4th TBO Industry Day

Sep 7. 2022



Reminders

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



• Please mute your microphones



- There are multiple ways to ask a question:
 - Submit your questions via email <u>9-AJT-TBO@faa.gov</u>
 - 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, Wendv 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 SWIM AIMM Data Comm TBFM TFMS TFDM 	 TBFM ✓ Arrival metering ✓ Extended metering → Terminal metering 	 TBFM Automation ✓ Time based departure management TFMS ✓ Pre-departure reroutes ○ Surface Viewer TFDM ○ Automated surface management including 	 TFMS ✓ Route Availability Planning ✓ Airborne Reroutes Data Comm ✓ Initial En Route Services ○ Full En Route Services
o = In Development ✓ = Operationally Available in	n at least one location	surface metering <u>Data Comm</u> ✓ Tower Services	

NITCH.

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

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)

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

Operating Areas Pacific

North West North West Mountain



South Central



Data Comm Tower Data Services – 64 Towers

Data Comm Initial En Route Services – ZMA (2022)

Data Comm Full En Route Services (starting 2022)

Reroute Impact Assessment/TFMS R15 (2022)

En Route Departure Capability (EDC)

PDRR & ABRR (except ZNY)

IDAC at all ARTCCs (2023)

TFDM initial 10 sites (2024)

NAS-Wide

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North Central

North East Corridor



Northeast Corridor

- \checkmark 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 \checkmark
- IDAC
- TFDM at CLT Build 2 (2024)

Legend

- Completed
- In progress (Expected completion)
- On hold



12

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

Data Comm Initial En Route Services – ZKC, ZID, ZDC, ZMP, ZOA

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





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

52 Airports



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)

		Daily Affivais		Capacit	ty Utili	zation >	>= 75% a	and 95%
7BW	BOS	452	BOS		12%		36%	
700	BWI		BWI	496	13%			
200	DCA	415	DCA		169	6		45%
	IAD	361	IAD	= 196 596				
σ	RDU	220	RDU	09.96				
ZIX	MCO	502	MCO	196 596				
	FLL	397-1	FLL	0% 3%				
	MIA	665	MIA	= 196	1196			
2	PBI	270	PBI	-	1496		29%	
Se	TPA	• H 307	TPA	1% 4%				
E ZNY	EWR	• • 5 49	EWR			19%		48%
a	HPN	• 1-1 140 •	HPN	396 796				
st	JFK		JFK	796		24%		
E	LGA	506	LGA			22%		51%
	PHL	· · · · · · · · · · · · · · · · · · ·	PHL	496	12%			
	TEB	220	TEB	6%	169	6		
ZTL	ATL	• • • • • • • • • • • • • • • • • • • •	ATL	0% 5%				
	CLT	• • • • • • • 690 • •	CLT	3%		19%		
ZAU	MDW	•• += 231	MDW	296 796				
	ORD		ORD	6%		19%		
ZFW	DAL	••••••••••••••••••••••••••••••••••••••	DAL	_			28%	4496
	DFW	· · · · · · · · · · · · · · · · · · ·	DFW	3%	12%			
g ZHU	AUS	• • • • • • • • • • • • • • • • • • •	AUS	3%	1296			
re	HOU	• • 246	HOU	5%	15%			
A	IAH	• • • • 559	IAH	296	1196			
	MSY	•••••11161 •	MSY	196396				
Z ZID	CVG	• • • • • • • • • • • • • • • • • • • •	CVG	0%				
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t,	STL	•• •••• 209	STL	0%				
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Ŭ	MEM	326	MEM	096296				
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	PIT	• +	PIT	0%				
ZAB	PHX	• • • • • • • 5 84	PHX	= 1 % 8%	6			
ZDV	DEN	• • • • • • • • • • • • • • • • • • • •	DEN	296	1296			
ZLA	BUR	• + 130	BUR	0%				
e	LAS	• • • • • • • • • •	LAS	596		22%		
Ar	LAX	• • • • • • • • • • • • • • • • • • • •	LAX	1 96		2096		
9	LGB	• + 69	LGB	0%				
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er	SNA	•	SNA	0.001	1196	23%		
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e	SFO	• • • • • • • • • • • • • • • • • • • •	SFO	89	6	21%		
3	SJC	•••••••••••••••••••••••••••••••••••••••	SJC	496	10%			
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		-										
BOS	38%		BOS	0.2M								
BWI	1696		BWI	0.4M				_				
DCA	2396		DCA	_		3.6M						
IAD	26%		IAD		2.2M							
RDU	34%		RDU	_								
мсо	39%		MCO	1.	5M			_				
FLL	33%		FLL			3.6M						
MIA	30%		MIA	-			5.4M			_		
PBI	49%		PBI	_			5.7M					
TPA	51%		TPA	1.	4M							
EWR	36%		EWR	_	-			7.8M				
HPN	60%		HPN	0.8M								
JFK	27%		JFK	_			5.4M					
LGA	36%		LGA	_		4.5	M					
PHL	19%		PHL	1.3	M							
TEB	43%		TEB		3.	1M						
ATL	5596		ATL	0.6M								
CLT	44%		CLT	0.7M								
MDW	1196		MDW	0.4M								
ORD	42%		ORD					8.1M				
DAL	30%		DAL	0.2M								
DFW	31%		DFW	_	2.2M							
AUS	3196		AUS	0.1M								
HOU	17%		HOU	p.om								
IAH	1996		IAH	0.7M								
MSY	89%		MSY	0.0M								
CVG	33%		CVG	0.0M								
IND	21%		IND	0.1M								
MCI			MCI									
STL			STL									
BNA	15%		BNA	0.0M								
MEM	3796		MEM	0.4M								
MSP	1196		MSP	0.1M								
CLE			CLE									
DTW	13%		DTW	0.0M								
PIT	25%		PIT	0.0M								
PHX	24%		PHX	p.om								
DEN	30%		DEN	0.1M								
BUR	32%		BUR	0.0M								
LAS	3896		LAS	1	6M							
LAX	3196		LAX		1.8M							
LGB	2996		LGB	p.om								
SAN	8%		SAN	0.2M								
SNA	3296		SNA	0.1M								
VNY	52%		VNY	0.0M								
SLC	2196		SLC	0.0M								
OAK	29%		OAK	0.0M								
SFO	3196		SFO	0.2M								
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Opportunity Space (2/2)

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	ZDC	BWI2.9	BWI	0.2
		DCA 43	DCA	0.2
		140 21		2.5
		IAD 2.1	TAD	2.5
Ð			RDU	
5	ZJX	MCO 2.5	MCO	
A	ZMA	FLL 1.4	FLL	0.4
<u>,</u>		MIA2.6	MIA	0.0
2		PBI - 4.1	PBI	0.6
s S		TPA 3.4	TPA	1.8
5	ZNY	EWR - 3.2	EWR	2.9
te l		HPN 4.3	HPN	2.7
as		15K 4.6	JEK	1.7
		160 25	IGA	2.6
			DUI	23
		FRL 1.0	TED	25
	771			11
	ZTL	AIL 3.0	AIL	
	1	CLI 4.2	CLT	
	ZAU	MDW 1.0	MDW	3.3
		ORD 2.3	ORD	1.9
	ZFW	DAL 2.9	DAL	2.8
		DFW 3.6	DFW	1.2
	ZHU	AUS 1.3	AUS	0.0
a D		HOU 3.2	HOU	0.0
5		IAH2.9	IAH	0.5
A		MSY 1.3	MSY	
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ి	7845		SIL	
_	ZIVIE	BNA 2.0	BNA	
			MEM	0.0
	ZMP	MSP – 2.7	MSP	
	ZOB	CLE 2.0	CLE	0.0
		DTW 2.2	DTW	0.1
		PIT 2.6	PIT	1.2
	ZAB	PHX 0.9	PHX	0.0
	ZDV	DEN - 2.5	DEN	0.4
	ZLA	BUR - 0.8	BUR	1.5
_		LAS 0.6	LAS	0.0
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BWI		BWI	5.1
DCA	0.1	DCA	4.5
IAD	0.3	IAD	4.8
RDU	- 0.5	RDU	8.3
MCO	1.0	MCO	6.2
FLL	0.2	FLL	0.0
MIA	0.7	MIA	0.0
PBI		PBI	0.0
TPA	0.1	TPA	1.2
EWR	0.0-1	EWR	0.5
HPN	0.5	HPN	10.9
JFK	0.3	JFK	3.8
LGA	0.1	LGA	4.9
PHL	0.7	PHL	4.6
TEB	0.1	TEB	1.9
ATL	0-0	ATL	2.7
CLT	0.1	CLT	4.7
MDW	0.6	MDW	6.9
ORD	0.2	ORD	4.9
DAI	0.4	DAL	0.0
DEW	0.5	DEW	1.0
AUS	0.8	AUS	0.0
HOU	0.2	HOU	4 1
IAH	0.8	INH	2.0
MSV	0.3	MSV	0.0
CMH	0.9	CMH	3.9
CVG	0.6	CVG	4 4
IND	0.4	IND	6.6
MCI	0.6	MCI	2.0
STI	0.2	STI	6.2
BNA		BNA	3.5
MEM	0.3	MEM	18
MSP	0.3	MSP	9.4
CLE	0.0	CLE	4.1
DTW	0.2	DTW	10.5
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SAN	0.2	SAN	7.0
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SLC		SLC	3.2
SEO	0.2	SEO	5.2
SIC	0.1	SIC	5.5
SJC	10.1	SJC	6.5
SIVIE	0.2	SIVIE	6.9
PDX	0.5	PDX	0.0
SEA	0.0	SEA	12.1
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	BWA DCA IAD RDU MCCO FLL MIA PBI TPA EWR HPN IFK LGA PHK LGA PHK LGA PHK CGM MDW ORD ORD ORD ORD ORD ORD ORD ORD	BW 10.1	BWI 0.1

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10.5 10.5 8.2 10.0 10.0 12.4 12.8 12.4 12.8 12.4 12.8 12.4 10.0 12.4 12.8 12.4 12.8 12.4 12.8 12.4 12.8 12.4 12.8 12.4 13.2 10.5 13.2 10.5 16.9 12.1	4.1						
8.2 10.0 12.4 17.6 17.6 17.5 17.5 10.0 10.1 12.4 12.4 13.2 16.9 16.1 16.2 12.1		10.5					
$\begin{bmatrix} 6.3 \\ 8.0 \\ 10.0 \\ 12.4 \\ 7.5 \\ 7.5 \\ 10.5 \\ 6.9 \\ 6.1 \\ 6.8 \\ 12.1 \\ 10.5 \\ 11.2 \\ 10.5 \\ 11.2 \\ 10.5 \\ 11.2 \\ 10.5 \\ 11.2 \\ 10.5 \\ 11.2 \\ 10.5 \\ 11.2 \\ 10.5 \\ 11.2 \\ 10.5 \\ 11.2 \\ 10.5 $		8.2					
8.0 12.4 12.4 12.4 12.4 12.4 12.4 12.4 12.4 12.4 12.4 12.4 12.4 14.4 12.4 14.4 12.4 14.4 12.4 14.4 12.4 14.4 12.4 14.4 12.4 14.4 12.4 14.4 12.4 14.4 12.4 14.4	6.3	3				-1	
10.0 12.4 12.4 12.4 12.4 12.4 10.5 10.5 11.2 10.5 11.2 10.5 11.2 10.5 11.2 10.5 11.2 10.5 11.2 10.5 11.2 10.5 11.2 10.5 11.2 10.5 11.2 10.5 11.2 10.5 11.2 10.5		8.0	H				-
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2.8 7.6 7.0 7.6 7.0 7.6 7.1 11.2 10.5 11.2 3.2 10.5 6.9 12.1		12	2.4	-			4
7.6 7.0 7.5 11.2 10.5 3.2 6.9 6.1 6.8 12.1	2.8	· ·					
7.0 17.5 10.5 5.3 6.9 6.1 6.8 12.1		7.6				-	
	7	.0				4	
		7.5					
10.5 5.3 6.9 16.1 6.8 12.1		111.2					
		110.5					_
	32	10.0					
	5.2						
	3.3	0			1		
	0	.9				-	
	16.1	0	-				1
12.1	0	- 10	1			1	
		12	. 土				-

Opportunities per Flt (1/4)







Opportunities per Flt (2/4)



















Opportunities per Flt (3/4)







Opportunities per Flt (4/4)





















Total Opportunities

















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



ded in the Top 10 Air



BO

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



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







TBFM Arrival Metering

Weekly Use		Daily Duration	Proportion	of Metered Arrivals		Assigned De	elay		Com	pliance		
ZBW BOS 1.0	BOS +	23	BOS 1496		BOS	37%	52% 11%	BOS	1096	83%	8%	_
ZDC BWI	BWI		BWI		BWI			BWI				
DCA	DCA		DCA		DCA			DCA				
IAD	IAD		IAD		IAD		Delay Type	IAD		Co	mpliance Type	
	RDU		RDU		RDU		5+ min	RDU			1.5+ min late	
AT ZJX MCO	MCO		MCO		MCO		< 5min	MCO			1 5+ min early	
U ZMA FLL	FLL		FLL		FLL		Zero	FLL			1.51 min carry	
	DRI		DDI		DDI	-		DDI				
			ТРА		TDA	-		TDA				
E ZNY EWR	EWR		EWR		EWR			EWR				
U HPN	HPN		HPN		HPN			HPN				
JFK JFK	JFK		JFK		JFK			JFK				
LGA LGA	LGA		LGA		LGA			LGA				
PHL	PHL		PHL		PHL			PHL				
TEB	TEB		TEB		TEB			TEB				
ZTL ATL 6.8	ATL	18.3	ATL	• • • • • • • • • 85% -	ATL	72%	28% 0%	ATL 3	96	88%	8%	
CLT 6.8	CLT +	12.1		• • • • • • • • • • • • • • • • • • •	CLT	64%	35% 1%	CLT B	9 0	77%	19%	
ZAU MDW	MDW		MDW		MDW			MDW				
				6206	DAL	4196	50% 9%		06	9106	506	
DFW 10	DEW	16	DFW		DEW	46%	47% 7%	DEW 2	96	94%	5%	
ZHU AUS	AUS		AUS	· · · · · · · · · · · · · · · · · · ·	AUS			AUS				
U HOU 2.5	HOU F	2.3	HOU 26	96	HOU	60%	36% 4%	HOU	96	88%	8%	
AH 3.3	IAH F	3.2	IAH HANNE MARKAN	3396	IAH	60%	38% 2%	IAH 1	96	91%	7%	
8 MSY	MSY	-	MSY	-	MSY			MSY				
ZID CMH	CMH		СМН		CMH			CMH				
CVG CVG	CVG		CVG		CVG	_		CVG				
	IND		IND		IND			IND				
ZKC MCI	MCI		MCI		MCI			MCI				
	SIL		SIL		SIL			SIL				
		- # 1-b		70.6	MEM	52%	45% 3%	MEM	1096	76%	14%	
7MP MSP 1.6	MSP	H 1-0- · ·	MSP 1296		MSP	59%	34% 6%	MSP	996	86%	5%	
ZOB CLE	CLE		CLE		CLE			CLE				
DTW	DTW		DTW		DTW	-		DTW				
PIT	PIT		PIT		PIT			PIT				
ZAB PHX 6.4	PHX F	2.3	PHX	3396	PHX	62%	38% 0%	PHX 3	96	85%	12%	
ZDV DEN 7.0	DEN	• • • • • • • • • • • • • • • • • • •	DEN ••	······································	DEN	78%	21% 0%	DEN	96	96%	3 <mark>%</mark>	
ZLA BUR	BUR		BUR		BUR			BUR			-	
5.9		9.2		69%	LAS	67% 68%	33% 0%		90	95%	3%	
		14:0	LAA	8496 1		00%0	52% 0%			5370	090	
SAN 50	SAN	6.3	SAN	4196	SAN	63%	37% 0%	SAN 1	96	94%	4%	
Z SNA	SNA		SNA		SNA			SNA				
о VNY	VNY		VNY		VNY			VNY				
E ZLC SLC 5.5	SLC +	11.2 ·····	SLC 1896	0 0	SLC	64%	35% 1%	SLC 2	96	89%	9%	
to ZOA OAK	OAK		ОАК		OAK			OAK				
SFO 2.5	SFO +	- 1 2.0 · · ·	SFO 10%		SFO	67%	31% 2%	SFO 3	96	89%	8%	
S SJC	SJC		SJC		SJC			SJC				
SMF	SMF		SMF		SMF			SMF				
	PDX	and the class	PDX SEA	001	PDX	EE06	2906	PDX	04	9606	1406	-
0 1 2 3 4 5 6 7		5 10 15 20 25	0% 20%	40% 60% 80% 100%	SEA	0% 20% 40%	60% 80% 100%	SEA S	20% 4	0% 60%	80% 100%	TCA
Avg. Number of Days per Week		Duration (hrs)	2010	Arrivals (%)		Arrivals	(%)		_370	Arrivals (%)		Y
			L		L							-



TBFM Extended Metering

	Weekly Use	Daily Duration	Proportion of Metered Arrivals	Assigned Delay	Compliance
ZBW BOS		BOS	BOS	BOS	BOS
ZDC BWI		BWI	BWI	BWI	BWI
DCA	_	DCA	DCA	DCA	DCA
IAD DDU		IAD	IAD	Delay Type	Compliance Type
		MCO	MCO	MCO 5+ min	MCO 1.5+ min late
ZIX MCO		FU	FL	FII Smin	FI Compliant
		MIA	MIA	MIA	MIA 1.5+ min early
∠ PBI		PBI	PBI	PBI	PBI
ທ TPA		TPA	TPA	TPA	ТРА
E ZNY EWR		EWR	EWR	EWR	EWR
HPN to		HPN	HPN	HPN	HPN
G JFK		JFK	JFK	JFK	JFK
LGA		LGA	LGA	LGA	LGA
TEB		TEB	TFR	TEB	TEB
ZTL ATL		ATL	ATL	ATL	ATL
CLT		CLT	CLT	CLT	CLT
ZAU MDW		MDW	MDW	MDW	MDW
ORD		ORD	ORD	ORD	ORD
ZFW DAL		DAL	DAL	DAL	DAL
DFW		DFW	DFW	DFW	DFW
C ZHU AUS		HOU	AUS	AUS	HOU
Ø MSY		MSY	MSY	MSY	MSY
S ZID CMH		СМН	СМН	СМН	СМН
CVG		CVG	CVG	CVG	CVG
		IND	IND	IND	IND
ZKC MCI		MCI	MCI	MCI	MCI
G STL		STL	STL	STL	STL
O ZME BINA		BNA	BNA	BNA	BNA
7MP MSP		MSP	MSP	MSP	MSP
ZOB CLE		CLE	CLE	CLE	CLE
DTW		DTW	DTW	DTW	DTW
PIT		PIT	PIT	PIT	PIT
ZAB PHX	7.0	PHX H-1 2.51	PHX • - 2296 • •	PHX 59% 41% 0%	PHX 5% 93% 2%
ZDV DEN	7.0	DEN 19.4-1	DEN • • • • • • • • • • • • • • • • • • •	DEN 74% 26% 0%	DEN 2% 94% 4%
		BUR	BUR	BUR	BUR
	7.0			LAS 25% 0%	LAS 96% 1%
		LGB	LGB	LGB	LGB
SAN		SAN	SAN	SAN	SAN
SNA SNA		SNA	SNA	SNA	SNA
VNY VNY		VNY	VNY	VNY	VNY
ZLC SLC		SLC	SLC	SLC	SLC
ZOA OAK		CAK	SEO	SEO	SEO
		SIC	SIC	SIC	SIC
SMF		SME	SME	SME	SME
ZSE PDX		PDX	PDX	PDX	PDX
SEA		SEA	SEA	SEA	SEA
	0 1 2 3 4 5 6 7	0 5 10 15 20	0% 20% 40% 60% 80% 100%	0% 20% 40% 60% 80% 100%	0% 20% 40% 60% 80% 100%
	Avg. Number of Days per Week	Duration (hrs)	Arrivals (%)	Arrivals (%)	Arrivals (%)

TBFM Dep Scheduling into Arrival Timeline

Weekly Use	Daily Duration	Proportion of Scheduled Arrivals	Assigned Delay	Compliance
ZBW BOS 1.8	BOS 1.3	BOS H 2961	BOS 18% 64% 18%	BOS 25% 56% 19%
ZDC BWI	BWI	BWI	BWI	BWI
DCA	DCA	DCA	DCA	DCA
IAD	IAD	IAD	IAD	IAD
ng RDU	RDU	RDU	RDU Delay Type	RDU Compliance type
ZIX MCO	MCO	MCO	MCO 15+ min	MCO 1.5+ min late
g ZMA FLL	FLL	FLL	FLL == < 15 min	FLL Compliant
-S MIA	MIA	MIA	MIA	MIA 2.5+ min early
	PBI	PBI	PBI	PBI
	ТРА			
	EWR			
S HPN	HPN			
	JFR		JFK	
		DUL	LGA	DUI 16% 60%
4.0 TED			PHL 3270 4370 370	
			ATI 54% 43% 24%	ΔΤΙ 15% 75% 10%
			CIT 50% 44% 5%	CIT 15% 75% 10%
	MDW	MDW	MDW	MDW
ORD	ORD	ORD	ORD	ORD
ZEW DAL 7.0	DAL 1.4	DAL	DAL 25% 58% 17%	DAL 21% 70% 10%
DFW 7.0	DFW 2.1	DFW •	DFW 39% 58% 3%	DFW 8% 79% 13%
ZHU AUS	AUS	AUS	AUS	AUS
HOU 7.0	HOU H0.5	HOU 1-19%	HOU 26% 66% 8%	HOU 14% 73% 13%
Ž IAH 7.0	IAH Hi 0.6	IAH H 6%	IAH 26% 64% 10%	IAH 11% 76% 12%
a MSY	MSY	MSY	MSY	MSY
S ZID CMH	СМН	СМН	СМН	СМН
a CVG	CVG	CVG	CVG	CVG
S IND	IND	IND	IND	IND
C ZKC MCI	MCI	MCI	MCI	MCI
번 STL	STL	STL	STL	STL
3 ZME BNA	BNA	BNA	BNA	BNA
MEM 2.7	MEM IBIO	MEM 10%	MEM 36% 42% 23%	MEM 22% 64% 14%
ZMP MSP 7.0	MSP 0.8	MSP H 6%	MSP 52% 46% 2%	MSP 16% 66% 19%
ZOB CLE	CLE		CLE	CLE 1204 1204 1204
DTW 7.0	DTW 14.9	DIW	DIW 58% 41% 1%	DIT 75% 75% 12%
PII 745 DUV	PII		PII DUV 46% 51% 20%	PHY 14% 77% 9%
ZAB PHX 7.0	PHX H 2.2		PHX 40% 51% 3%	DEN 19% 68% 13%
	DIID		BID	BUR
			145 35% 59% 6%	LAS 20% 70% 10%
		LAX ++ 5%	LAX 45% 51% 4%	LAX 22% 69% 8%
	IGB	LGB	LGB	LGB
SAN 6.6	SAN 0.8	SAN H 5%	SAN 46% 51% 396	SAN 20% 70% 10%
SNA SNA	SNA	SNA	SNA	SNA
S VNY	VNY	VNY	VNY	VNY
E ZLC SLC 7.0	SLC H 1.0	SLC	SLC 42% 56% 1%	SLC 16% 72% 11%
ZOA OAK	OAK	OAK	OAK	OAK
SFO 7.01	SFO IO11	SFO # 3% -	SFO 41% 52% 7%	SFO 16% 71% 13%
≥ sjc	SJC	SJC	SJC	SJC
SMF	SMF	SMF	SMF	SMF
ZSE PDX 2.3	PDX Hella.0	PDX HI 5%	PDX 76% 24% 1%	PDX 1496 7596 1196
SEA 7.0	SEA 3.8	SEA H-1296	SEA 49% 46% 49%	SEA 19% 71% 10%
0 1 2 3 4 5 6 7	0 5 10 15	0% 20% 40% 60% 80% 100%	0% 20% 40% 60% 80% 100%	0% 20% 40% 60% 80% 100%
Avg. Number of Days per Week	Duration (hrs)	Arrivals (%)	Arrivals (%)	Arrivals (%)

BOA

TBO TBFM Dep Scheduling into EDC Timeline

Weekly Use	Daily Duration	Proportion of Scheduled Arrivals	Assigned Delay	Compliance
ZBW BOS 1.4	BOS 111	BOS W 296	BOS 49% 43% 9%	BOS 17% 74% 9%
ZDC BWI 7.0	BWI 10.4	BWI HIS%1.	BWI 66% 31% 3%	BWI 15% 77% 8%
DCA 7.0	DCA 6.0	DCA 34%-	DCA 64% 33% 2%	DCA 12% 78% 10%
IAD 7.0			IAD 62% 33% 5%	IAD 13% 75% 12%
rg RDU	RDU	RDU	RDU	RDU
	MCO H04-	MCO W296	MCO 49% 45% 5%	MCO 16% 75% 10%
		FIL HIPM	ELI 58% 38% 49%	FLI 15% 73% 12%
		MIA HI3%	MIA 58% 39% 30	MIA 15% 74% 11%
PRI 65	PBI 102	PBI	PBI 45% 47% 8%	PRI 19% 69% 12%
	TPA Iblo	TDA N-196	TPΔ 57% 40% 30	TPA 18% 73% 9%
	FWP Harmonia and a second seco	FWR	EWR 46% 45% 9%	EWR 16% 76% 9%
		HDN H 206	HDN 27% 59% 15%	HPN 24% 62% 14%
7.0			IEK 50% 44% 5%	IFK 16% 75% 8%
			IGA 51% 43% 6%	I LGA 16% 75% 8%
			PHI 59% 38% 3%	PHI 12% 79% 9%
TER 7.0			TEB 40% 53% 50%	TEB 22% 69% 9%
		ΔΤΙ ΙΦ%	ΔΤΙ 53% 40% 7%	ATI 15% 70% 15%
		CIT Inter	CIT 55% 27% 7%	CIT 12% 76% 12%
7AU MDW 7A			MDW 7496 2504 104	MDW 13% 81% 60%
			OPD 5106 4404 664	OPD 1496 7796 996
				A DAL 12% 78% 0%
ZFW DAL 6.7	DAL		DAL 00% 30% 49	DEW 996 8496 706
7.0	DFW 5./		AUC 50% 41% 57%	AUS 696 7596 1996
ZHU AUS	AUS III:4-IIIII	AUS 1000	A05 50% 44% 0%	
HOU	HOU		HOU 2006 2006 2006	
IAH 7.0			IAH 71% 28% 2%	MCV
MSY	MSY	MSY	MSY	
ZID CMH	CMH	CMH	CIVIH Delay Type	Civin Compliance type
CVG	CVG	CVG	CVG 15+ min	LUD 1.5+ min late
IND	IND	IND	IND <= <15 min	Compliant
ZKC MCI	MCI	MCI	MCI Zero	MCI 2.5+ min early
STL	STL	STL	STL	SIL
ZME BNA	BNA	BNA	BNA	BNA
MEM 1.1	MEM 0.7-1	MEM HI3%	MEM 48% 41% 11%	MEM 1190 7690 1390
ZMP MSP 7.0	MSP IO.1	MSP Hi296	MSP 59% 40% 1%	/ MSP 11% 79% 9%
ZOB CLE	CLE	CLE	CLE	CLE
DTW 7.0	DTW I0.0I-	DTW HH296	DTW 81% 18% 0%	1 DTW 7% 89% 440
PIT	PIT	PIT	PIT	PIT
ZAB PHX 3.9	PHX Hereitzen hann hann hann hann hann hann hann ha	PHX HIB%	PHX 52% 45% 2%	PHX 16% 72% 12%
ZDV DEN 7.0	DEN 1.7	DEN HI1696	DEN 63% 34% 2%	DEN 12% 80% 7%
ZLA BUR	BUR	BUR	BUR	BUR
LAS 7.0	LAS 11.9	LAS	LAS 40% 53% 7%	LAS 1796 7196 1196
LAX 7.0	LAX	LAX · -HI121496	LAX 46% 49% 49%	LAX 13% 81% 6%
LGB	LGB	LGB	LGB	LGB
SAN 4.9	SAN H0.3 I	SAN Hi2%	SAN 52% 45% 3%	SAN 14% 77% 8%
SNA	SNA	SNA	SNA	SNA
VNY	VNY	VNY	VNY	VNY
ZLC SLC 7.0	SLC	SLC H 8%I	SLC 63% 35% 2%	SLC 13% 74% 13%
ZOA OAK 2.4	OAK Hille:6	OAK HIB96 ·	OAK 61% 36% 3%	OAK 18% 69% 13%
SF0 5.1	SFO	SFO H 5% + I	SFO 44% 45% 12%	SFO 18% 70% 12%
SJC	SJC	SJC	SJC	SJC
SMF 1.7	SMF Hillo.s	SMF HI 496	SMF 66% 31% 3%	i SMF 15% 67% 18%
ZSE PDX	PDX	PDX	PDX	PDX
SEA	SEA	SEA	SEA	SEA
0 1 2 3 4 5 6 7	0 5 10 15	0% 20% 40% 60% 80% 100%	0% 20% 40% 60% 80% 100%	0% 20% 40% 60% 80% 100%
Avg. Number of Days per Week	Duration (hrs)	Arrivals (%)	Arrivals (%)	Arrivals (%)

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Application of MITs

Weekly Use	Restriction Duration	MIT Value	Stringency by Providing Facility
			ZAB ZAU ZBW ZDC ZDV ZFW ZHU ZID ZJX ZKC ZLA ZLC ZMA ZME ZMP ZNY ZOA ZOB ZSE ZTL
ZBW BOS	BOS H 1.9 H	BOS	BOS
ZDC BWI 5.9	BWI HHEO	BWI	BWI
DCA 7.0	DCA I-13+	DCA 30% 34%	DCA DCA
IAD 7.0	IAD I-I 1:10	IAD 36% 31% MIT Value (NM)	IAD III III III III III III III III III
RDU RDU	RDU	RDU 5	RDU
ZJX MCO	MCO 1.8 1.8	MCO 10	MCO MCO MODELLA
J ZMA FLL 7.0	FLL 2.0	FLL 23956901596	FLL FLL
0 MIA 7.0	MIA 2.3	MIA 52%	MIA
S PBI 7.0	PBI 3.0 ·····	PBI 46%	PBI
о тра 5.1	TPA 1	TPA So So	TPA
E ZNY EWR 7.0	EWR 2.2	EWR 22% 39% 25%	EWR
1.9	HPN 2.3 2.3	HPN HPN	HPN
00 JFK 7.0	JFK	JFK 39% 25%	JFK
ш <u>LGA</u> 6.9	LGA 1-15	LGA 49% 19%	
PHL 6.4	PHL	PHL 44%	
TEB 5.9		TEB 38%26%	
ZTL ATL 6.9	ATL Helle	ATL	ATL ALL ALL ALL ALL ALL ALL ALL ALL ALL
CLT 3.5			
ZAU MDW 6.2	MDW Hi0.5	MDW	MDW
ORD 7.0		ORD 19% 40% 15% 22%	ORD
ZFW DAL 1.0		DAL	
DFW 7.0	DFW H10	DFW 37% 46%	DFW
g ZHU AUS 2.4		AUS	
	HOU H0.8	HOU	
4.6			
	MISY HILES	MSY	
		CVG 100%	
(Å) IND 4.5			
		SIL	
O ZME BNA 0.4		BNA	BNA
7MD MCD			MEM
		DTW 100%	DIW
	DIT 123	DIT 100%	
	PHX III B		PH/
		BID	
		IGB	IGB
SAN 52	SAN Hilels	SAN	SAN
		SNA	SNA
0.9		VNY	VNY
E ZLC SLC	SLC HD.8	SLC	SLC
ZOA OAK 1.7	OAK Hiltel	OAK	OAK
SFO 5.2	SFO HILIO-I	SFO	SFO
SJC 0.9	SJC HHL.O	SJC	SJC
SMF 0.1	SMF 1.3	SMF	SMF
ZSE PDX 0.0	PDX 0.5	PDX 100%	PDX
SEA 0.2	SEA 2.2	SEA	SEA
0 1 2 3 4 5 6 7	0 5 10 15 20		
		ON IN IN IN TH ON OR TR	Stringency 0 3,781,725
Avg. Number of Days per Week	Duration (hrs)	Number of Restrictions	
			-

BO

Equipage and Use of RNP IAP with RF Turns



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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





TBO Analytics Highlights

- Established an infrastructure for *automated* integration of critical data-sources
- Enables <u>standardized and quick</u> comparison of critical metrics at select locations and customized periods of interest
- <u>Supports a broad range of needs and users</u>
 - 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...
- <u>Complements</u> reporting by other FAA tools and provides <u>consistent</u> evaluations for the same inputs
- *Living tool* with increasing user-base and requests for expanding its capabilities



Integrated Data

Individual Flight Data





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1

TBO Analytics Tool: Content

Fec Adi	deral Aviation ministration	TBO Analytics				Pi		
Airport DEN	Period 1 - Start January 3, 2020 Beginning at 00002	Period 1 - End January 30, 2020 Ending at 23592	Period 2 - Start October 3, 2021 Beginning at 00002	. O	eriod 2 - End ctober 30, 2021 nding at 23592	Reportable Hours True	Apply	Perio P P
Airport Co	ontext - DEN							
Repo	Period 1: Januar	y 3, 2020 to January 30, 20 Reported)20 Weather Category		Reported Ru	Period 2: October 3, 2021	to October 30 Reporte	, 2021 d Weather Cat
34R, 35I	., 35R 16L, 16R, 17R		v		16L, 16R, 17	34R, 35L, 35R		v
Call 100% 80% 60%	led Rates During Reportable	Hours	Norm. Diversions Cancel	rm. lations	Called Rat	es During Reportable Hours	0 Arrivals 9	Norm. Diversion

C 0% 0 5 10 15 20 25 30 35 00 10 15 20 25 30 35 00 10 15 20 25 30 35 00 10 15 20 25 30 35 00 10 15 20 25 30 35 00 10 15 20 25 30 35 00 10 15 20 25 30 35 00 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 15 10



Airport Context

Differences in operating conditions

TBFM Arrival Metering System Overview

• Differences in use of Arrival Metering System

Operational Topics of Interests

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







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: RNP Use

KDEN Monthly RNP AR Utilization



KLAX Monthly RNP AR Utilization





Complementary Insights: RNP Use







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



TBO JTBO 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 (<i>Apr</i>) TFDM Operational testing at WJHTC (<i>Apr</i>); initial operational testing at CLE (<i>Jun</i>) TBFM/TFDM SW Interoperability assessment with Ops teams (<i>Jun</i>)
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 (<i>May</i>) iTBO Training and Education for ATCSCC: 3 Phases- Overview of TBO (<i>Mar</i>), TBFM Functionality (<i>May</i>), TBFM Mechanics and Use Case (<i>Aug</i>) TFDM initiated training for Tech Ops (<i>Jun</i>) eLMS Course 60005744: TBFM Air Traffic Control System Command Center Training for ATCSCC Personnel (<i>Aug</i>) SW—ZOA training on metering for LAS (<i>Sep</i>)
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



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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

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Appendix – Metric Definitions

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

