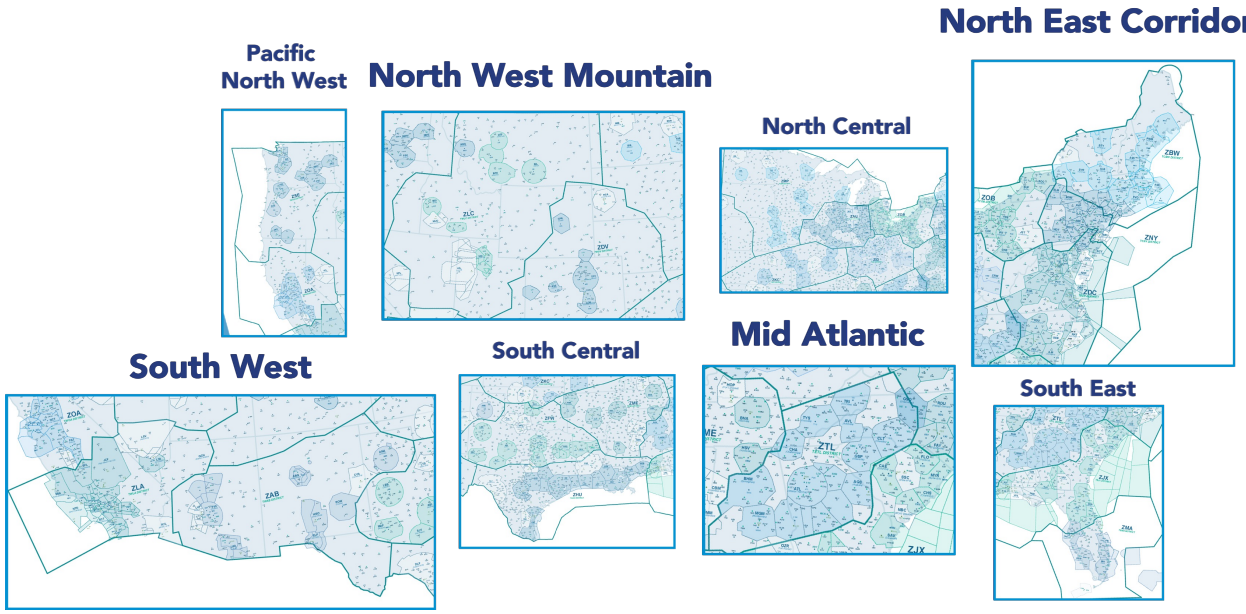


South-Central

- Updating the IAH/HOU arrival systems
- EDC dep scheduling system for AUS

Updated Strategy for TBO Integration

Operating Areas



- Focus on the initial four OAs and key airports established a foundation for TBO in the NAS
- It is now the time to expand the focus onto other OAs for a more balanced approach to evolving the NAS, and support more agile decision-making and expanded customization of TBO at service delivery points
- Integration of future Airspace Modernization efforts
- Scope of future work dependent on budgetary allocations

Opportunities to Improve Performance in the NAS

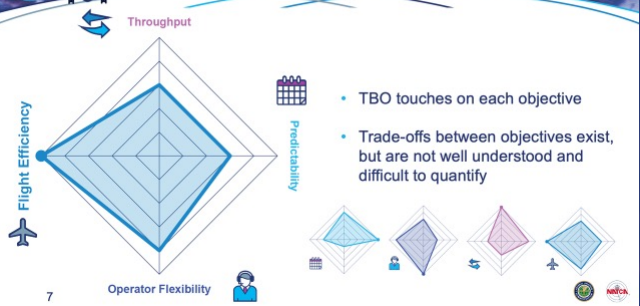
Almira Ramadani, *Air Traffic Services*
Curt Rademaker, *System Operations Services*
Dave Knorr, *NextGen*

Data-Driven Operational Improvements

Analysis Supporting Lifecycle Management

- Shortfall analyses
- Analyses of alternative improvements
- Cost-Benefit analyses
  - Stakeholder views
  - Exogenous vs intended outcomes
  - Qualitative vs quantitative views
  - Monetization
- Post-implementation analyses
  - Technical (system performance)
  - Operational (use and outcomes)
  - Benefit achievement

TBO Objectives

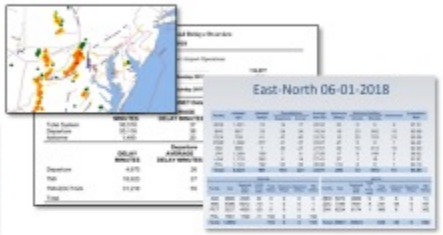


- TBO touches on each objective
- Trade-offs between objectives exist, but are not well understood and difficult to quantify

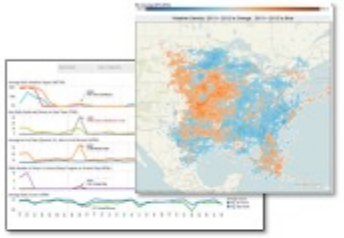
Past Exchanges on Benefit Expectations

Data Collection and Analysis Timeframes

Traffic Managers, Airline Operators, Area Supervisors



Traffic Managers, Airline Operators, Quality Assurance Specialists



Traffic Managers, Airspace Managers, Analysts, Quality Assurance, Safety, Airlines, Research Organizations

Real-Time	Next Day	Monthly/Seasonal
Real-time performance monitoring of current operations and TFM Strategy	Use previous day performance analysis to improve the current day operations	Long term trends to improve airspace design and procedures and review TFM actions and results

Analysis Objectives

- Expand TBO implementation beyond the initial four operating area
- Identify Site-specific opportunities to improve NAS operations, system efficiency, and flight performance
- Coordinate and focus various improvement activities across the ATO

Our Approach

Gather Quantitative Data

- Define Metrics and data sources
- Evaluate site-specific performance and opportunities for improvement
- Rank airports based on various performance attribute
- Identify top candidates for operational improvements

Gather Quantitative Data

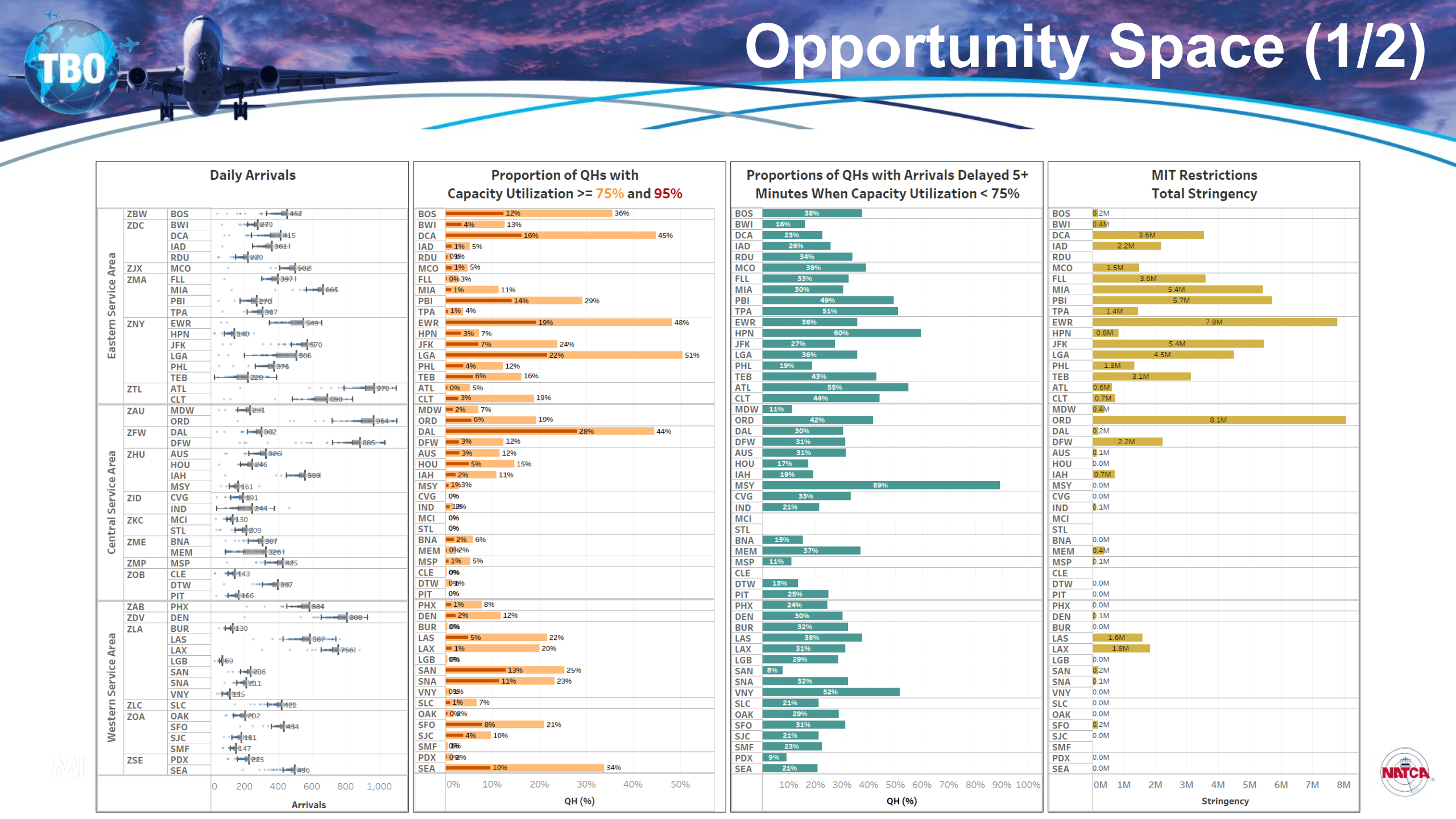
Consider Opportunities per Flt

- 75th percentile of daily arrival counts
- Proportion of QrtHrs with capacity utilization at or above 75% of arrival called rates
- Sequencing delay and level-offs within 40 NM of destination (median)
- Sequencing delay and level-offs between 40 and 120 NM of destination (median)
- Proportion of QrtHrs with aircraft that were delayed more than 5 minutes and arrived during periods with capacity utilization lower than 75%

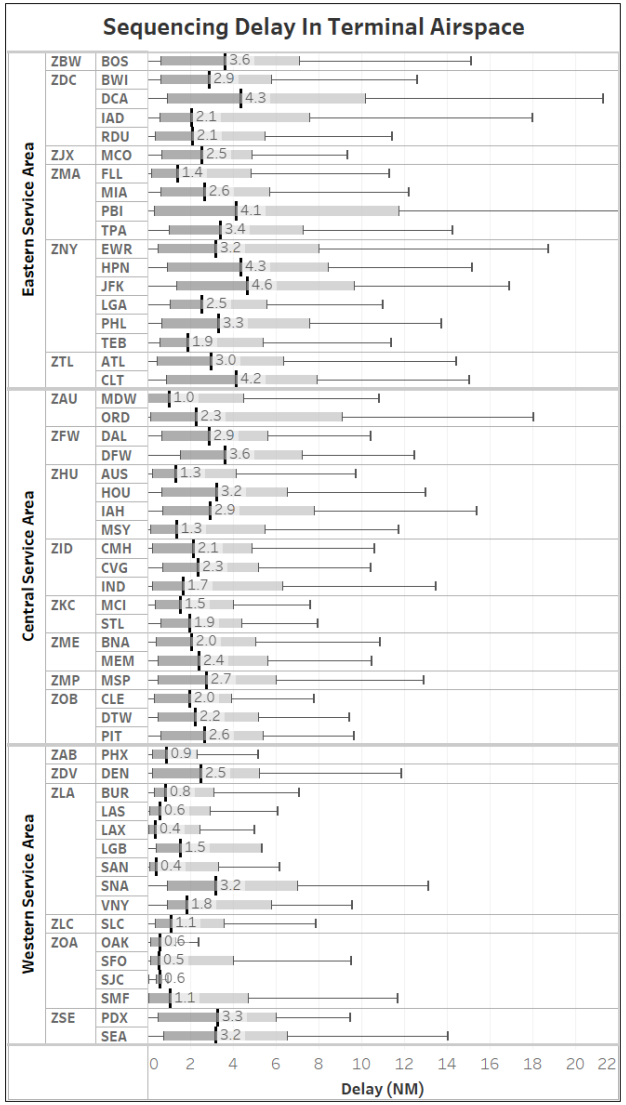
Consider Total Opportunities

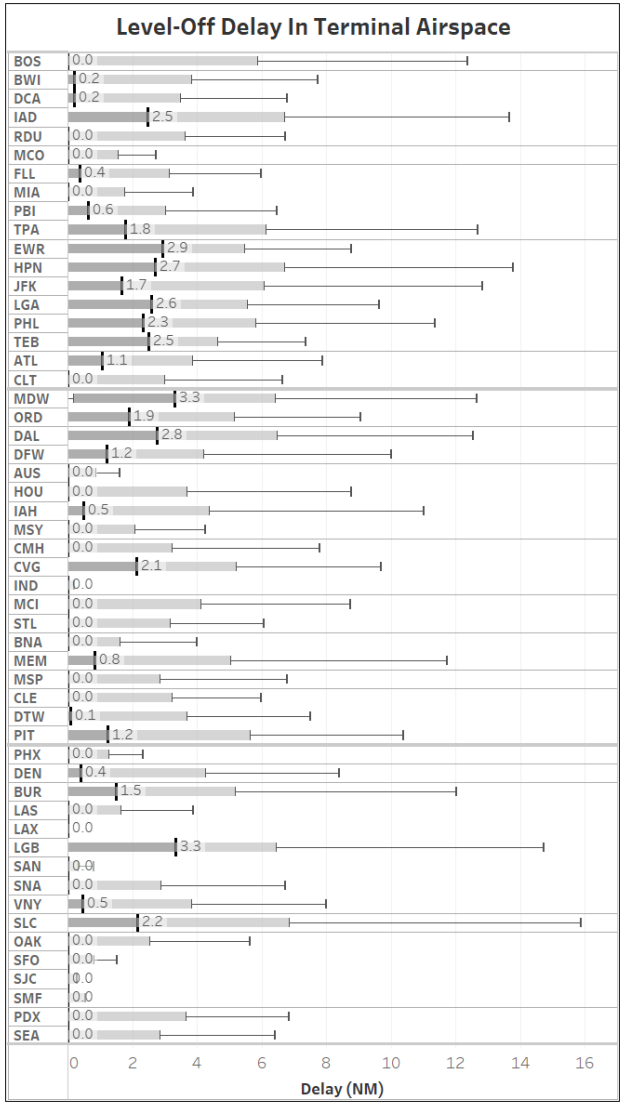
- Proportion of QrtHrs with capacity utilization at or above 75% of arrival called rates
- Sequencing delay and level-offs within 40 NM of destination (total)
- Sequencing delay and level-offs between 40 and 120 NM of destination (total)
- Proportion of QrtHrs with aircraft that were delayed more than 5 minutes and arrived during periods with capacity utilization lower than 75%
- Proportion of NAS stringency applicable to destination-specific arrivals

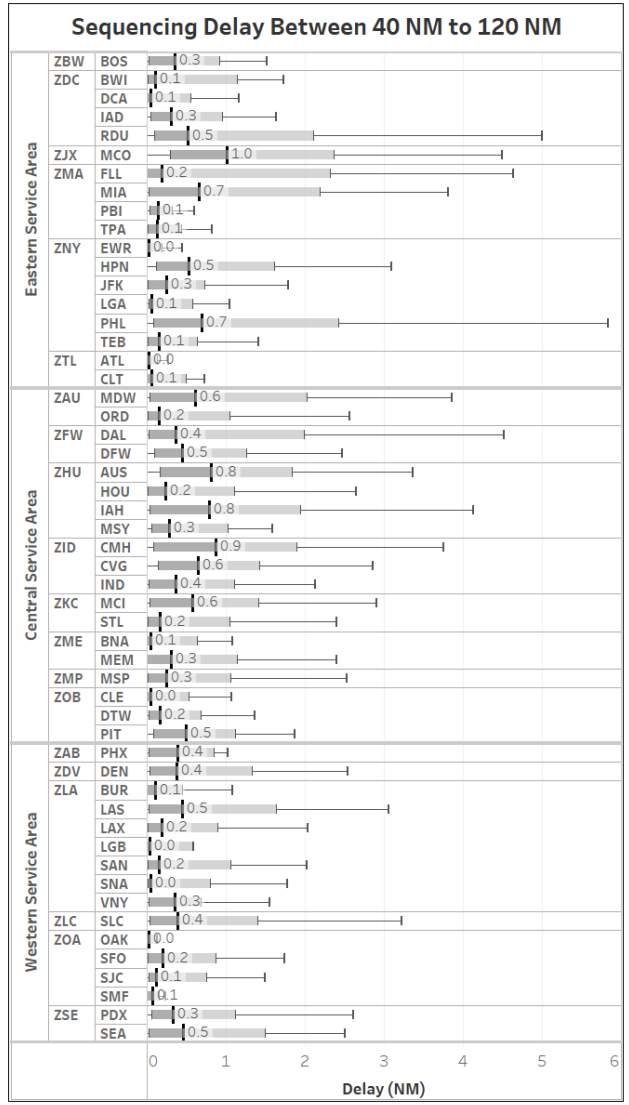
Opportunity Space (1/2)

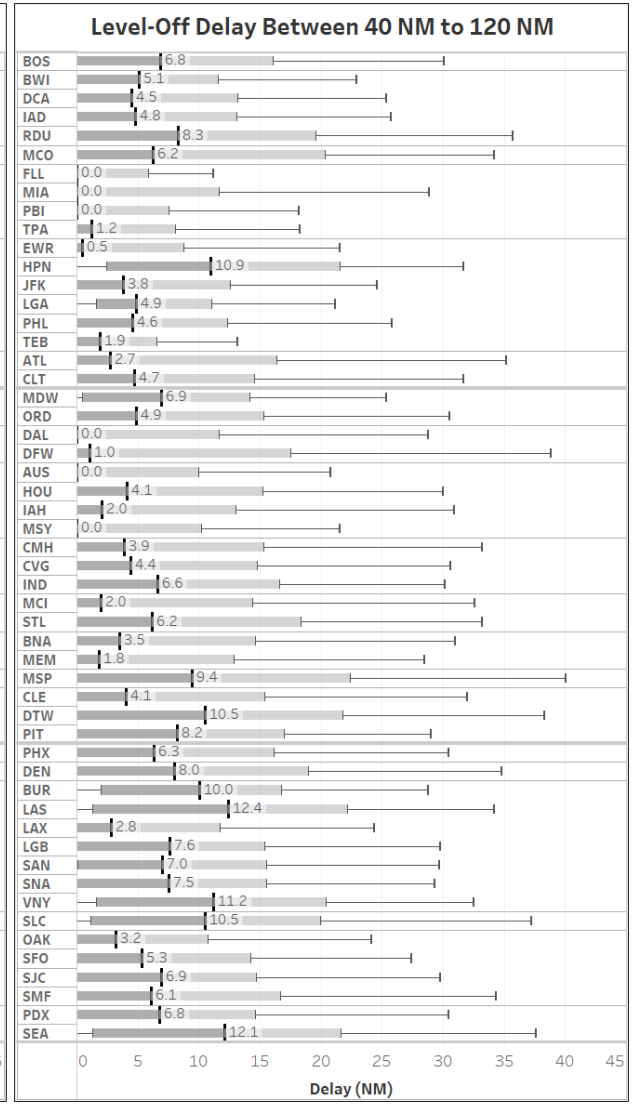


Opportunity Space (2/2)

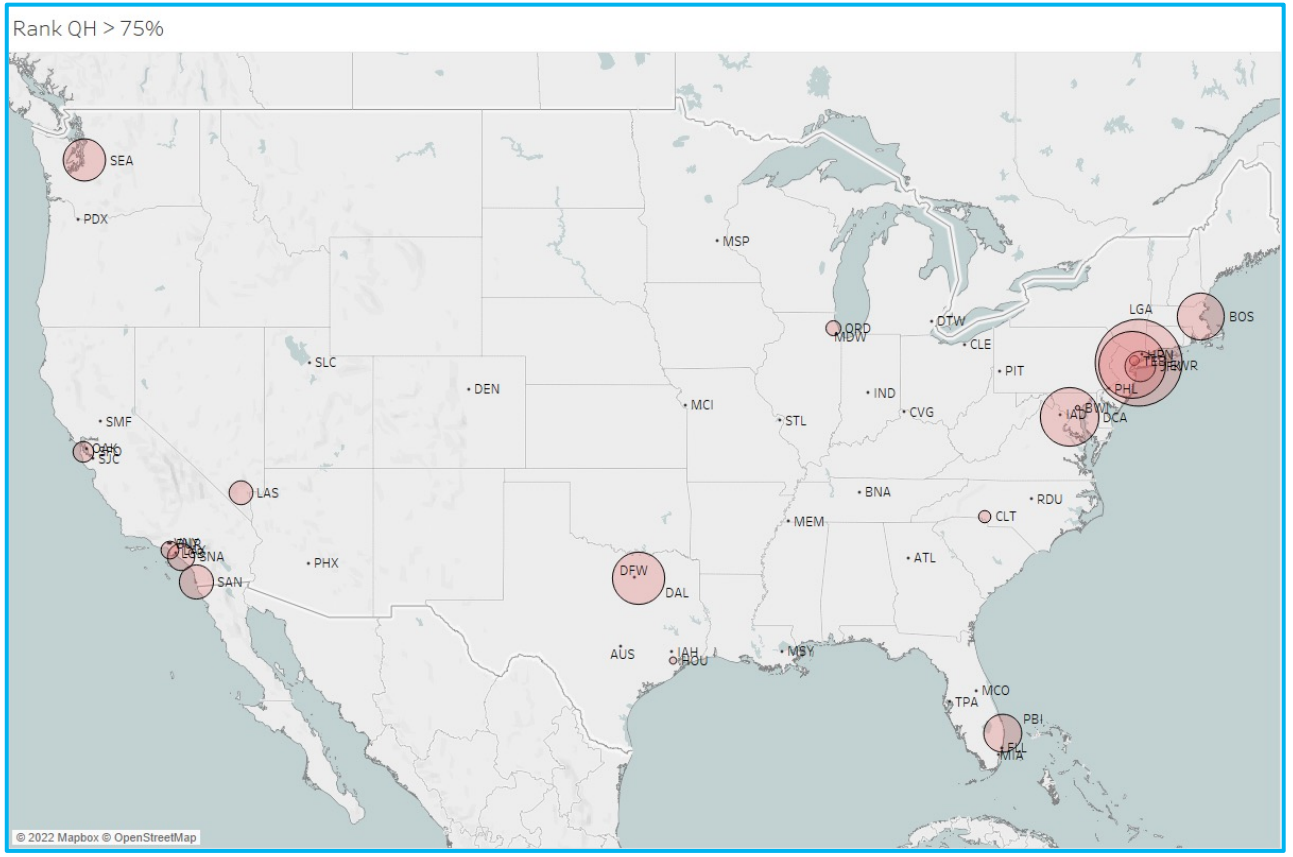






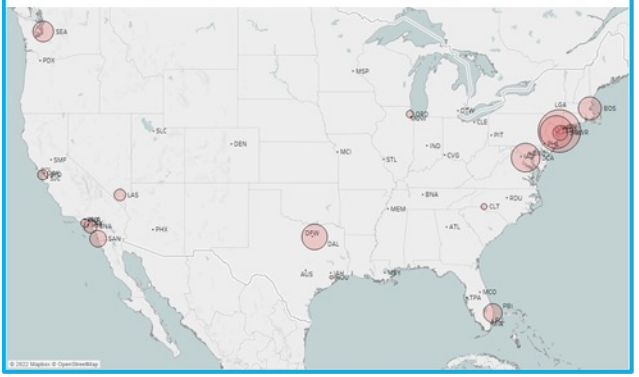


Opportunities per Flt (1/4)

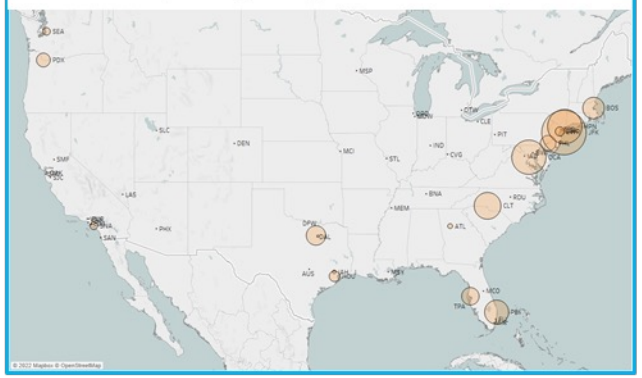


Opportunities per FIt (2/4)

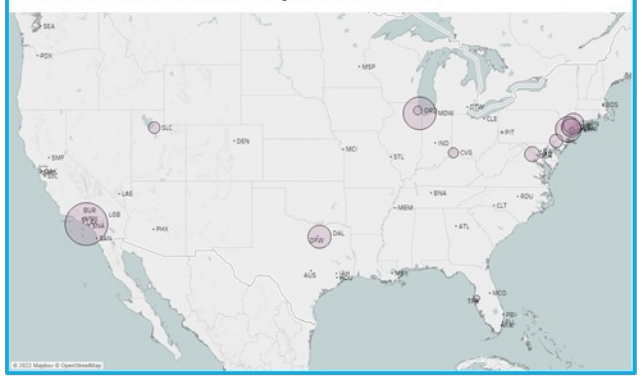
Rank for Capacity Utilization Exceeding 75%



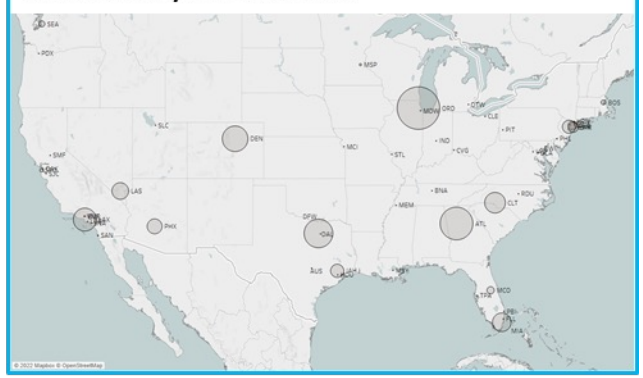
Rank for Sequencing Delay inside 40 NM



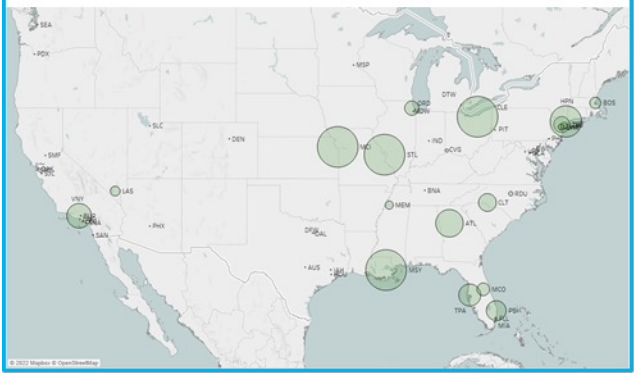
Rank for Level-off Delay inside 40 NM



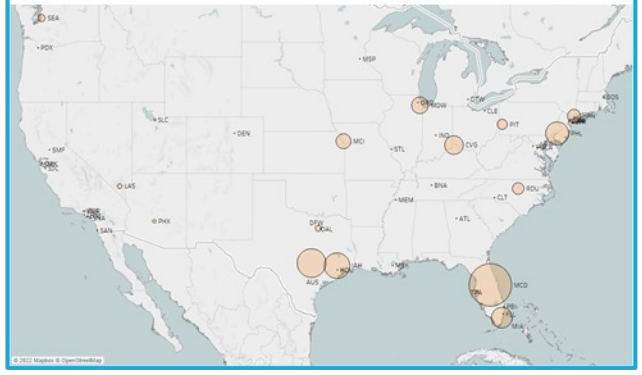
Rank for Daily Arrival Volume



Rank for Airport Efficiency Opportunity Score



Rank for Sequencing Delay between 40 and 120 NM



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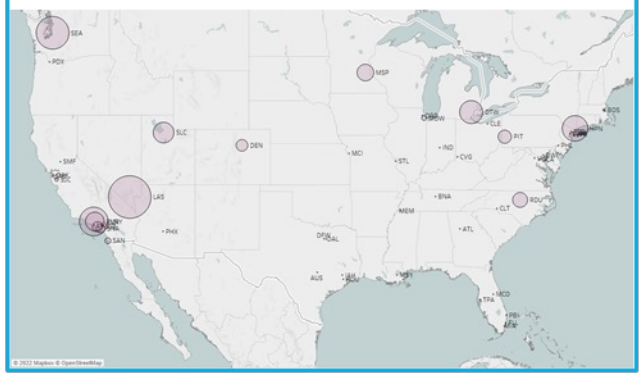
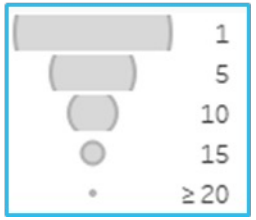
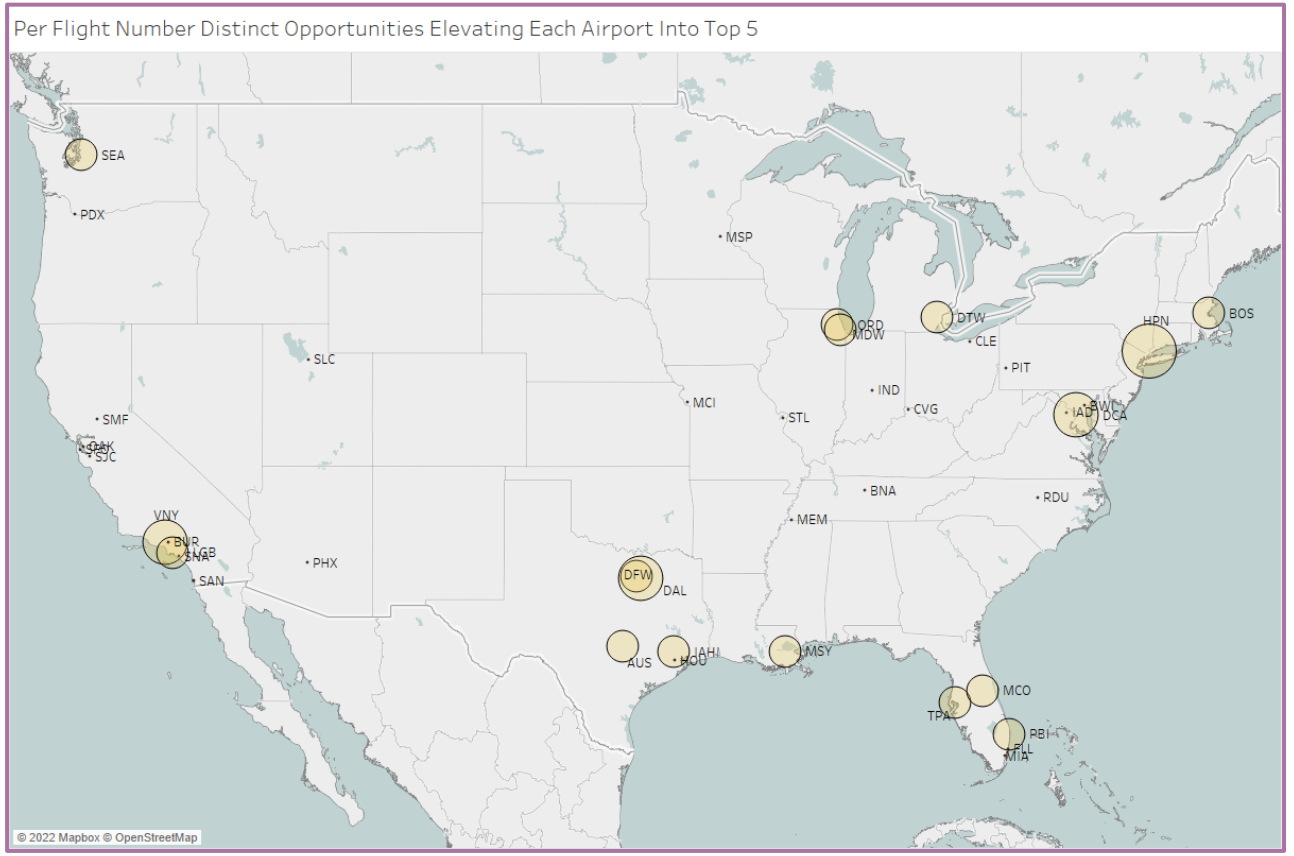


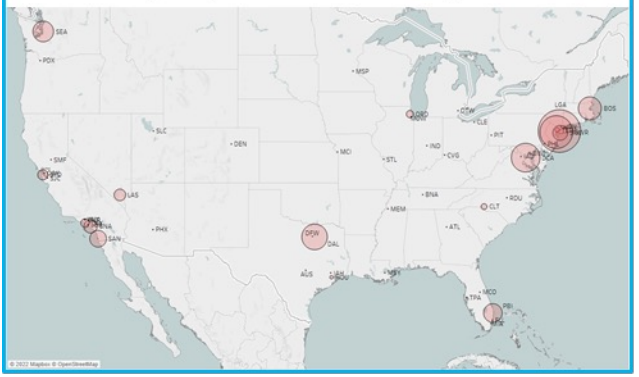


Opportunities per Flt (3/4)

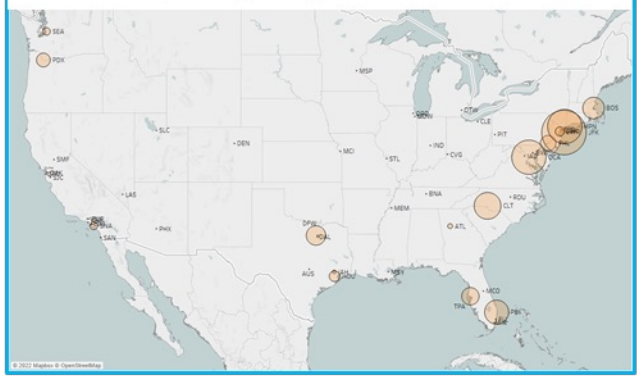


Opportunities per FIt (4/4)

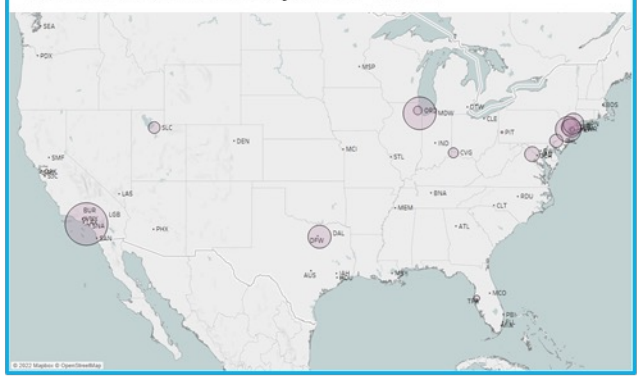
Rank for Capacity Utilization Exceeding 75%



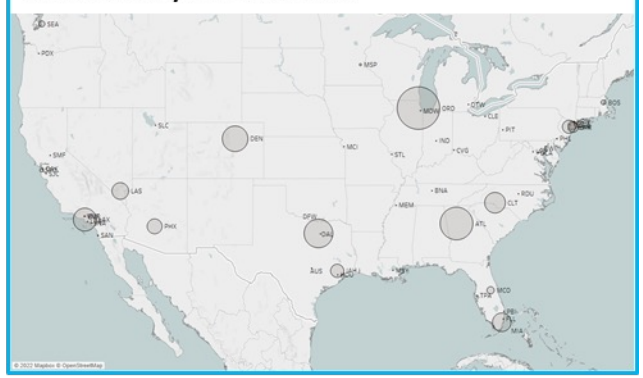
Rank for Sequencing Delay inside 40 NM



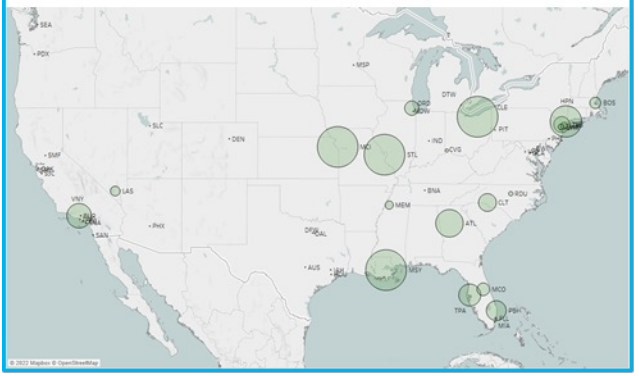
Rank for Level-off Delay inside 40 NM



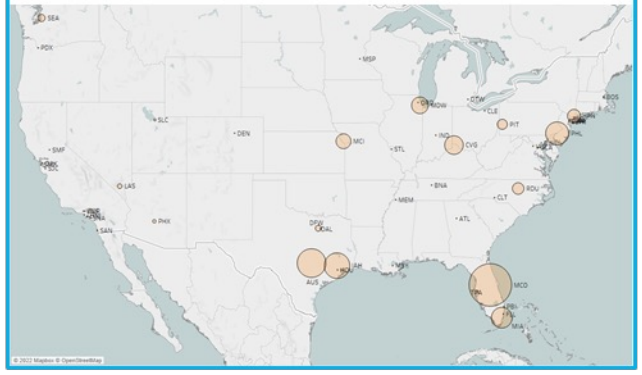
Rank for Daily Arrival Volume



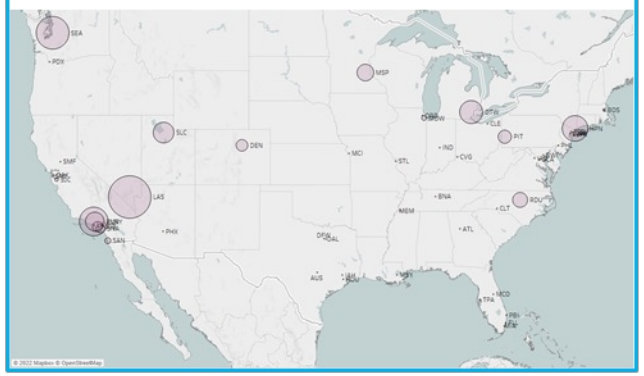
Rank for Airport Efficiency Opportunity Score



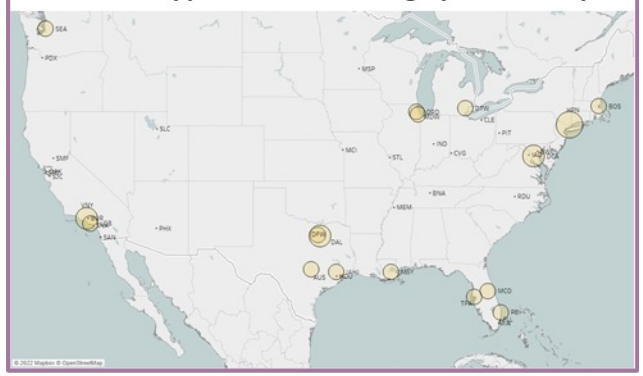
Rank for Sequencing Delay between 40 and 120 NM

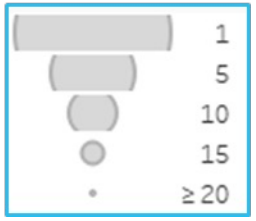


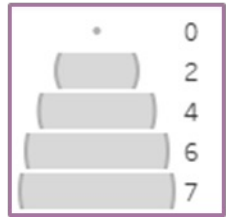
Rank for Level-off Delay between 40 and 120 NM



Number of Opportunities Elevating Apts to the Top 5

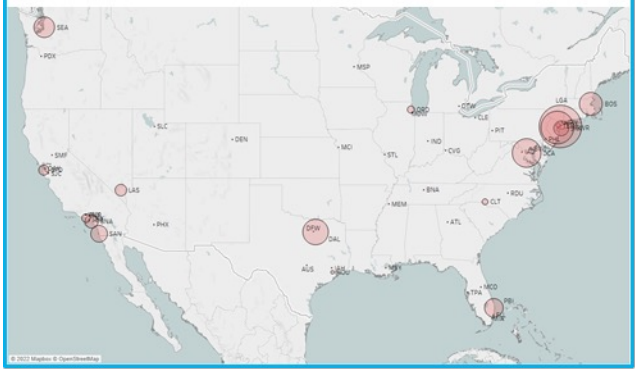




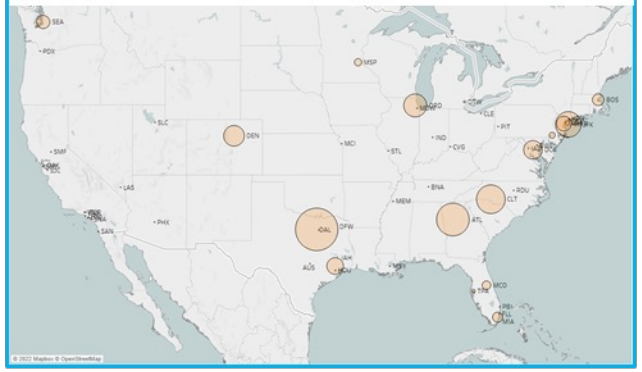


Total Opportunities

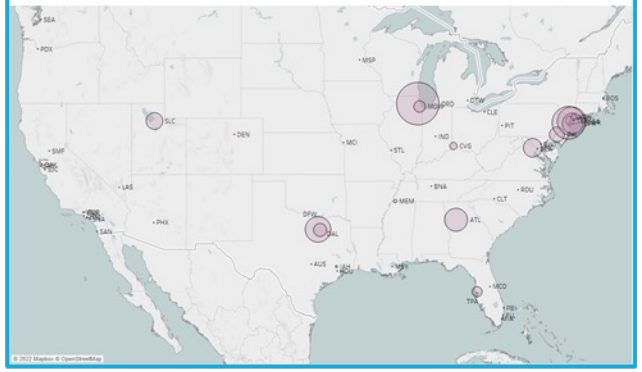
Rank for Capacity Utilization Exceeding 75%



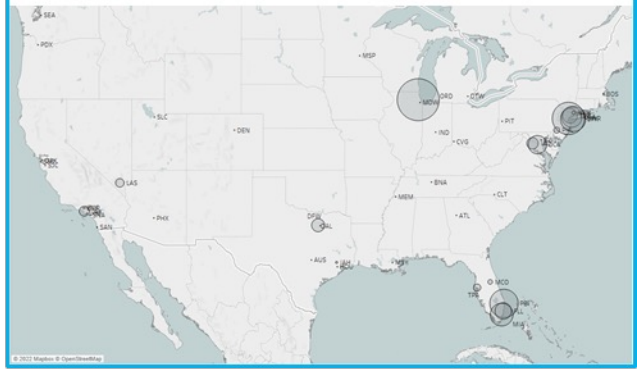
Rank for Sequencing Delay inside 40 NM



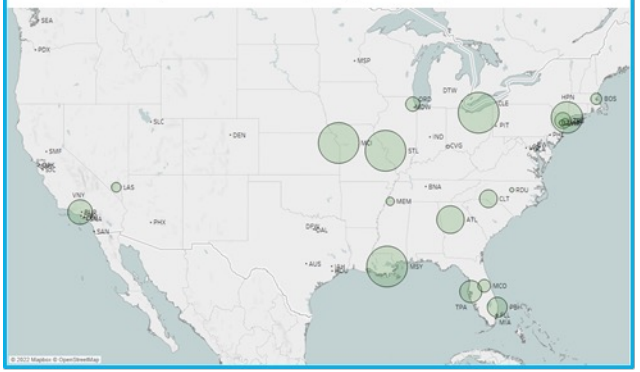
Rank for Level-off Delay inside 40 NM



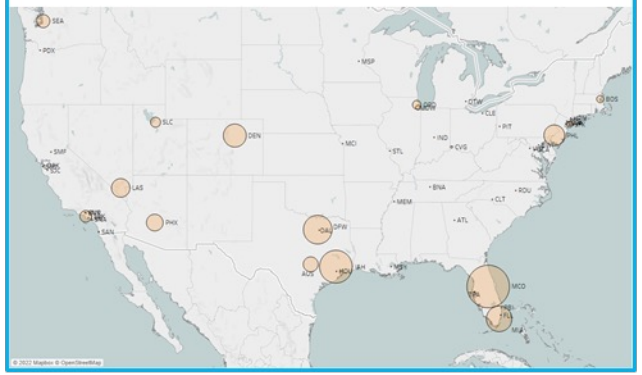
Rank for Proportion of MIT Stringency



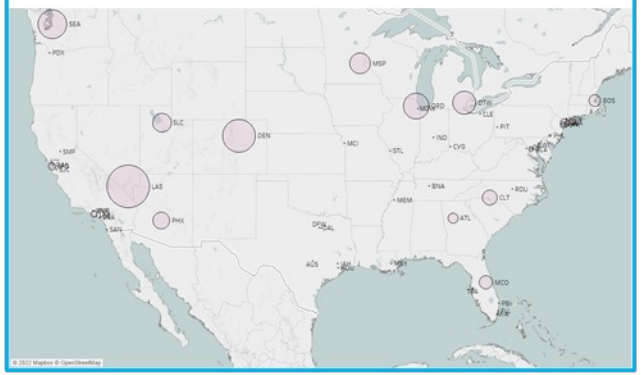
Rank for Airport Efficiency Opportunity Score



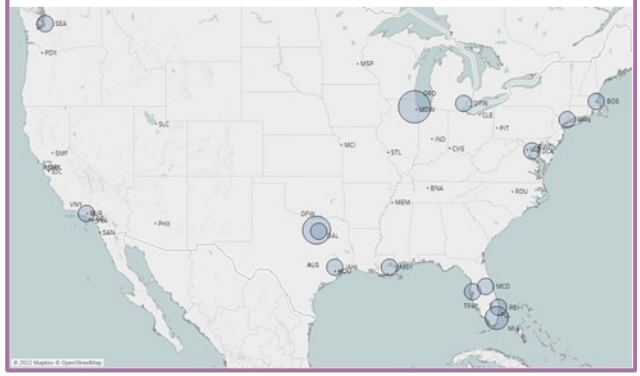
Rank for Sequencing Delay between 40 and 120 NM

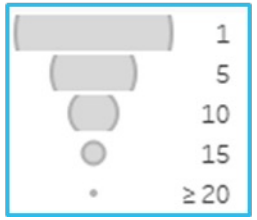


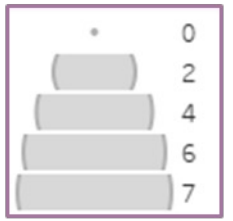
Rank for Level-off Delay between 40 and 120 NM



Number of Opportunities Elevating Apts to the Top 5

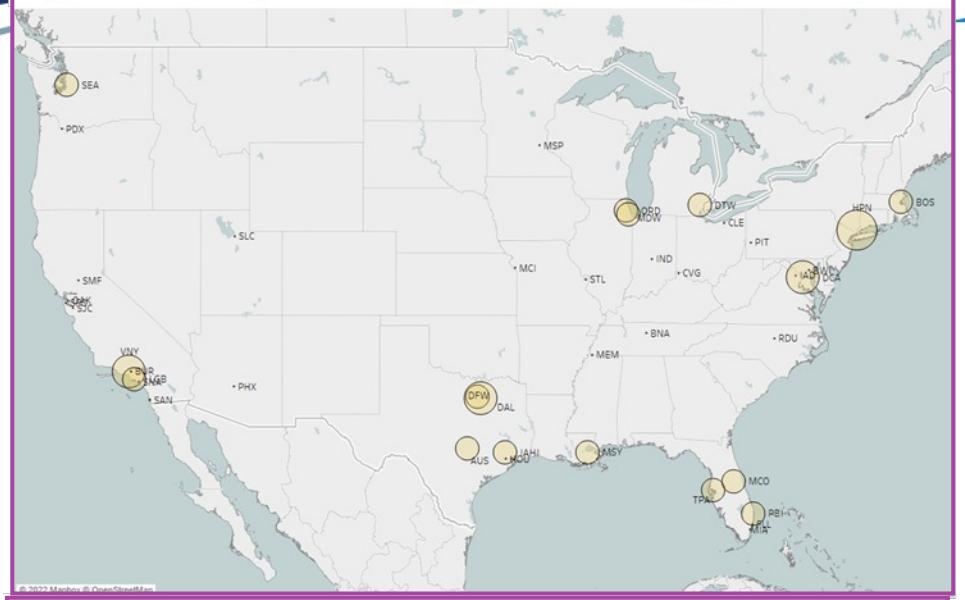




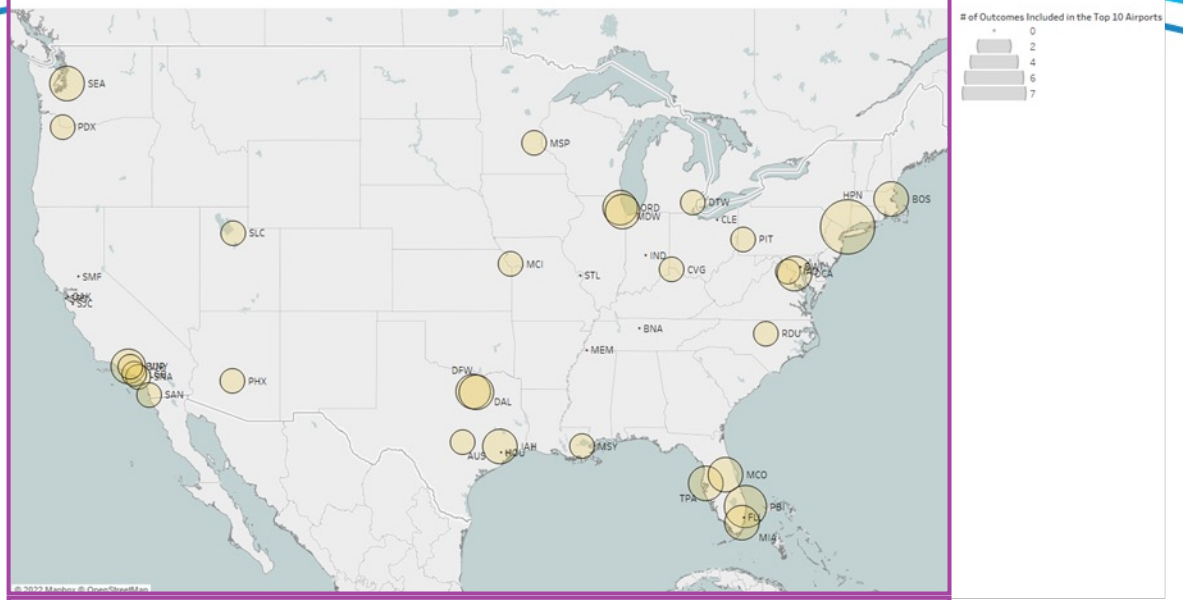


Summary of simple objective data-driven info

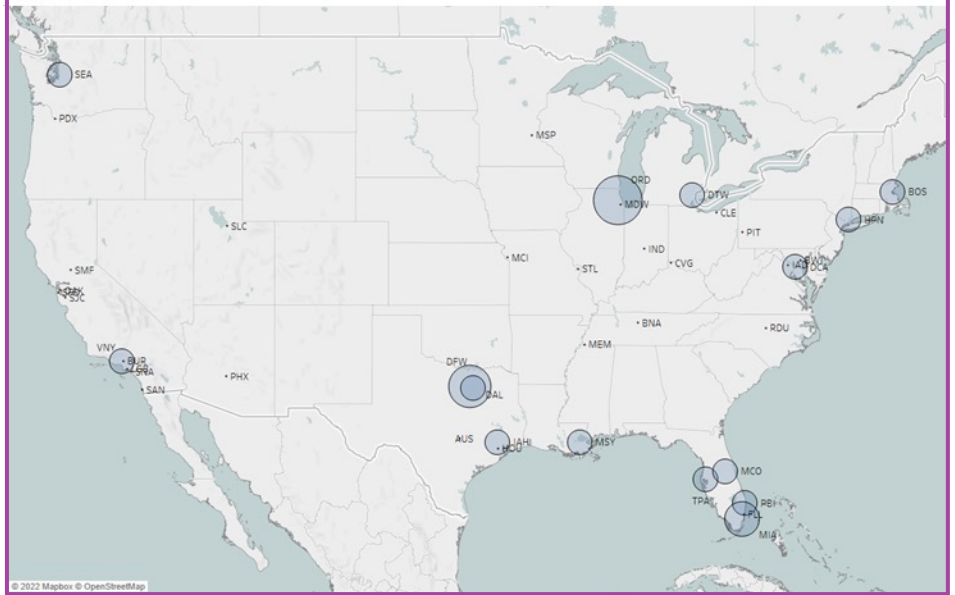
Opportunities Per Flight: Number of Opportunities Elevating Apts to the Top 5



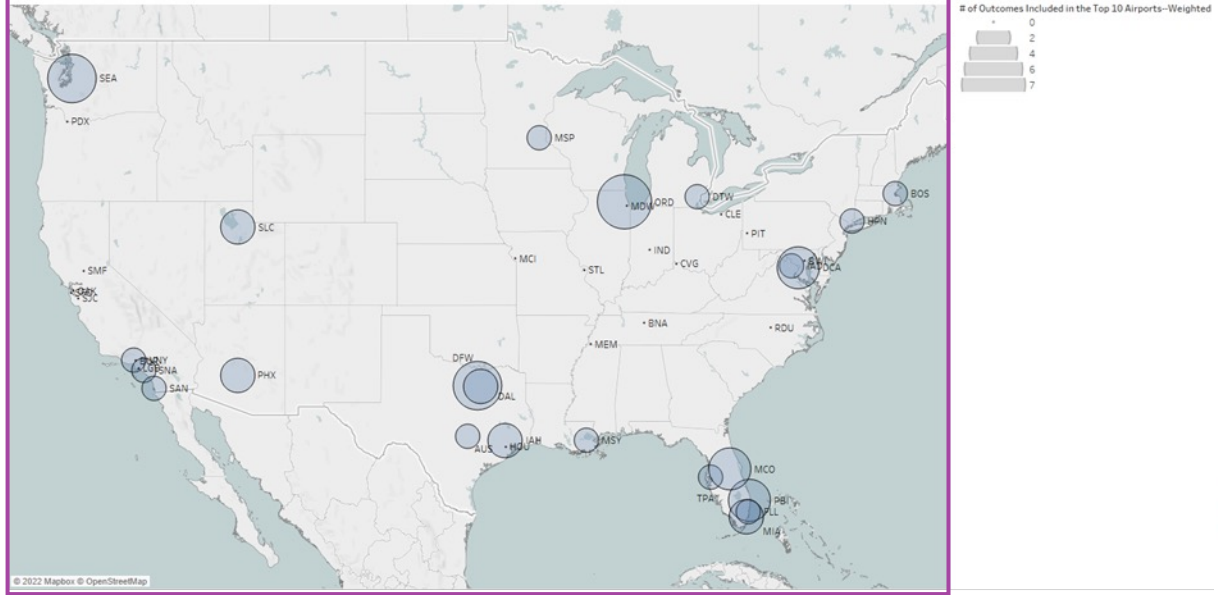
Opportunities Per Flight: Number of Opportunities Elevating Apts to the Top 10



Total Opportunities: Number of Opportunities Elevating Apts to the Top 5



Total Opportunities: Number of Opportunities Elevating Apts to the Top 10



Our Approach

Gather Quantitative Data

- Define Metrics and data sources
- Evaluate site-specific performance and opportunities for improvement
- Rank airports based on various performance attribute
- Identify top candidates for operational improvements

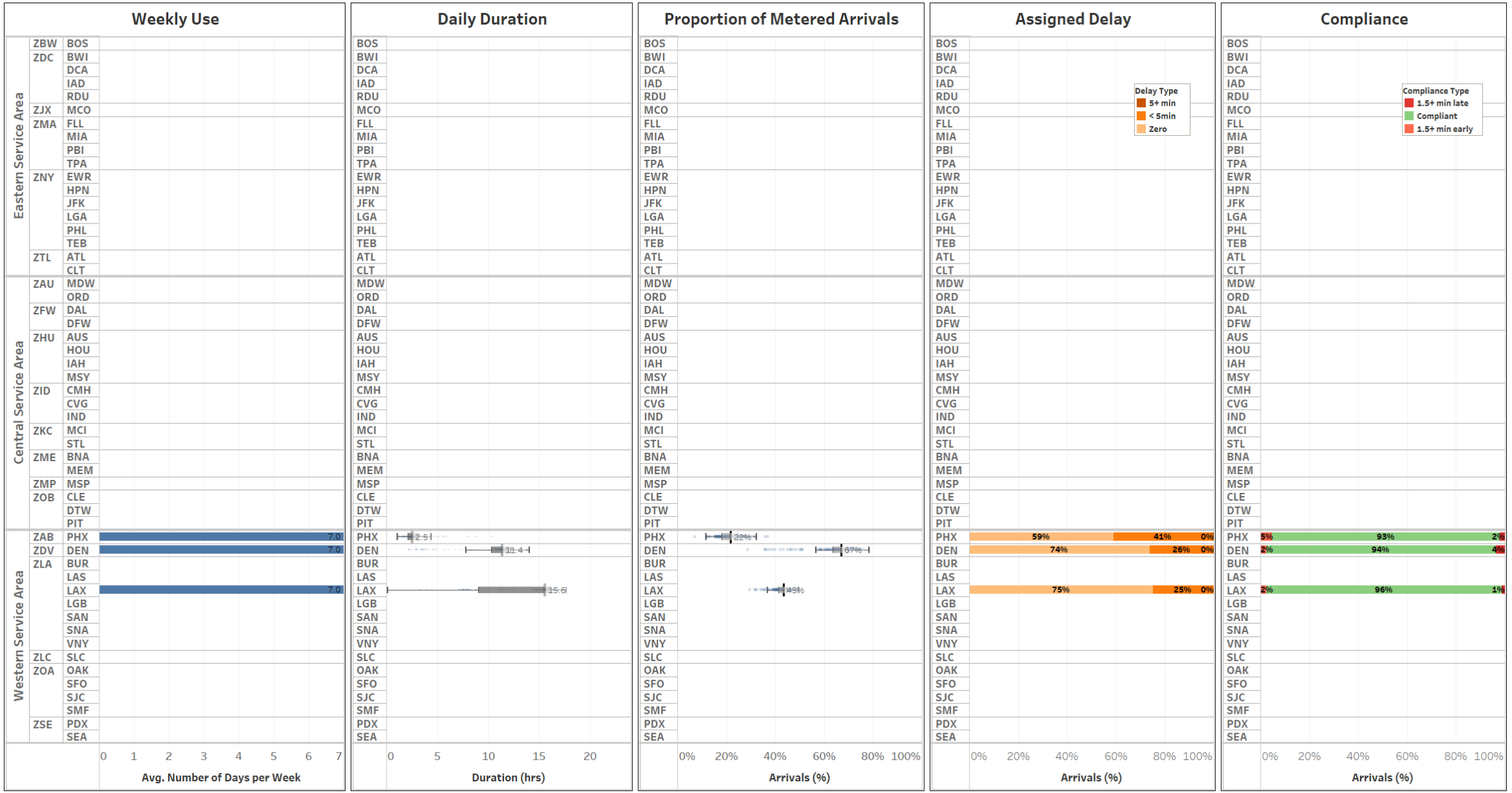
Gather Qualitative Feedback & Perspectives

- Initiatives and commitments already in progress
- Operational Insights
- Airspace Modernization Roadmaps
- Industry Priorities

We are here

TBFM Arrival Metering

TBFM Extended Metering

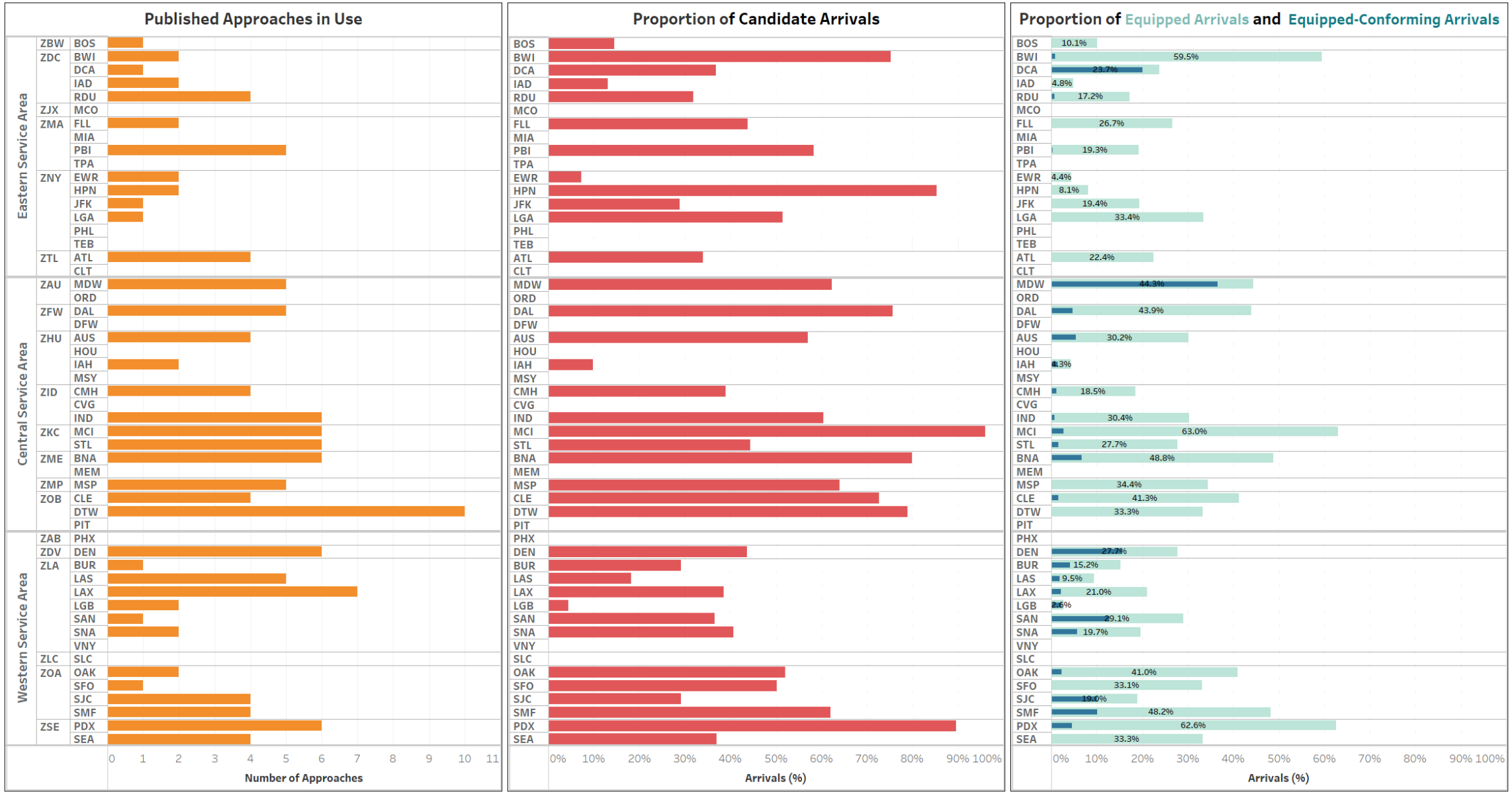


TBFM Dep Scheduling into Arrival Timeline

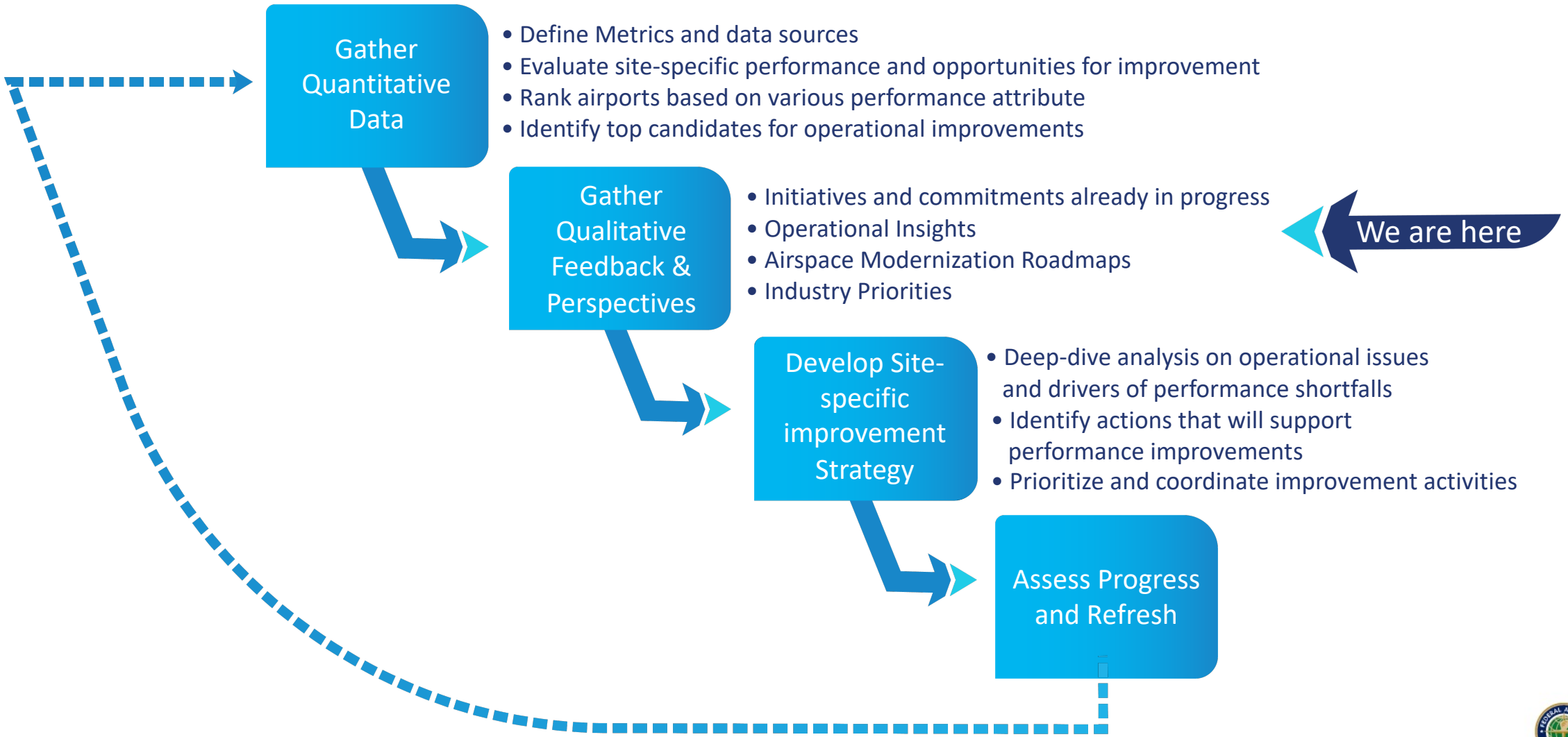
TBFM Dep Scheduling into EDC Timeline

Application of MITs

Equipage and Use of RNP IAP with RF Turns



Our Approach



Measuring Progress: TBO Analytics Demo

Almira Ramadani, *Air Traffic Services*

Brandon Smith, *TBFM Ops Team/NATCA*

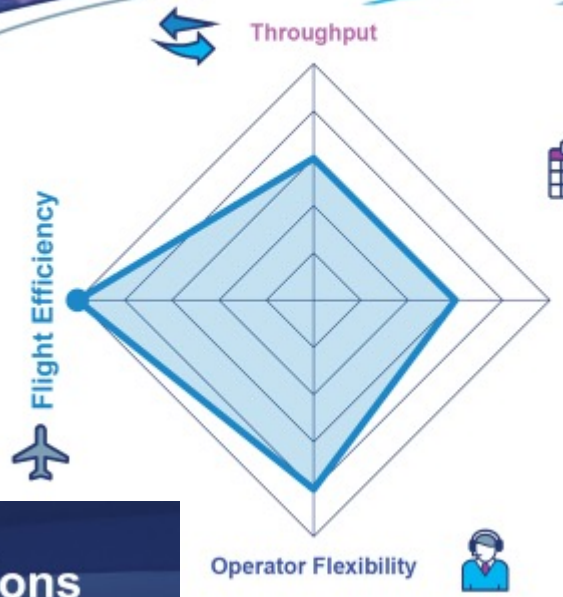
Dave Raymond and Curt Rademaker, *System Operations Services*

Data-Driven Operational Improvements

Analysis Supporting Lifecycle Management

- Shortfall analyses
- Analyses of alternative improvements
- Cost-Benefit analyses
  - Stakeholder views
  - Exogenous vs intended outcomes
  - Qualitative vs quantitative views
  - Monetization
- Post-implementation analyses
  - Technical (system performance)
  - Operational (use and outcomes)
  - Benefit achievement

TBO Objectives



- TBO touches on each objective
- Trade-offs between objectives exist, but are not well understood and difficult to quantify

Past Exchanges on Benefit Expectations

9-AJT-TBO@faa.gov

https://www.faa.gov/air_traffic/technology/tbo/

Data Collection and Analysis Timeframes

Traffic Managers, Airline Operators, Area Supervisors

Traffic Managers, Airline Operators, Quality Assurance Specialists

Traffic Managers, Airspace Managers, Analysts, Quality Assurance, Safety, Airlines, Research Organizations

Real-Time | **Next Day** | **Monthly/Seasonal**

Real-time performance monitoring of current operations and TFM Strategy

Use previous day performance analysis to improve the current day operations

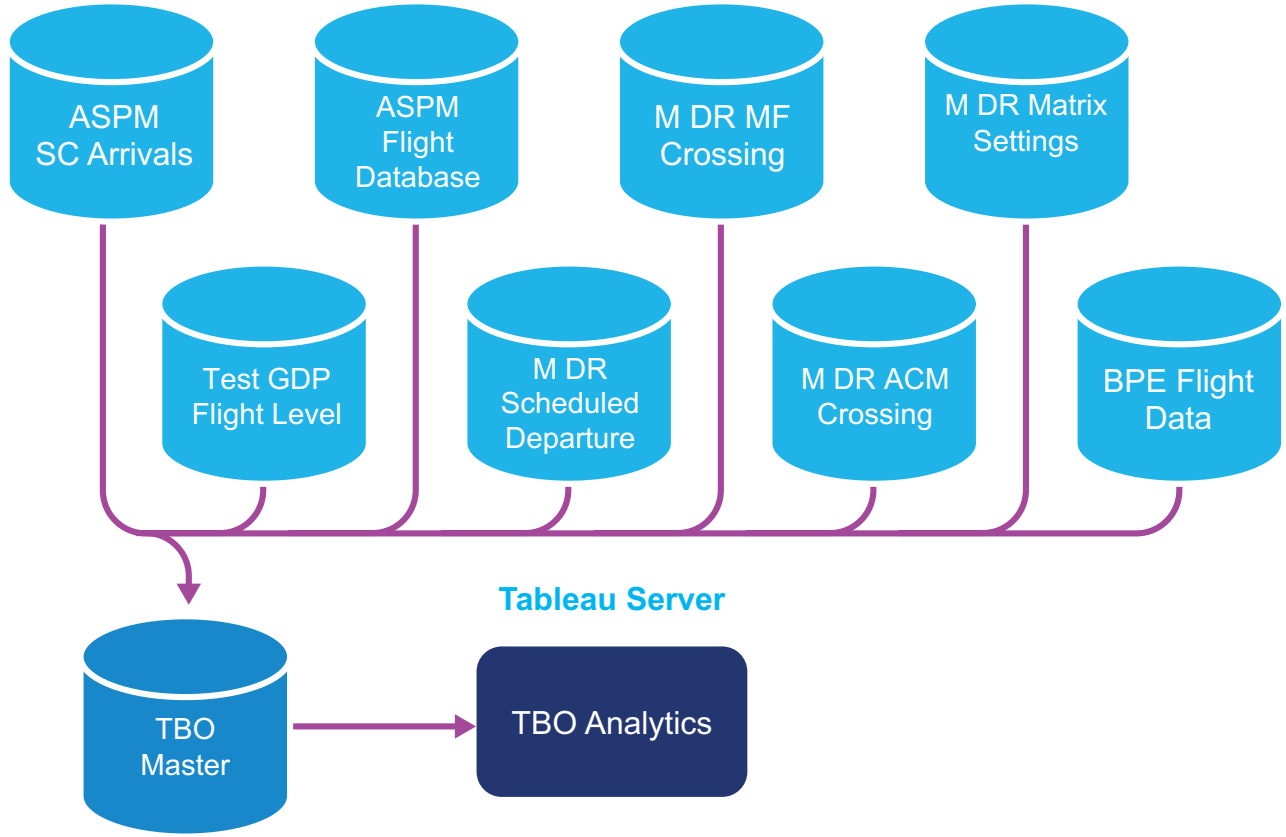
Long term trends to improve airspace design and procedures and review TFM actions and results

TBO Analytics Highlights

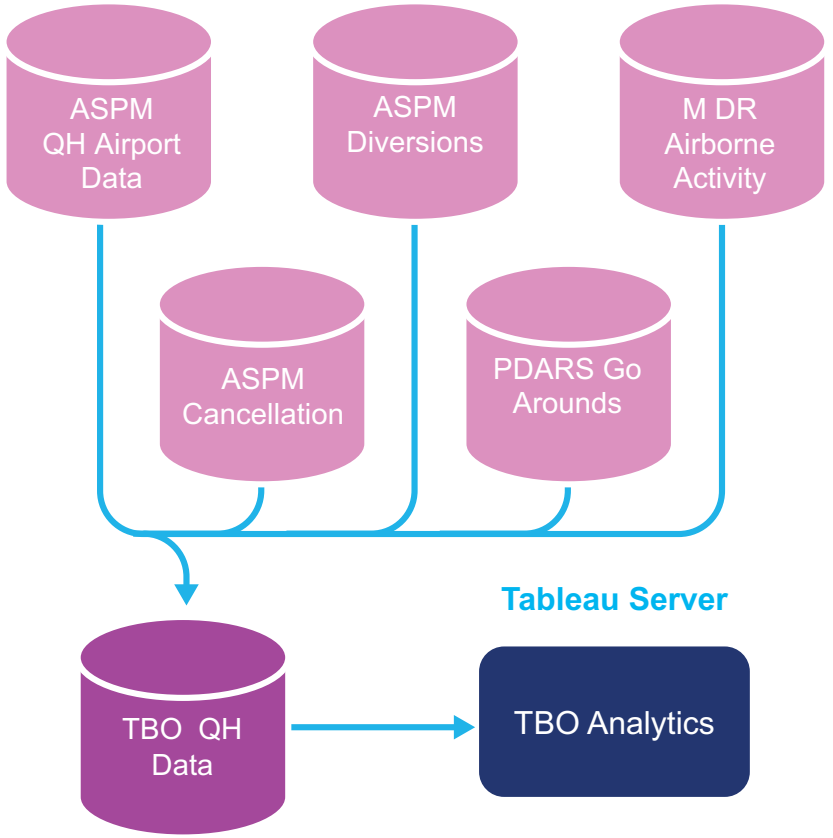
- Established an infrastructure for *automated* integration of critical data-sources
- Enables *standardized and quick* comparison of critical metrics at select locations and customized periods of interest
- *Supports a broad range* of needs and users
  - Have key benefit expectations been achieved? Are there additional opportunities for improvement?
  - Are there significant changes in TFM? Is use of TBM increasing and use of conventional TMIs decreasing?
  - What other insights do we need to consider when interpreting performance outcomes (context)?
  - It doesn't think for us, but it does provide critical insights we need to consider…
- *Complements* reporting by other FAA tools and provides *consistent* evaluations for the same inputs
- *Living tool* with increasing user-base and requests for expanding its capabilities

Integrated Data

Individual Flight Data



Quarter Hour Airport Data



TBO Analytics Tool: Content

Airport Context

- Differences in operating conditions

TBFM Arrival Metering System Overview

- Differences in use of Arrival Metering System

Operational Topics of Interests

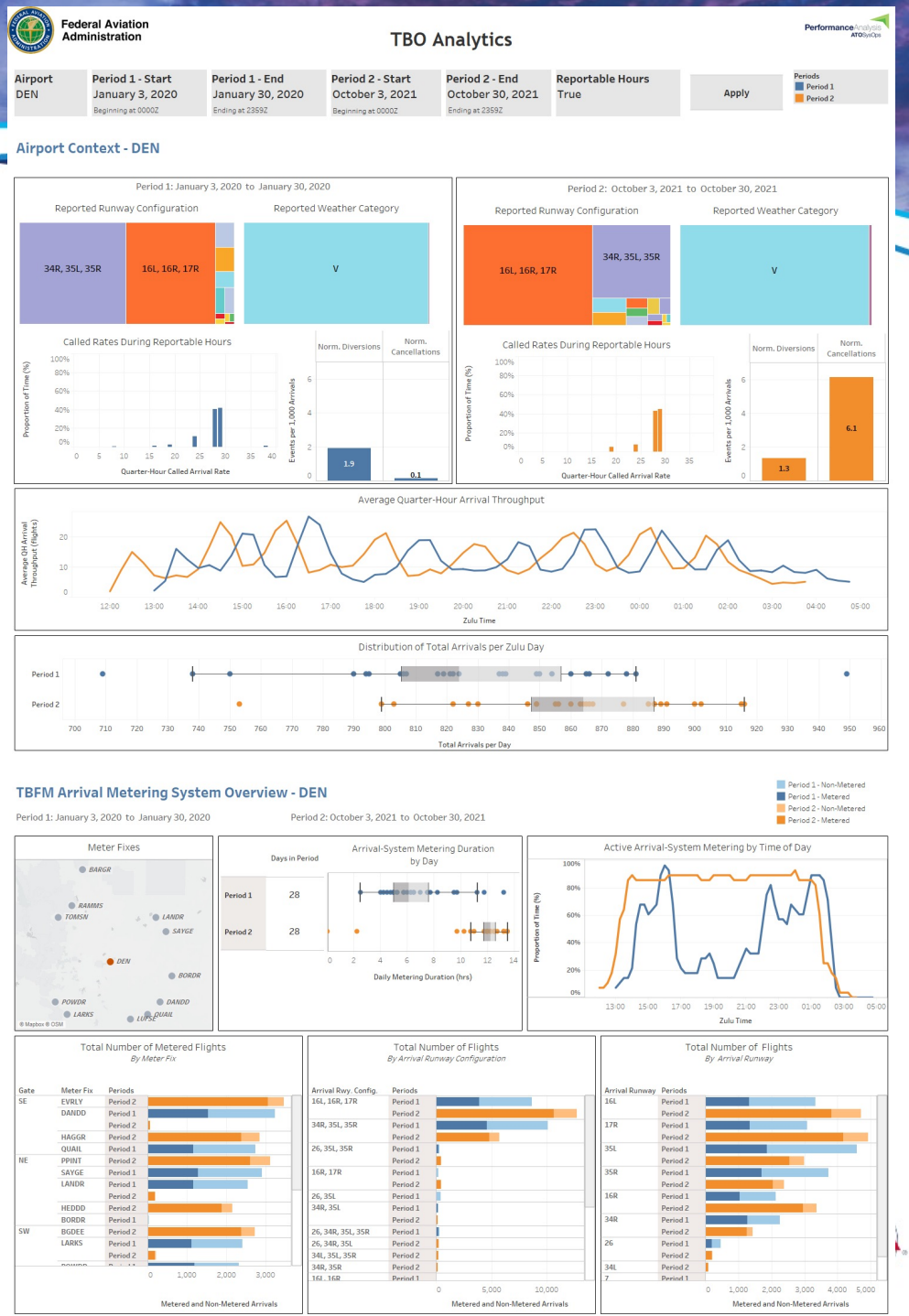
TBM and TMI Use and Outcomes

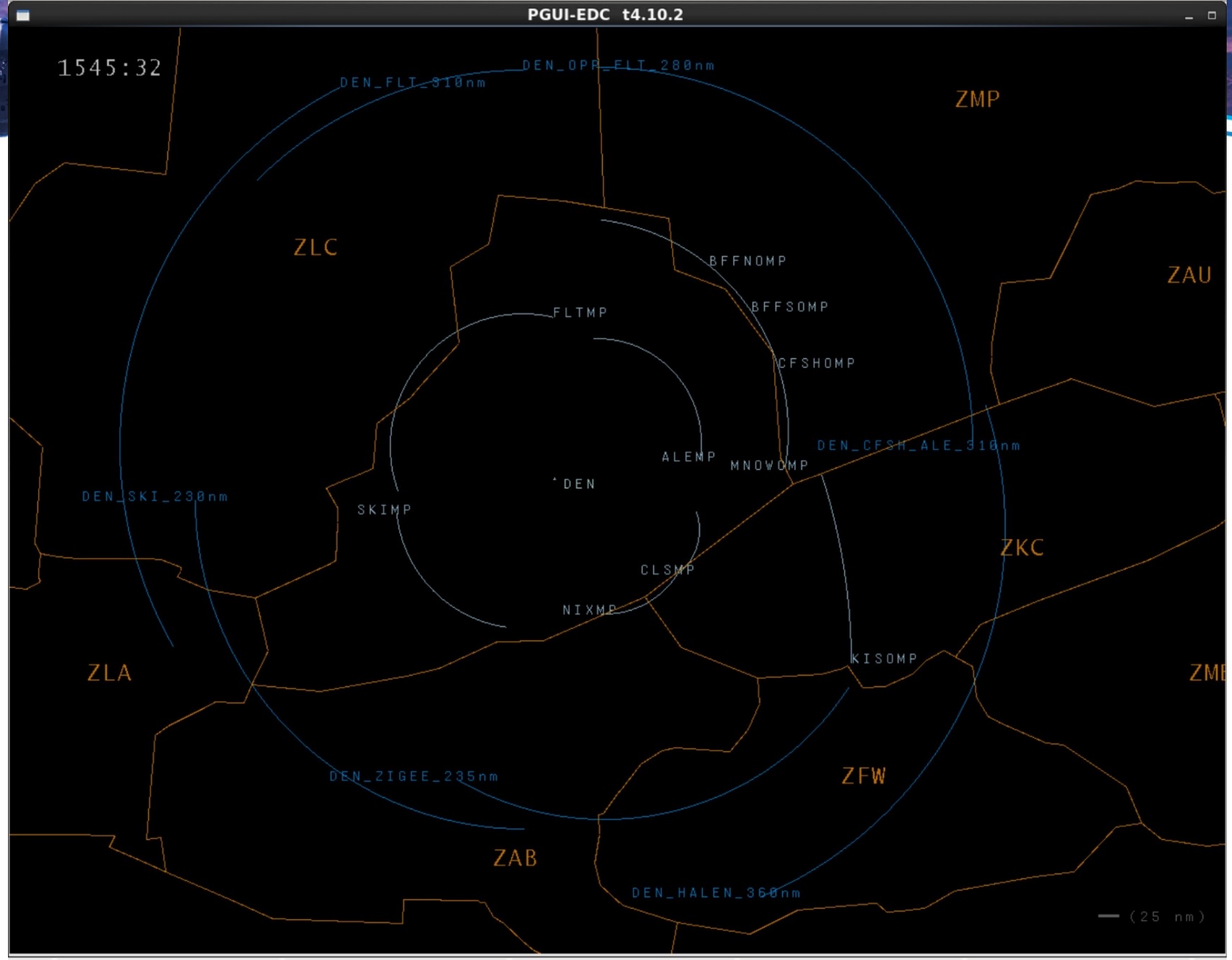
Benefit Expectations

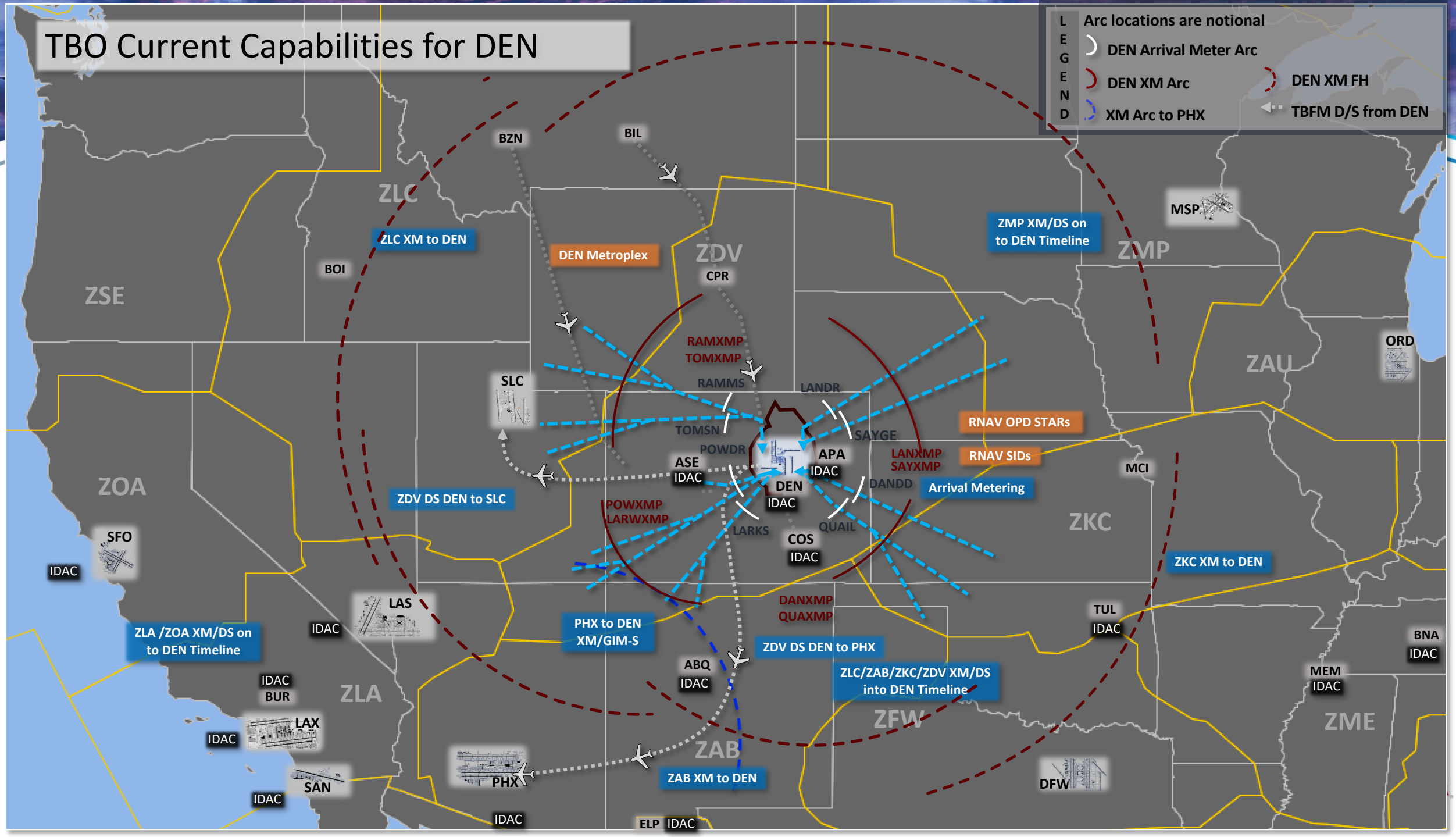
- Sequencing Delays in TRACON
- Runway Inter-Arrival Times and Quarter-Hour Throughput
- Time Between Aircraft Through the Meter Fix
- Taxi Out and Departure Delays at Origin Airports
- Application of MIT Restrictions
- Incremental Delays (TBFM Dep Sch and GDPs)
- TBFM Arrival System Metering Delay and Compliance
- TBFM Extended Metering Delay and Compliance
- TBFM Departure Scheduling Delay and Compliance

Context

- Time in TRACON For Metered Flights
- TBFM Assigned Runway Compared to Arrival Runway Used
- Go-Arounds




PGUI-EDC t4.10.2
1545:32
DEN_OPP_FLT_280nm
DEN_FLT_310nm
ZMP
ZLC
ZAU
BFFNOMP
BFFSOMP
FLTMP
CFSHOMP
DEN_CFSH_ALE_310nm
ALEMP
MNOWOMP
DEN
DEN_SKI_230nm
SKIMP
ZKC
CLSMP
NIXMP
KISOMP
ZLA
ZME
DEN_ZIGEE_235nm
ZFW
ZAB
DEN_HALEN_360nm
(25 nm)


TBO Current Capabilities for DEN
LEGEND
Arc locations are notional
DEN Arrival Meter Arc
DEN XM Arc
XM Arc to PHX
DEN XM FH
TBFM D/S from DEN
ZLC
ZLC XM to DEN
BZN
BIL
BOI
ZSE
DEN Metroplex
ZDV
CPR
ZMP XM/DS on to DEN Timeline
ZMP
MSP
ORD
ZAU
RAMXMP
TOMXMP
RAMMS
LANDR
SLC
TOMSN
SAYGE
POWDR
APA
IDAC
ASE
IDAC
LANXMP
SAYXMP
RNAV OPD STARs
RNAV SIDs
MCI
DANDD
Arrival Metering
DEN
IDAC
ZOA
ZDV DS DEN to SLC
POWXMP
LARWXMP
LARKS
QUAIL
COS
IDAC
ZKC
ZKC XM to DEN
SFO
IDAC
LAS
IDAC
DANXMP
QUAXMP
TUL
IDAC
BNA
IDAC
ZLA /ZOA XM/DS on to DEN Timeline
PHX to DEN XM/GIM-S
ZDV DS DEN to PHX
ABQ
IDAC
ZLC/ZAB/ZKC/ZDV XM/DS into DEN Timeline
MEM
IDAC
IDAC
BUR
ZLA
ZFW
ZME
LAX
IDAC
ZAB
ZAB XM to DEN
PHX
DFW
SAN
IDAC
IDAC
ELP
IDAC

Live demo

DEN, Nov 1-Jan 27: 2019/20 vs. 2021/22

- Airport Context
- TBFM Arrival Metering Use
- Did we move the needle in the right direction?
  - Sequencing Delays
  - MIT Use
  - TBFM Dep Scheduling
- Addl' outcomes
  - Taxi-out and departure delays
  - Go-arounds

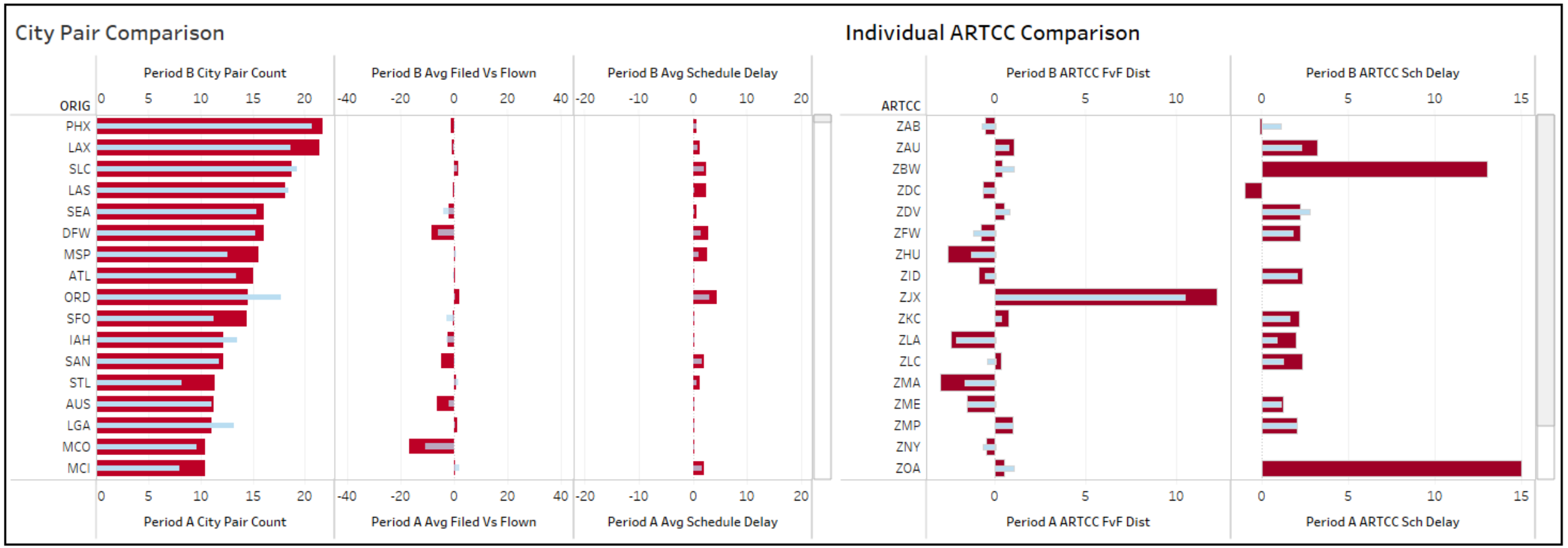
Complementary Insights: Filed vs. Flown

Airport: DEN

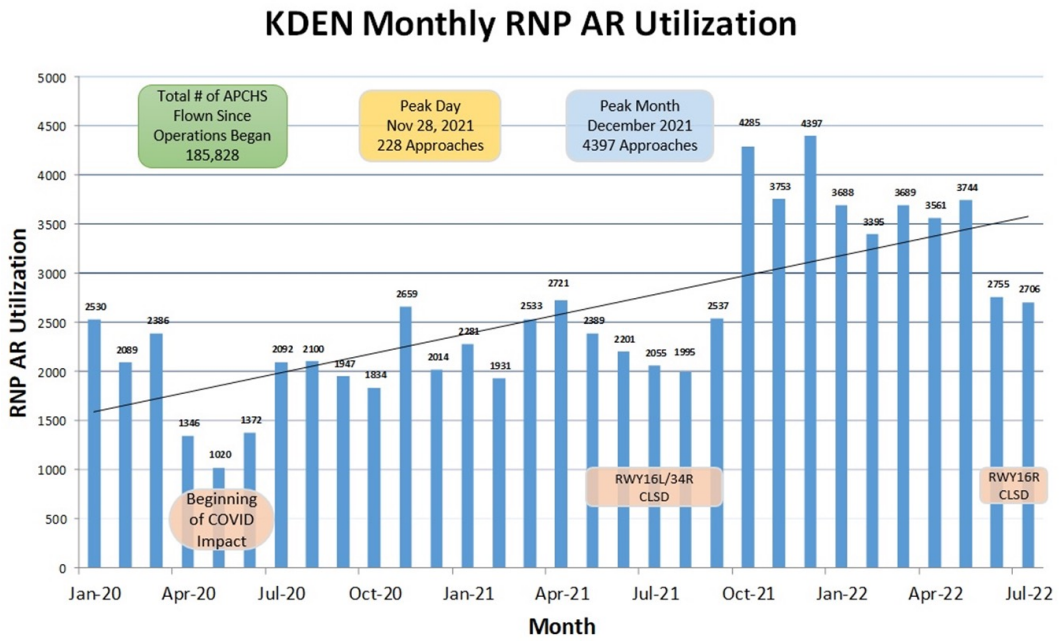
1 NOV 2019-31 Mar 2020
Period A: Multiple values # Days: 152

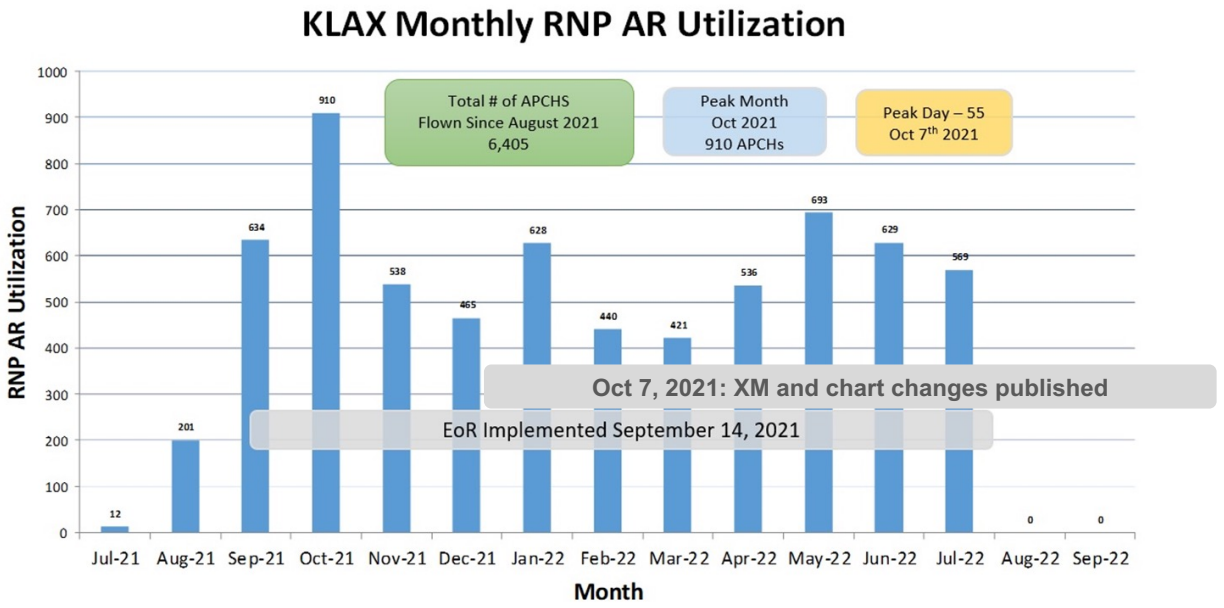
1 NOV 2021-31 Mar 2022
Period B: Multiple values # Days: 151

Weekday: All



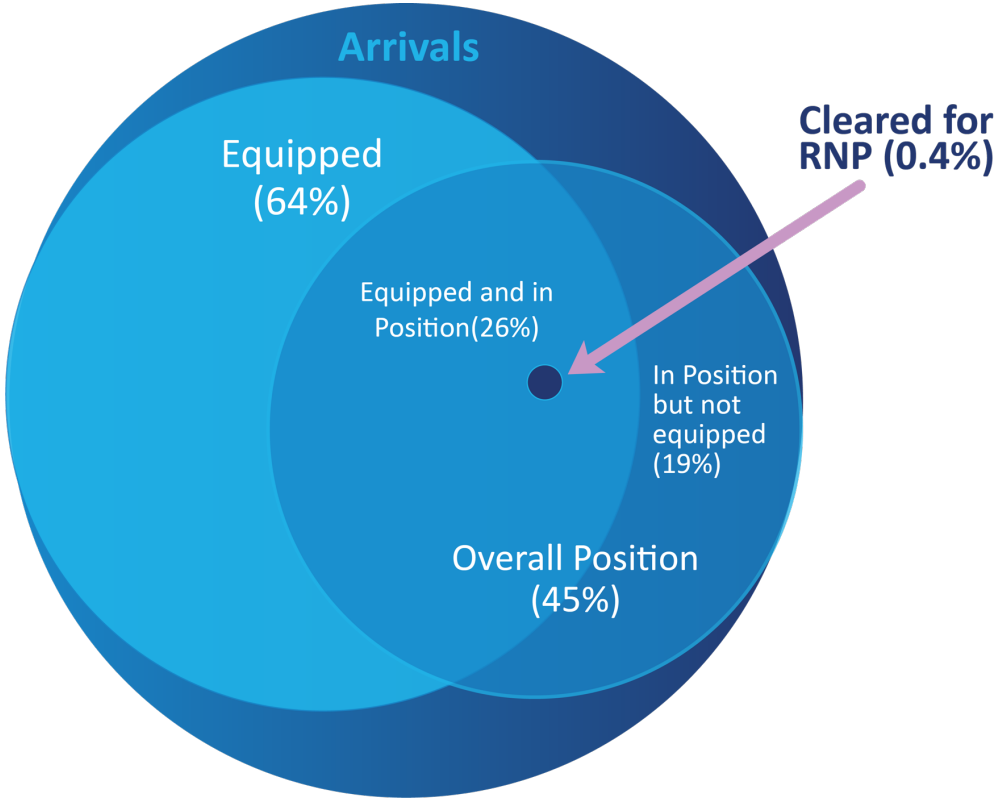
Complementary Insights: RNP Use



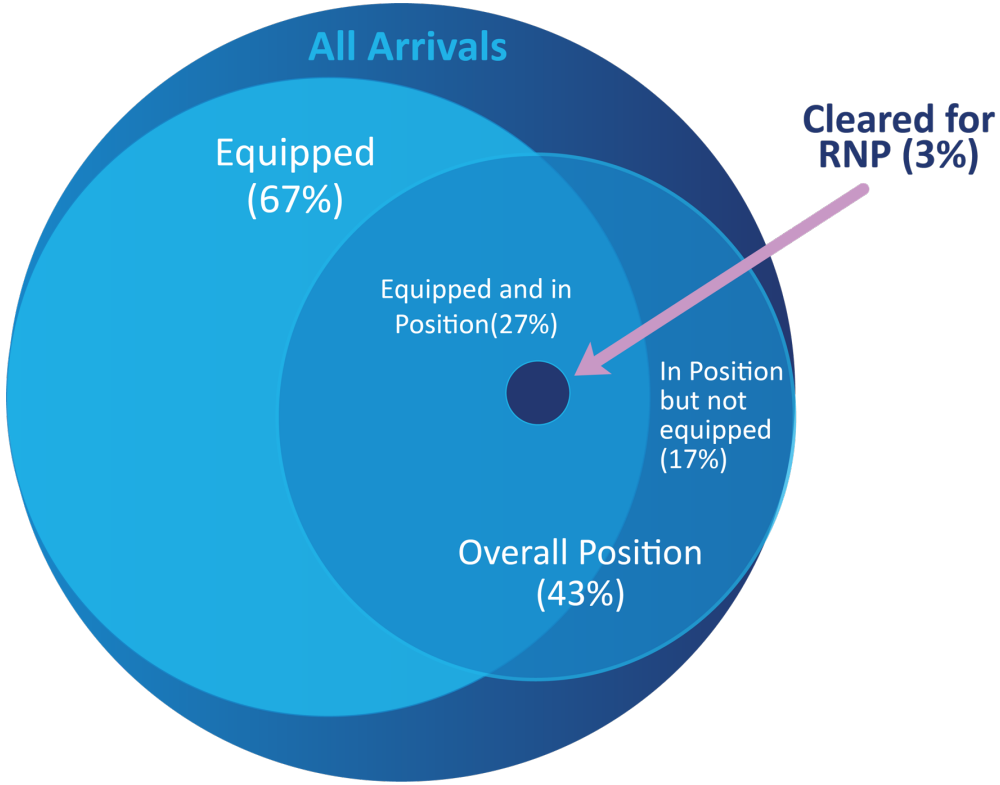


Complementary Insights: RNP Use

Jun 01, 2021 – Sept 13, 2021
LAX, Before EoR



Sept 14, 2021 – April 30, 2022
LAX, After EoR



In Summary…

TBO Analytics tool – a *living* tool that:

- Integrates data across multiple sources and evaluates performance outcomes for focal airports in the first four operating areas in a manner of seconds
- Helps understand both if the needle moved in the right direction, and if that movement was likely influenced by TBO
- Provides consistent reporting with other FAA tools that mine the same data sources
- Supports a wide range of analyses and reporting needs and users
- Provides data-driven insights that are necessary for understanding impacts made by TBO deployments, but does not interpret changes in performance

Wrap-up and Questions

iTBO Mid-Year Review of Accomplishments: 2022

Implementation Milestones	• TBFM v4.10.2 operational at ZAB/key site *(Jan)* • IDAC: NEC—MDT, ISP, ABE, ACY *(Jul);* NW Mountain—DEN, APA, COS, ASE *(Jul);* SE—MIA, FLL, RSW, PBI, TPA, FXE *(Aug)* • TBO efforts integral to FL initiative: SE—IDAC *(Aug/Sep);* OPF adapted in TBFM; ZMA—Possible Adjacent/Coupled scheduling to ATL/CLT/NY • SW—Extended Metering design development for LAS *(Sep)* • DataComm initial En Route services to ZOA *(Feb)*, ZMP *(May)*, ZMA *(Jun);* DataComm Full EnRoute services *(fall)* • TFMS R15: Reroute Impact Assessment, Surface Viewer—TFMS & TFDM *(Oct)* • TFDM IOC CLE Build 1.4 *(fall)*
Communication & Stakeholder Engagement	• First local TFDM CSIT meeting at CLT: FAA and stakeholders discussed surface automation, management, roles and responsibilities *(May)* • Coordinate TBO strategy with SESAR Deployment Coordination Committee (DCOM) *(Jun)* • TBO Industry Day *(Sep);* FAA TBO Summit *(Nov)*
Testing & Risk Mitigation	• SRM for Departure Scheduling to PHL *(Apr)* • TFDM Operational testing at WJHTC (*Apr*); initial operational testing at CLE *(Jun)* • TBFM/TFDM SW Interoperability assessment with Ops teams *(Jun)*
Training/ Education	• TMO Orientation training package: focused on TBO role in coordination and execution of iTBO in the field • DCC remote TBFM Training class first conduct completed, pending evaluation *(May)* • iTBO Training and Education for ATCSCC: 3 Phases- Overview of TBO *(Mar)*, TBFM Functionality *(May)*, TBFM Mechanics and Use Case *(Aug)* • TFDM initiated training for Tech Ops *(Jun)* • eLMS Course 60005744: TBFM Air Traffic Control System Command Center Training for ATCSCC Personnel (*Aug*) • SW—ZOA training on metering for LAS *(Sep)*
Workforce Alignment	• JO 3120.4 updates for ETMC and TBFM attendance • Update to FAA JO 7210.3 Chapter 18-10-4 Definitions *(May)* • Traffic Management National, Center, and Terminal, Section 21 Operations Plan *(Nov)*
Performance Assessment	• TBO Analytics enhancements: MIT restriction data, sequencing delays, incremental delays due to GDPs and TBFM departure scheduling *(June)* • TM capability health assessment *(ongoing as of Aug)*

Appendix – Metric Definitions

Metric	Definition	Source
Sequencing Delays in TRACON	The difference between the time in TRACON for a flight and the nominal time in TRACON for the flow (gate and arrival runway or meter fix and arrival runway). Calculation: Flight Time in TRACON minus nominal Time in TRACON.	TBFM Data
Runway Inter-Arrival Times and Quarter-Hour Throughput	Time between two consecutive aircraft across the runway threshold. Calculation: Identify time a lead aircraft crosses the runway threshold and time a trailing aircraft crosses runway threshold. Calculate IAT by taking the difference between the trailing and leading aircraft times crossing the runway threshold. Calculate count and proportion of flights with IATs falling within given intervals (i.e., bins). Both metered flights and non-metered flights are included. Additional Information: Calculated by individual runway but may be aggregated to obtain IAT distribution for a particular runway configuration.	Base Processing Environment (BPE) Data
Time Between Aircraft Through the Meter Fix	Time between two aircraft through the meter fix. Calculation: Identify time a lead aircraft crosses the meter fix and time a trailing aircraft crosses the meter fix. Calculate IAT by differencing trailing and leading aircraft times crossing the meter fix. Calculate count and proportion of flights with IATs falling within given intervals (i.e., bins). Both metered flights and non-metered flights are included. Additional Information: Calculated by individual meter but may be aggregated to obtain IAT distribution for a particular gate or corner post.	TBFM Data
Taxi Out Time at Origin Airports	It is the difference between Actual Gate Out time and Actual Wheels Off time, in minutes. It is the actual taxi-out time for flights with reported Out-Off-On-In (OOOI) data, otherwise it is estimated. Calculation: The taxi-out metric is queried directly from ASPM using the field TO.	ASPM Flight Data
Schedule Departure Delay at Origin Airports	Definition: The runway departure delay in minutes assigned by TBFM. Calculation: The difference between the TBFM-scheduled time of departure (STD) and the estimated time of departure (ETD). Additional Information: Metric calculated for departures destined to selected airport.	TBFM Data
Application of MIT Restrictions: Weekly Use	Average number of days per week when MIT restrictions were in place.	NTML
Application of MIT Restrictions: Restriction Duration	Duration in hours of each restriction that was in place.	NTML
Application of MIT Restrictions: MIT value	Distribution of restrictions by MIT value (in NM).	NTML
Application of MIT Restrictions: Stringency	Stringency, defined as the restriction duration in hours multiplied by the MIT value; it shows the severity of the restrictions.	NTML
Application of MIT Restrictions: Filed vs. Flown Distance	Difference between flown distance and filed distance for arrivals affected by MITs. Positive values indicate that the flight flew additional distance than planned.	AJR-G's filed vs. flown data
Incremental Delays (TBFM Dep Sch and GDPs)	The assigned TBFM delay that does not overlap with the assigned GDP delay for flights with both GDPs and TBFM departure scheduling. Calculation: Final TBFM Scheduled departure time minus EDCT in minutes. Additional Information: Negative incremental TBFM delay indicates a flight was scheduled to depart earlier than the EDCT.	EDCT Flight Level Data TBFM Data

Appendix – Metric Definitions

Metric	Definition	Source
TBFM Arrival System Metering: Delay	The airborne delay in minutes assigned by TBFM to a metered flight to maintain a de-conflicted arrival schedule at the destination airport. Calculation: The difference between the TBFM-scheduled time of arrival (STA) and the TBFM-estimated time of arrival (ETA) at the meter fix.	TBFM Data
TBFM Arrival System Metering: Delay Rate	The fraction of flights with zero delay, with less than 5 minutes of delay, and with 5 or more minutes of delay. Calculation: The ratio between the number of compliant flights and the total number of flights metered to the arrival system.	TBFM Data
TBFM Arrival System Metering: Compliance	The accuracy with which a flight crossed the meter fix with respect of its STA. Calculation: The difference between the actual cross time and the STA at a meter fix. Additional Information: A flight is “Compliant” when crossed the meter fix within -1.5 minutes and 1.5 minute of its STA, “1.5+ min Early” when crossed it earlier than 1.5 minutes of its STA, and “1.5+ min Late” when crossed it later than 1.5 minutes of its STA.	TBFM Data
TBFM Arrival System Metering: Compliance Rate	The fraction of flights with zero delay, with less than 5 minutes of delay, and with 5 or more minutes of delay. Calculation: The ratio between the number of compliant flights and the total number of flights metered to the arrival system.	TBFM Data
TBFM Extended Metering Delay	The airborne delay in minutes assigned by TBFM to a metered flight to maintain a de-conflicted arrival schedule at the XM arc. Calculation: The difference between the TBFM-scheduled time of arrival (STA) and the TBFM-estimated time of arrival (ETA) at XM arc.	TBFM Data
TBFM Extended Metering Compliance	The accuracy with which a flight crossed the XM arc with respect of its STA. Calculation: The difference between the actual cross time and the STA at a XM arc. Additional Information: A flight is “Compliant” when crossed the XM arc within -1.5 minutes and 1.5 minute of its STA, “1.5+ min Early” compliant when crossed it earlier than 1.5 minutes of its STA, and “1.5+ min Late” compliant when crossed it later than 1.5 minutes of its STA.	TBFM Data
TBFM Departure Scheduling Delay	The runway departure delay in minutes assigned by TBFM. Calculation: The difference between the TBFM-scheduled time of departure (STD) and the estimated time of departure (ETD). Additional Information: Metric calculated for departures destined to selected airport.	TBFM Data
TBFM Departure Scheduling Compliance Rate	The fraction of flights that departed compliant with their STD. Calculation: The ratio between the number of compliant departures and the total number of scheduled departures . Additional Information: A flight is “Compliant” when departed within -2.5 minutes and 1.5 minute of its STD, “2.5+ min Early” when departed earlier than 2.5 minutes of its STD, and “1.5+ min Late” compliant when departed later than 1.5 minutes of its STD. Metric calculated for departures destined to selected airport.	TBFM Data
Time in TRACON For Metered Flights	Time a flight spent inside the Terminal airspace; calculated for metered flights only. Calculation: Difference between meter fix crossing time and wheels-on time.	TBFM Data
TBFM Assigned Runway Compared to Arrival Runway Used	Comparison between the TBFM-assigned runway at the time the flight crossed the meter fix and the actual arrival runway, as reported in CountOps data. Calculation: Pull directly from TBFM data. Both the percentage and total number of flights for each category are shown for each period.	TBFM Data CountOps Data
Go-Around Rate	Number of go-arounds per 1,000 flights. Calculation: The number of arrivals with go-arounds is normalized by dividing it by the total number of arrivals and then multiplying it by 1,000. Additional Information: The presence of a go-arounds is determined algorithmically by PDARS. Go-arounds are joined to the quarter hour table by the time the go-around occurred.	PDARS Data

Appendix – Metric Definitions

Metric	Definition	Source
Airport efficiency opportunity score	•Proportion of QH periods in which at least one arrival was delayed 5 or more minutes by any delaying system (not total delay) while airport capacity utilization was less than 75% •Similar definition stands for 15 or more minutes of delay and arrival capacity utilization less than 90%	MITRE CAASD's TDAS, TFMS, NTML, ASPM
Delayed Arrivals	•Proportion of arrivals that were delayed 5 or more minutes by at least one system while airport capacity utilization was less than 75% by delaying system •Similar definition stands for 15 or more minutes of delay and arrival capacity utilization less than 90% •Caveat: if a flight has been delayed by more than one system, that flight will be included in each delaying system group and therefore, the total number of delayed arrivals will be inflated	MITRE CAASD's TDAS; TFMS; NTML