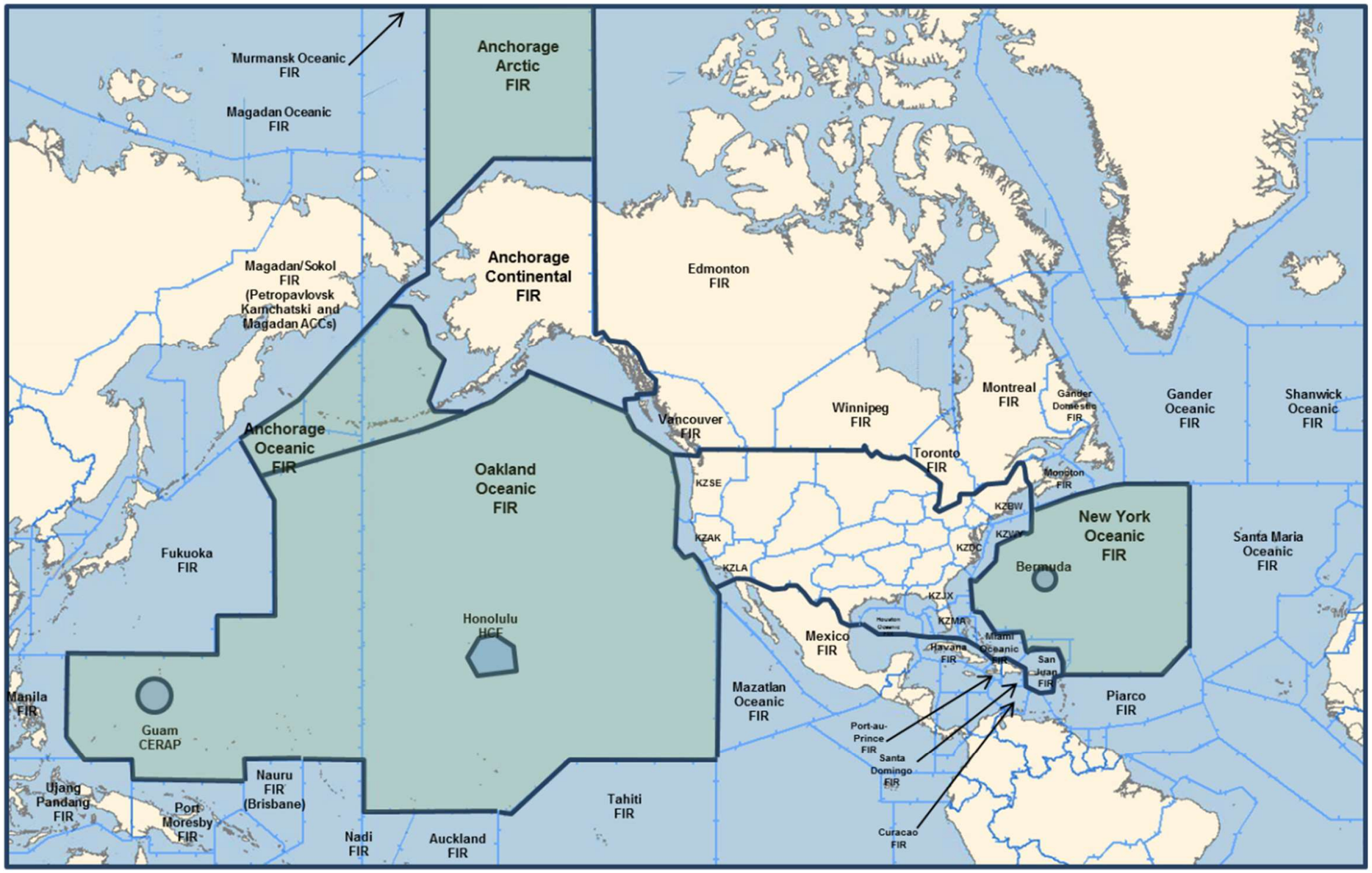
MissionSupport

AIR TRAFFIC FLOW MANAGEMENT IN THE UNITED STATES OF AMERICA

Presented by the United States of America

Federal Aviation Administration

April 2024



Daily interaction with 18 foreign ANSPs, 29 FIRs and 4 TMAs

MissionSupport

FAA Organizational Chart

Staff Offices

- Audit and Evaluation (AAE)
- Chief Counsel (AGC)
- Civil Rights (ACR)
- Communications (AOC)
- Finance and Management (AFN)
- Government and Industry Affairs (AGI)
- Human Resource Management (AHR)
- NextGen (ANG)
- Policy, International Affairs & Environment (APL)

Centers

- Mike Monroney Aeronautical Center
  - Enterprise Services Center (ESC)
  - FAA Academy
- Logistics Center
- William J. Hughes Technical Center

Regions

- Alaskan Region
- Central Region
- Eastern Region
- Great Lakes Region
- New England Region
- Northwest Mountain Region
- Southern Region
- Southwest Region
- Western-Pacific Region

Air Traffic Organization Service Units

Air Traffic Services (AJT)	System Operations (AJR)	Mission Support (AJV)	Technical Operations (AJW)	Flight Program Operations (AJF)
Provides safe, secure, and efficient management for the National Airspace System (NAS) and international airspace assigned to U.S. control.	Provides national air traffic and airport surface flow management and facilitates collaborative decision-making of FAA stakeholders.	Provides strategic direction for infrastructure and airspace design and ensures execution of policies and procedures.	Manages Air Navigation Services and Infrastructure and assures proper operation and maintenance of the NAS.	Responsible for all aspects of FAA Flight Program safety, administration, operations, training, and maintenance.

Safety and Technical Training (AJI)	Program Management Organization (AJM)	Management Services (AJG)
Identifies and mitigates operational risks and equips air traffic controllers and technical staff with knowledge and skills to reduce risk in the NAS.	Deploys and maintains air traffic systems and automation; enterprise services; and surveillance systems and technologies	Provides administrative support to the ATO Service Units enabling them to focus on their core mission.

MissionSupport

MissionSupport

MissionSupport

Air Traffic Systems

CNS Systems and Automation

Federal Aviation Administration

Major CNS Systems

Communication

- VHF/UHF Voice
- CPDLC (Terminal and Enroute)

Navigation

Ground Based

- VOR
- TACAN
- VORTAC
- NDB
- NAVAID based airways

Space Based

- GPS
- PBN Airways and procedures

Surveillance

- RADAR
- Terrestrial ADS-B Network
- Oceanic ADS-A/B/C
- Multi-Lateration

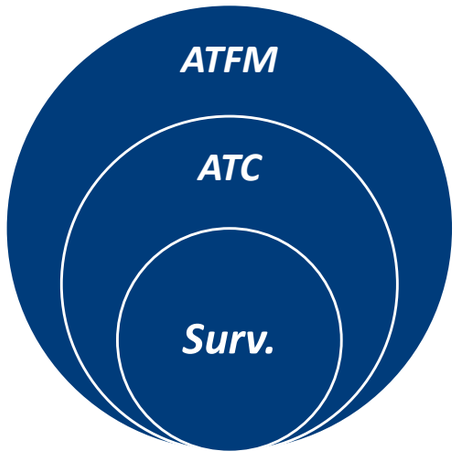
Major Automation Systems

Safety (Separation)

- ERAM (En Route Automation Modernization)
- STARS (Standard Terminal Automation Replacement System)
- ATOP (Advanced Technologies and Oceanic Procedures)
- mEARTS (Micro En Route Automated Radar Tracking System)

Efficiency (Management)

- Traffic Flow Management System (TFMS ~ national perspective)
- Time Based Flow Management (TBFM ~ regional perspective)
- Terminal Flight Data Manager (TFDM ~ airport perspective)



MissionSupport

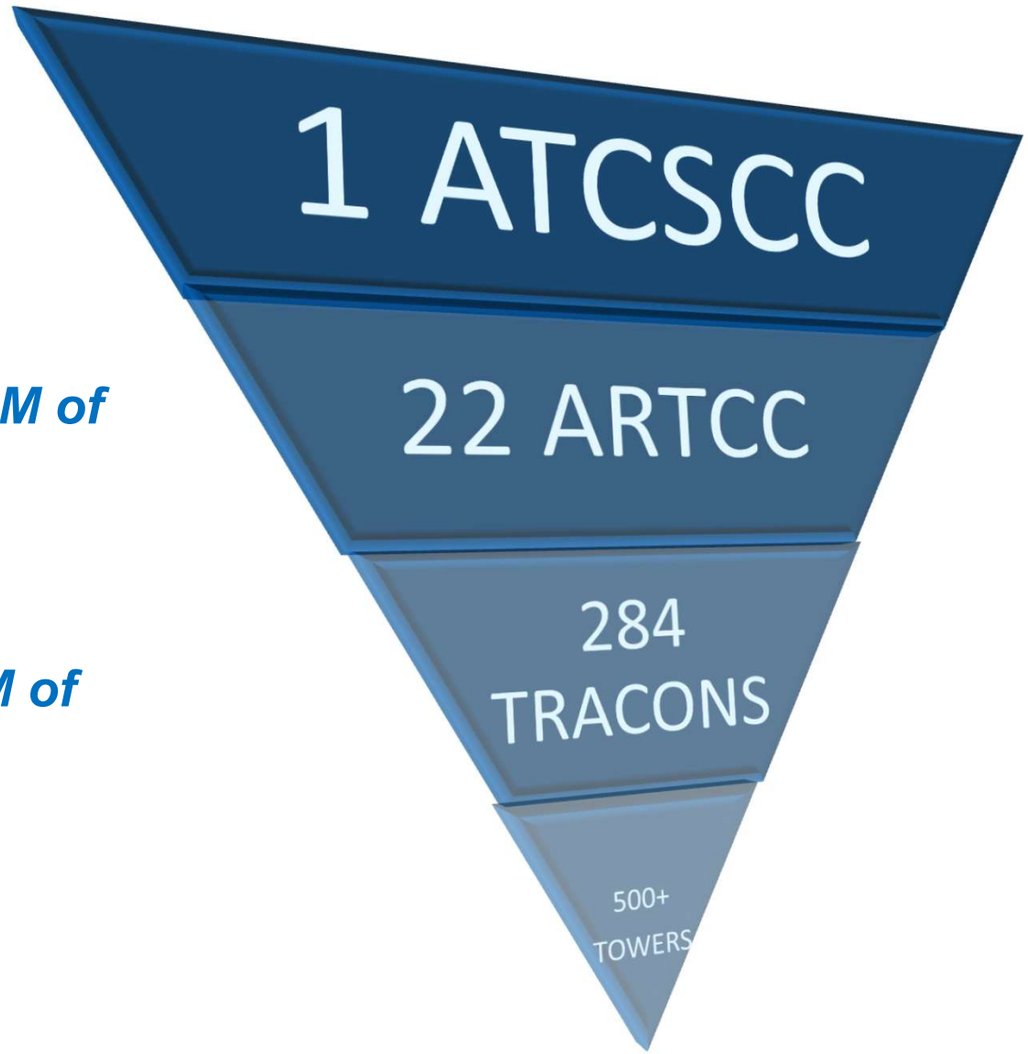
MissionSupport

Air Traffic Management in the US

Planning Horizons and Air Traffic Facility Roles

Federal Aviation Administration

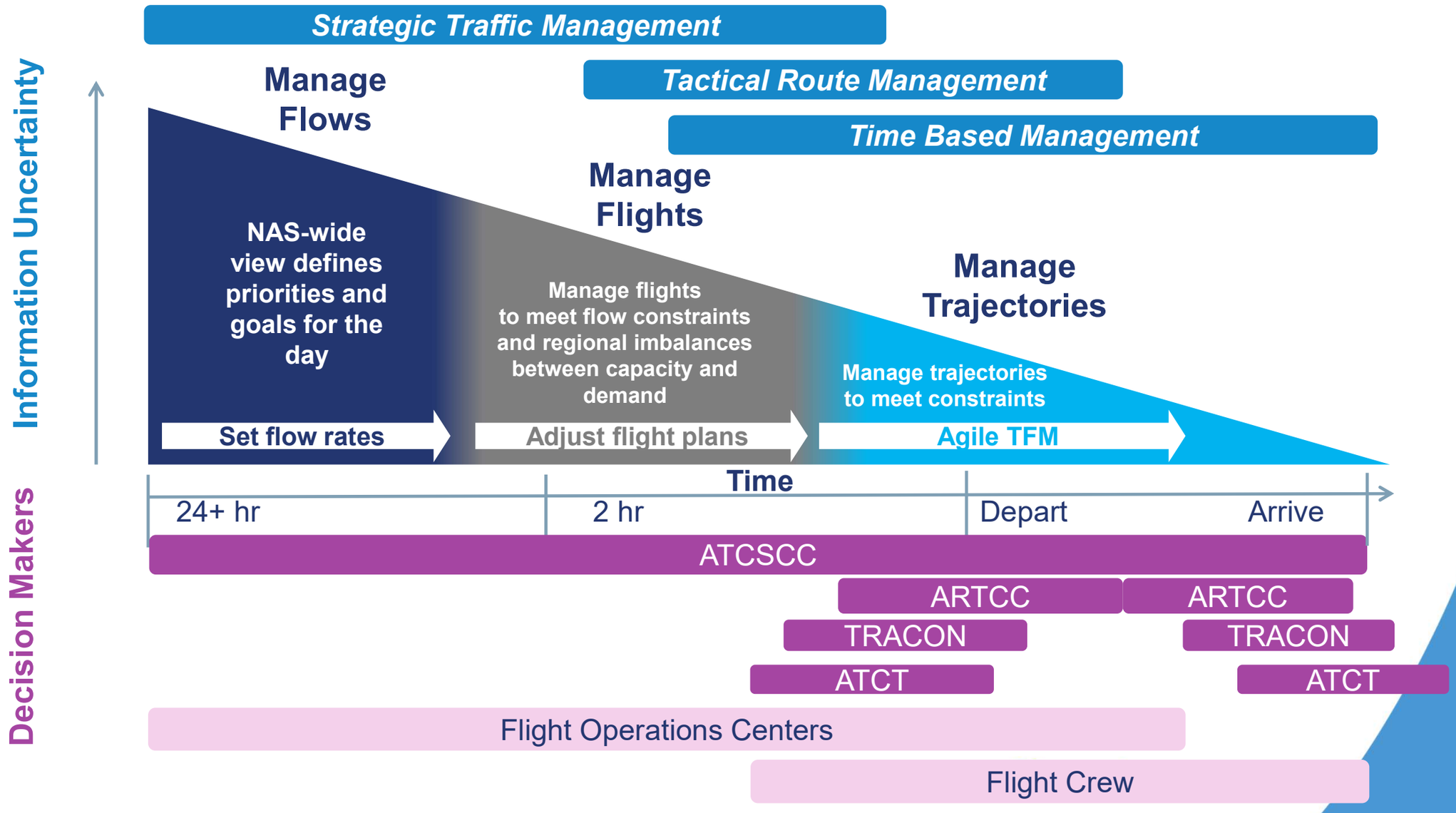
Air Traffic Management Hierarchy



Entire NAS	*National/International Perspective*
20 – 1000 NM of Airspace	*Regional Perspective*
5 – 100+ NM of airspace	*Local Perspective*
0- 5 NM of airspace	*Aerodrome Perspective*

MissionSupport

Traffic Management Across Different Planning Horizons



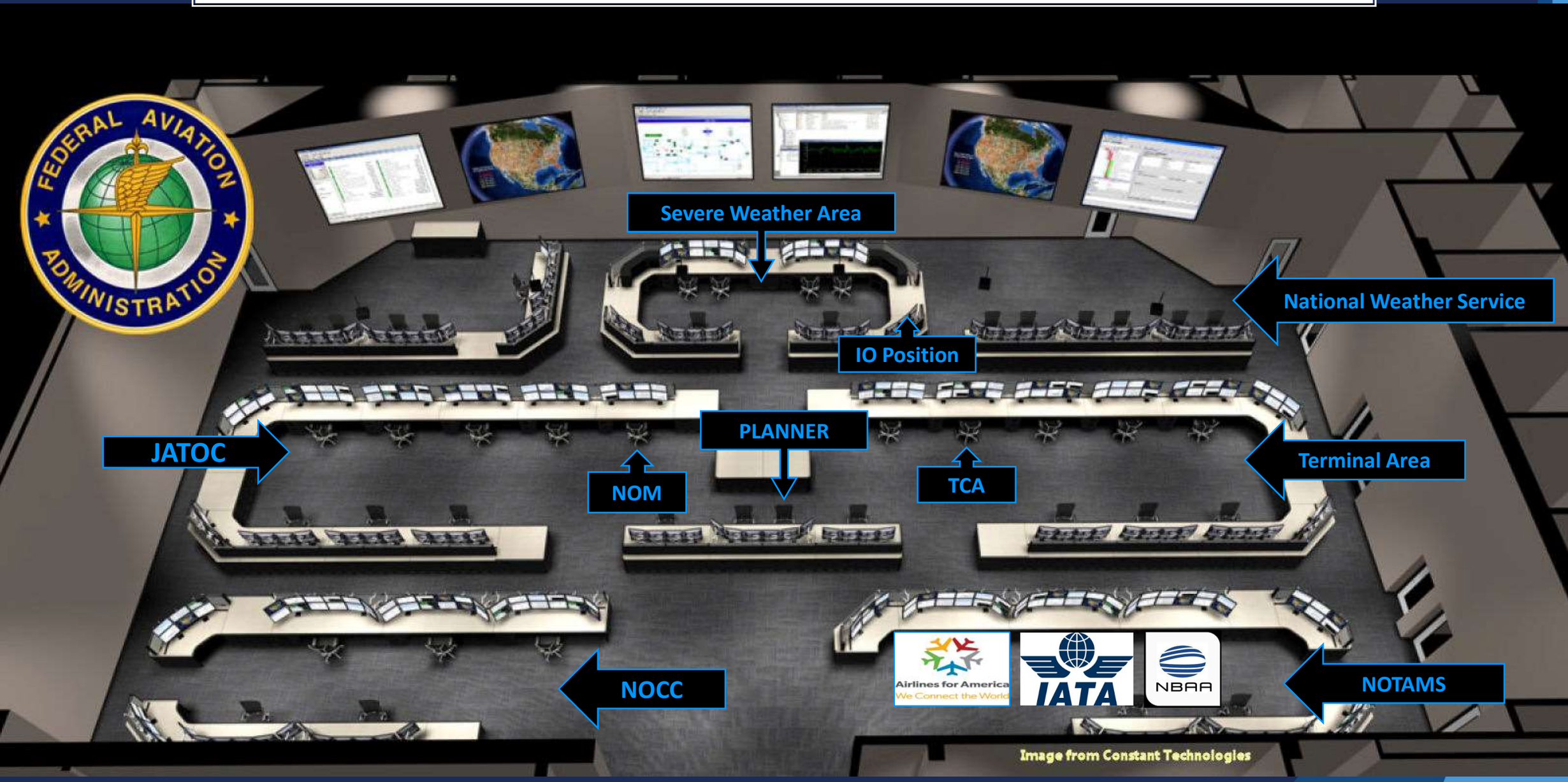
MissionSupport

Air Traffic Management in the US

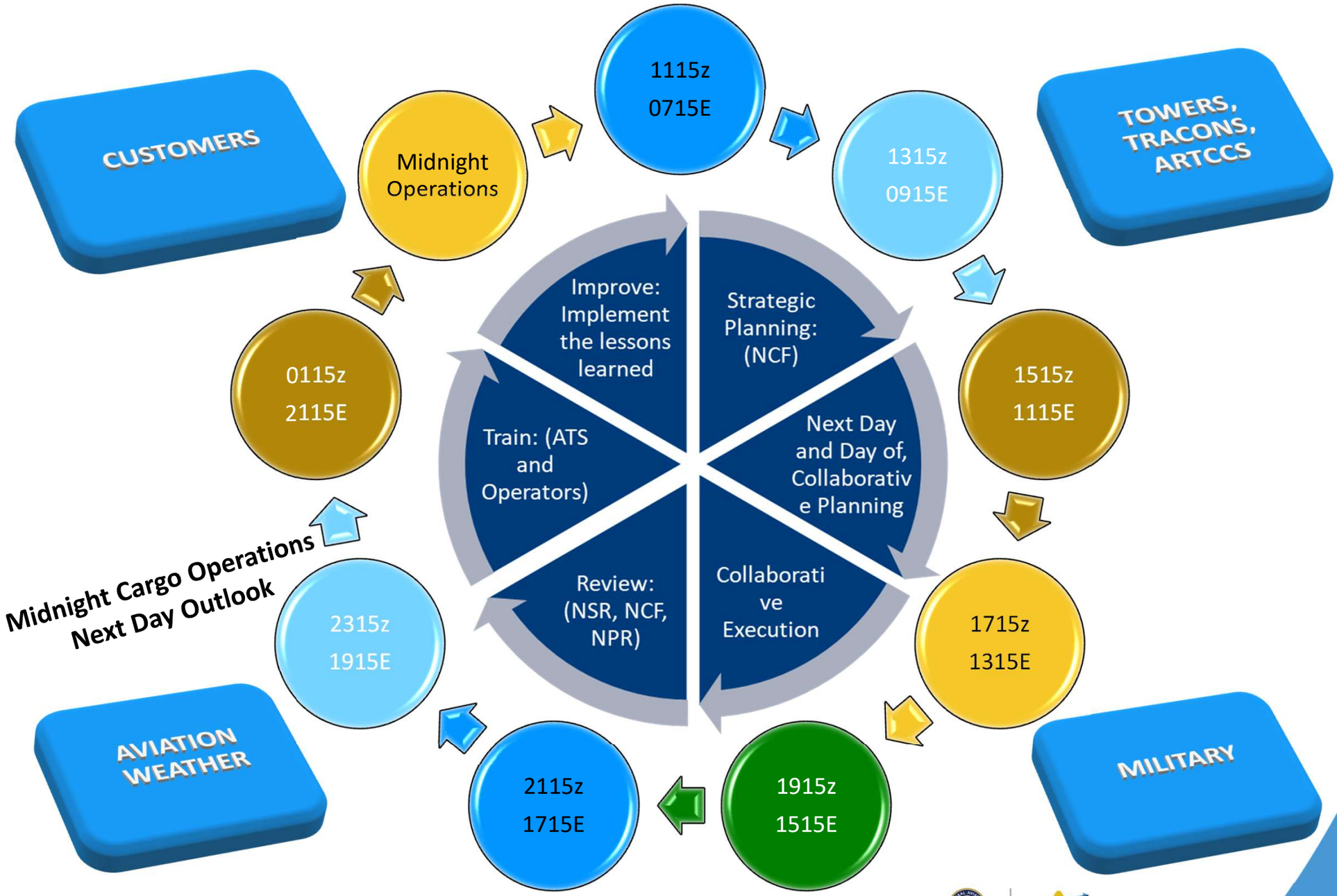
National/International Perspective

Federal Aviation Administration

ATCSCC Operating Positions



Collaborative Planning Process



MissionSupport

Strategic Traffic Management

How it Works

- Strategic Traffic Management sets the stage for the day of operations, which begins before the day of operations, and includes on-going information exchange between the FAA and Flight Operators
- Continuous Strategic Planning is enhanced with Continuous Planner tool and the National Operations Dashboard (NOD), leading to improved situational awareness as well as improved strategic planning & decision making for the operators
- When needed, use of strategic TMIs such as GDPs, AFPs and CTOP helps pre-condition air traffic flows for TBM.
- During an active CTOP, automation assigns route options and ground delays based on program objectives and operator preferences as defined in TOS, which are submitted on a flight specific basis.

Continuous Planner

Updated System Status, Planned or Expected Traffic Management Initiatives

FAA **Operators**

Accurate and Timely Flight Specific Data

Objectives:

- Improve demand predictions
- Improve schedule integrity on the day-of-operation
- Increase predictability on the day-of-operation
- More efficient use of available capacity
- Improve system efficiency
- Increase flexibility for flight operators

Enabling Capabilities:

- Continuous Planner Website
- Enhanced information sharing capabilities
- National Operations Dashboard (NOD)
- TFMS: TSD, GDP, AFP, CTOP, etc.

MissionSupport

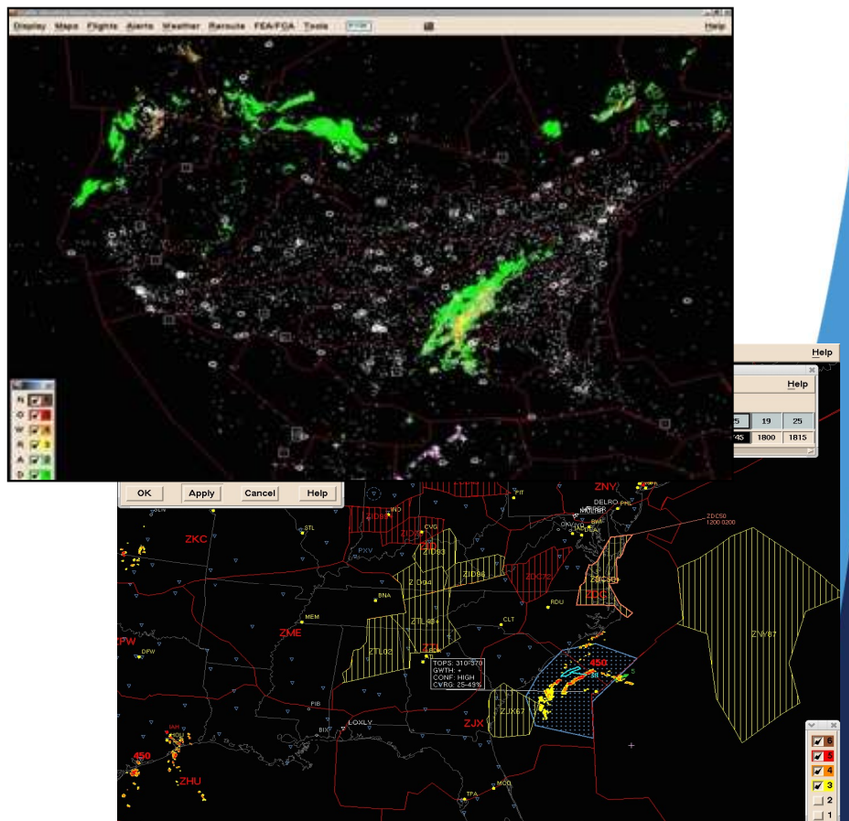
TFMS: NAS-Wide Flow Management

Purpose

- Creates demand predictions for airspace and airports
- Provides common situational awareness of current and forecasted weather impacts, SAA or other constraints
- Supports development of strategic TMIs to manage demand-capacity imbalances

Operational Improvements

- Enables pre-departure and airborne rerouting
- Provides visibility into surface operations through surface viewer
- Supports integrated traffic flow management by providing situational awareness of:
  - Demand
  - Delays for managing demand-to-capacity imbalances
  - Flight management options to users in conjunction with strategic TMIs



MissionSupport

Traffic Management Measures

Over the years and through our Collaborative Decision-Making process, many different Traffic Management Measures have been developed, as outlined below

- ✓ Altitude
  - ✓ Tunneling – descending arrivals under congested airspace
  - ✓ Capping – keeping departure aircraft under congested airspace
  - ✓ Low Altitude Arrival/Departure Routing (LAADR) – planned low altitude routes that operators fuel and file for
- ✓ Miles/Minutes-in-Trail – One ATS facility provides another the specified miles or minutes in trail (longitudinal) to mitigate excess volume or enable weather deviations. Minutes are used in non-surveillance environment and from some towers
- ✓ Fix Balancing – rerouting arriving or departing flights to relieve overloaded fixes or gates
- ✓ Airborne Holding – short term measure imposed by one ATS facility on another as a last minute measure or when weather makes a route impassable and deviating around it is not viable.
- ✓ Departure Sequencing Program – Precursor to TFDM, assigns departure times to deliver consistent flows over a fix or gate.

Traffic Management Measures Implemented via TFMS

- ✓ Ground Delay Program (GPD) – Generates CTOTs for arrival airport constraints
- ✓ Airspace Flow Program (AFP) – Generates CTOTs for enroute airspace constraints
- ✓ Collaborative Trajectory Option Program (CTOP) – Generates CTOTs and awards routes for a wide variety of constraints. Allows the ATO to define the constraint and the flight operator can apply their business model to the solution
- ✓ Ground Stop (GS) – Temporary stop of departures destined a constrained airport
- ✓ Reroutes
  - ✓ Required Routes – published via advisory and both ATS units and flight operators comply
    - ✓ City Pair based – defined by origin and destination airports
    - ✓ Flow Constrained Area based – defined by a line in the air, typically for convective weather
  - ✓ Integrated Collaborative Rerouting (ICR) – ATCSCC defines the line and operators avoid the line. Used for mid continent convection
  - ✓ Pre-Departure Reroute – ability for TFM units to amend filed proposals to meet constraints
  - ✓ Airborne Reroute – ability for TFM units to present reroute to ATC for issuance
  - ✓ Trajectory Option Set – Used in both CTOP and PDRR for operators to express their preferences.

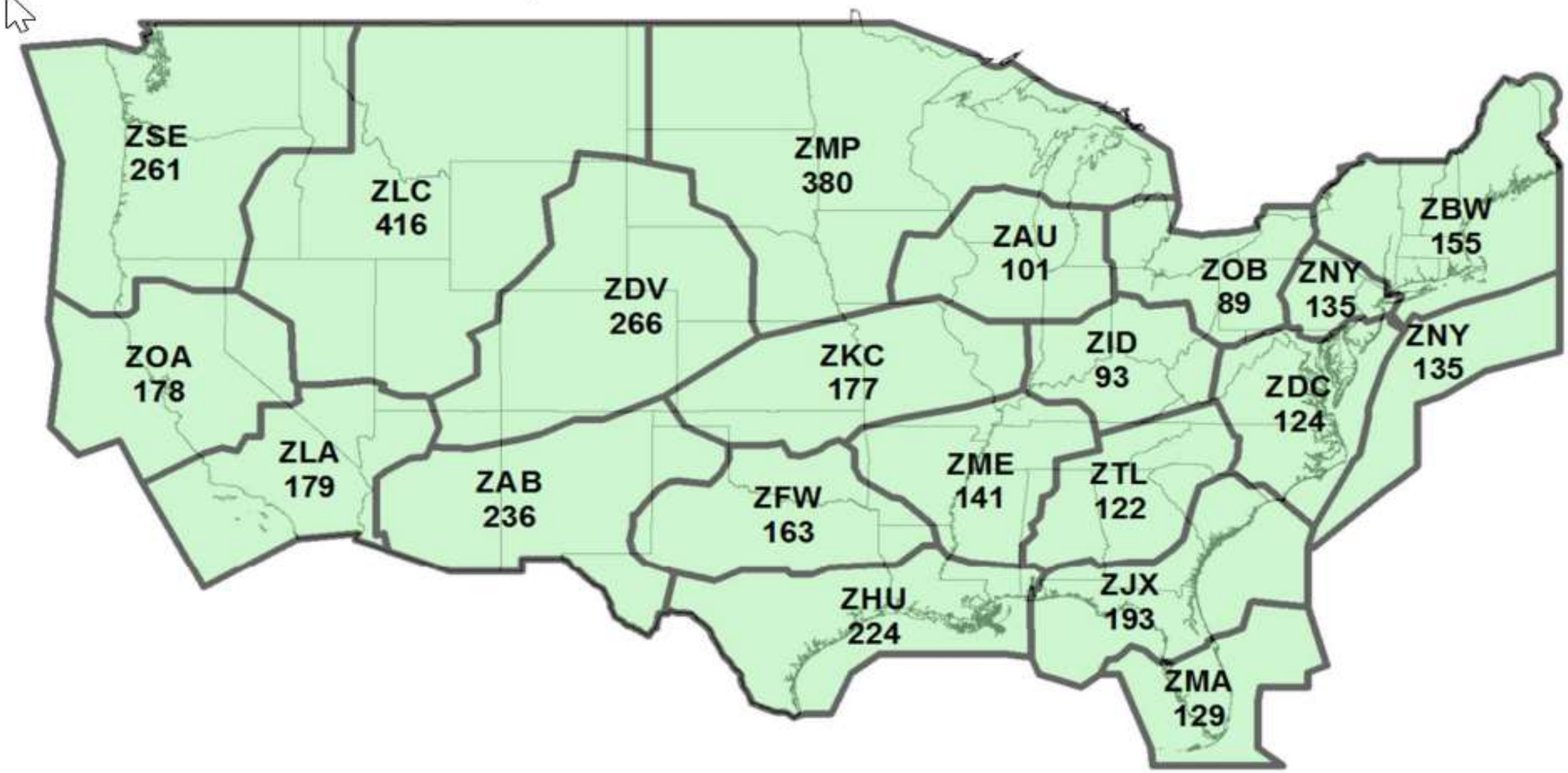
MissionSupport

Air Traffic Management in the US

Regional Perspective

Federal Aviation Administration

ARTCC Airspace Area (x 1,000 square miles)



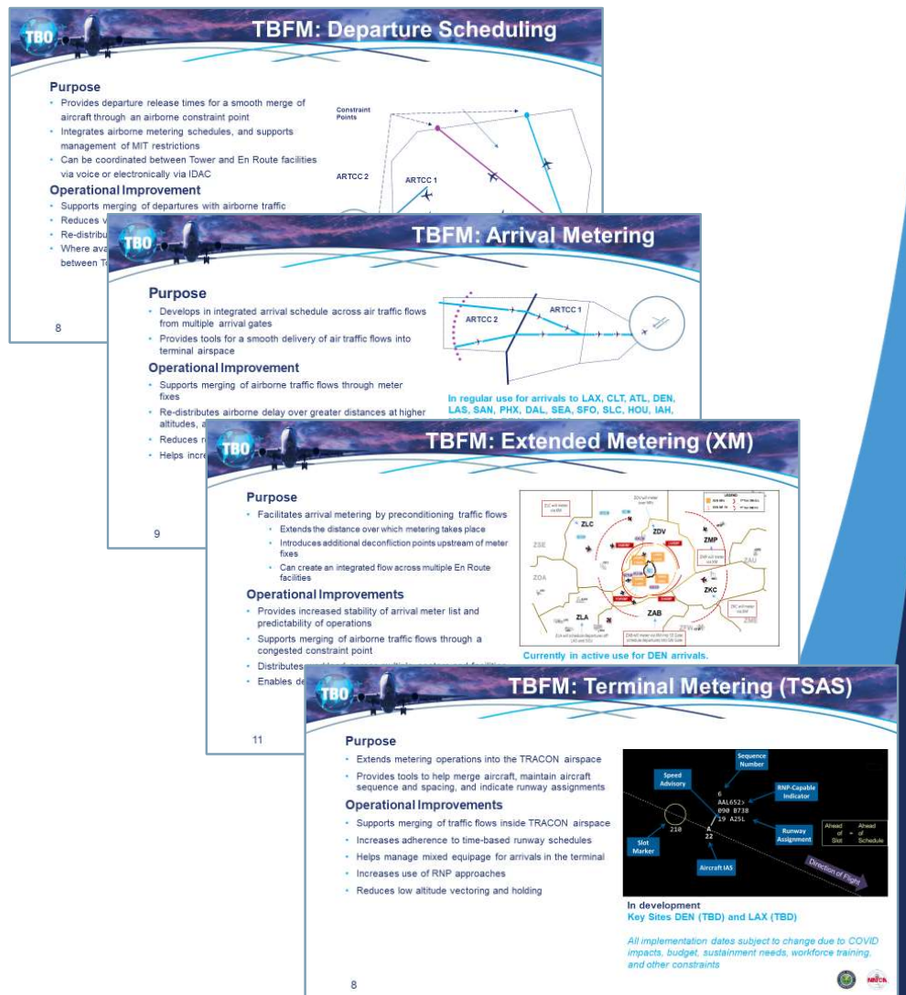
TBFM Overview

Purpose

- Helps manage air traffic flows by creating integrated time-based schedules through constraint points, and provides tools for smooth merging and sequencing of aircraft
- Applies additional spacing based on current and predicted traffic demand, aircraft trajectory and performance, winds, etc.
- TBFM capabilities are used to manage and coordinate anticipated delays through constraint points

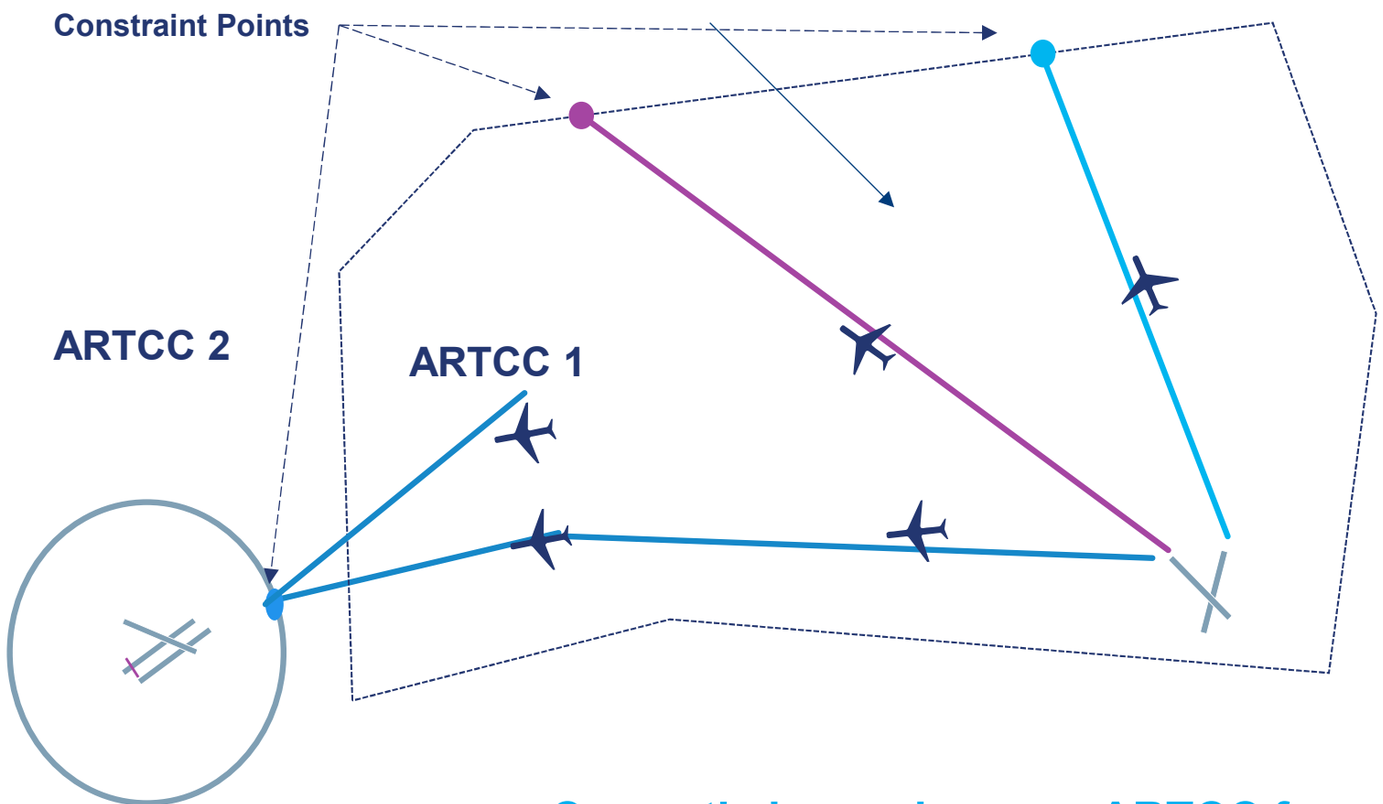
Operational Improvement

- Provides integrated plan to facilities, and improves situational awareness for the management of flows
- Distributes workload across multiple facilities
- Supports the merging of departures with airborne traffic
- Re-distributes airborne delays over greater distances at higher altitudes, and reduces holding and vectoring
- Reduces reliance on static MIT restrictions
- Helps increase adherence to PBN procedures



MissionSupport

TBFM: Departure Scheduling



How it works

- Schedules departures into an en route or arrival flow
- Calculates departure release time for a time-based schedule
- Can be used with used airborne metering or MIT restrictions
- Can be coordinated between tower and ARTCC via voice or electronically with IDAC

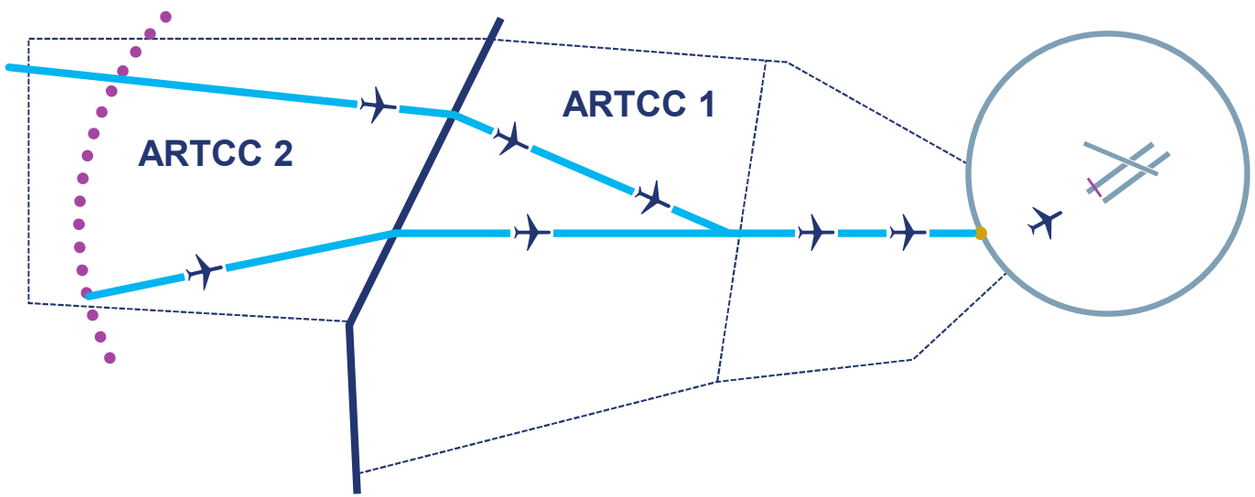
Benefit Mechanism

- Improves merging of departures with airborne traffic
- Reduces vectoring and other maneuvers
- Re-distributes delay to the ground

Currently in use in every ARTCC for constrained flows

MissionSupport

TBFM: Arrival Metering



How it works

- Provides en route controllers decision support tools to manage time-based schedule for airborne flights destined to a specific arrival airport.
- Can be complimented by Adjacent Center Metering (ACM) which allows TBFM to exchange trajectory information with upstream automation

Benefit Mechanism

- Improves merging of traffic flows on entry to terminal area
- Re-distributes airborne delay over greater distances at higher altitudes
- Reduces holding at low altitude
- Reduces reliance on static MIT restrictions

MissionSupport

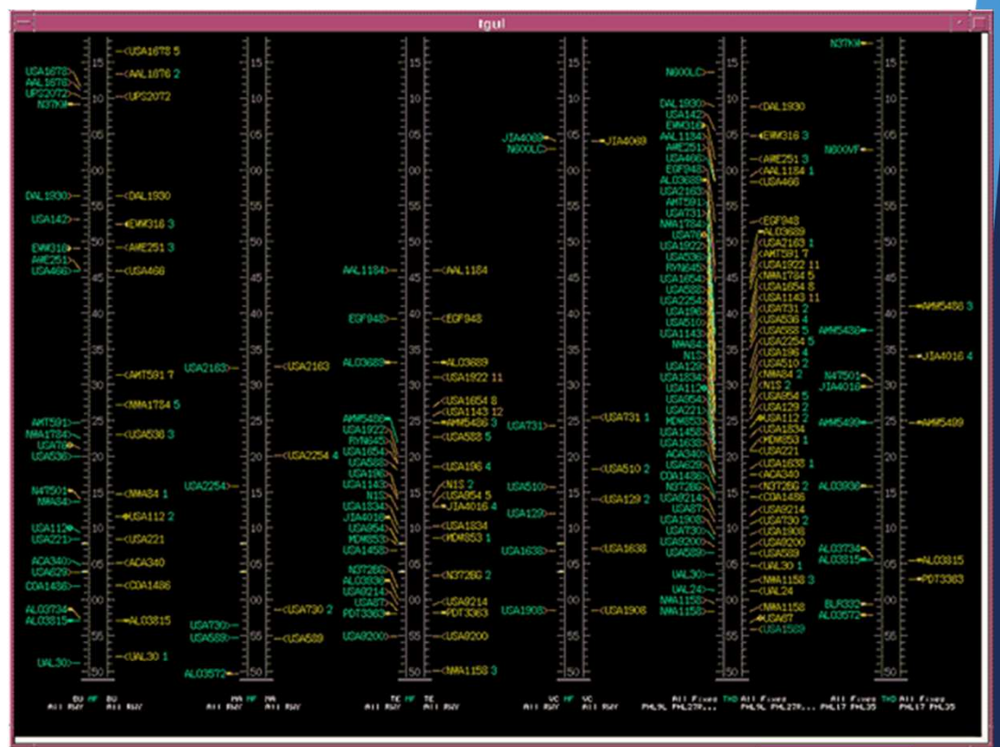
How Arrival Metering Works

What the automation does

- Estimates the time of aircraft arrival to the meter arc based on the flight plan, aircraft performance characteristics, wind forecasts, and local adaption
- Determines the earliest time and position of this aircraft in the schedule at the constraint point on the TRACON boundary and at the runway
- Schedules the aircraft into metering line by accounting for the applicable spacing based on traffic manager inputs
- When the aircraft crosses the freeze horizon, determines any delays that may need to be absorbed en route to the TRACON

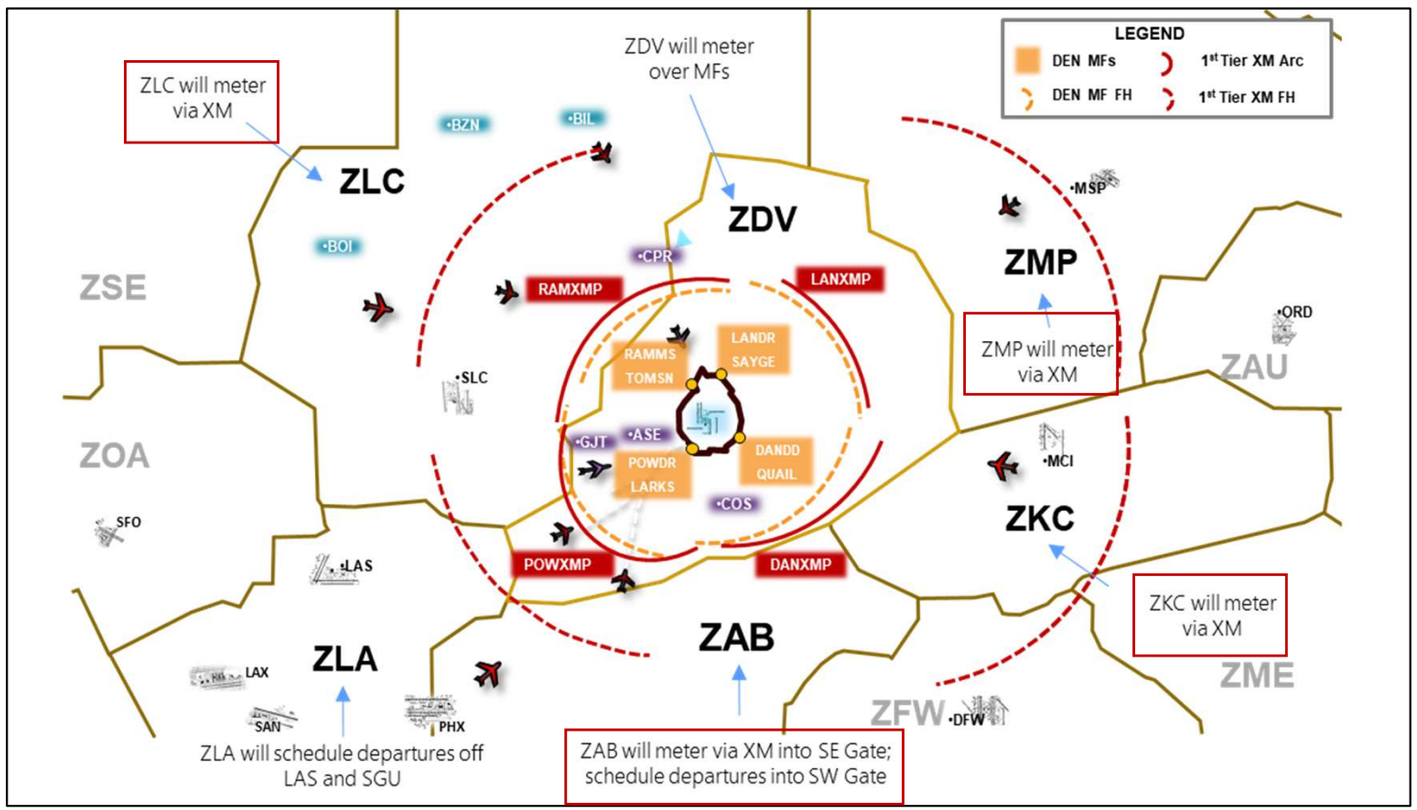
What the controller does

- Determines how to absorb any calculated delays and ensure that aircraft cross the constraint point at their scheduled time
- Traffic management personnel can manually adjust time-based schedules when needed



MissionSupport

TBFM: Extended Metering (XM)



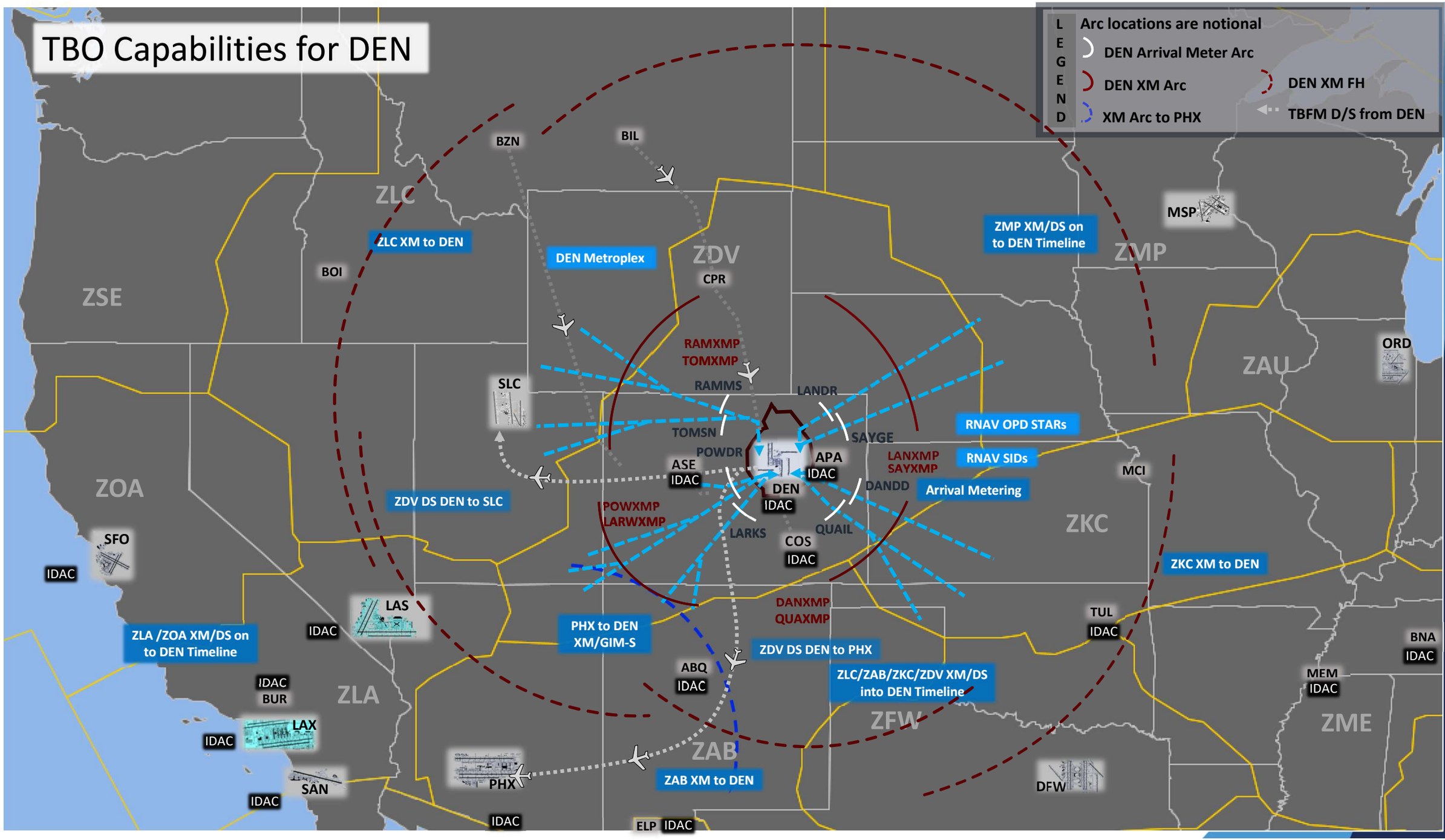
How it works

- Adds additional constraint points upstream from the meter fix
- Extends the distance over which TBFM delays can be managed

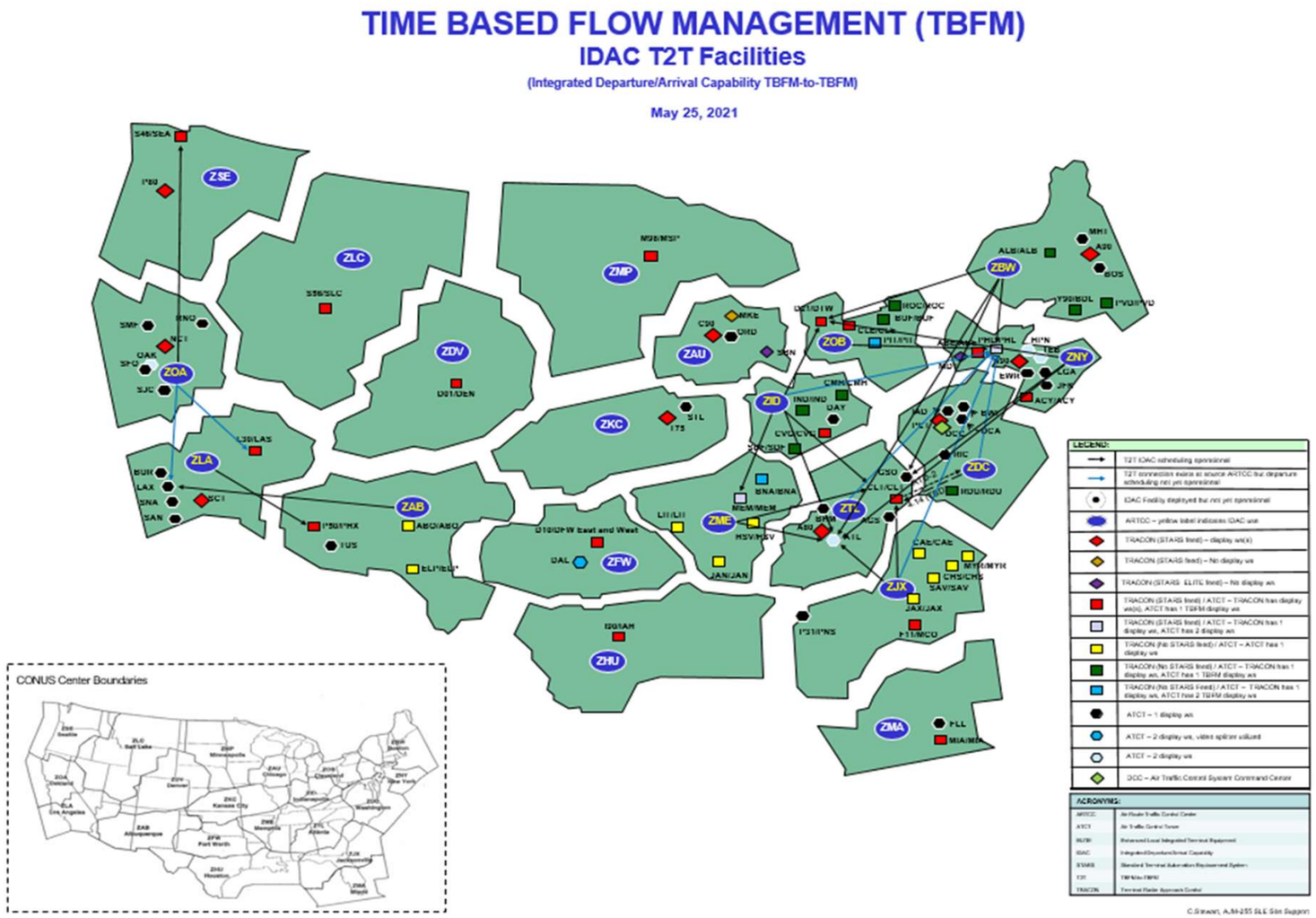
Benefit Mechanisms

- Improves merging of airborne traffic flows through a congested constraint point
- Improves stability of arrival meter list and predictability of operations
- Improves conformance with scheduled meter times
- Increases adherence to PBN STARs

MissionSupport


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

TBFM-to-TBFM (T2T) Functionality



Incremental Improvements

- Expanded T2T functionality in NEC
- Expanded departure scheduling capability for ZNY and ZBW departures to ATL and CLT metering systems

Benefit Mechanisms

- Reduces use of pass-back MIT restrictions
- Improves reliability and stability of metering schedules
- Achieves departure release times that are integrated with the overall end-to-end TBM operation

MissionSupport

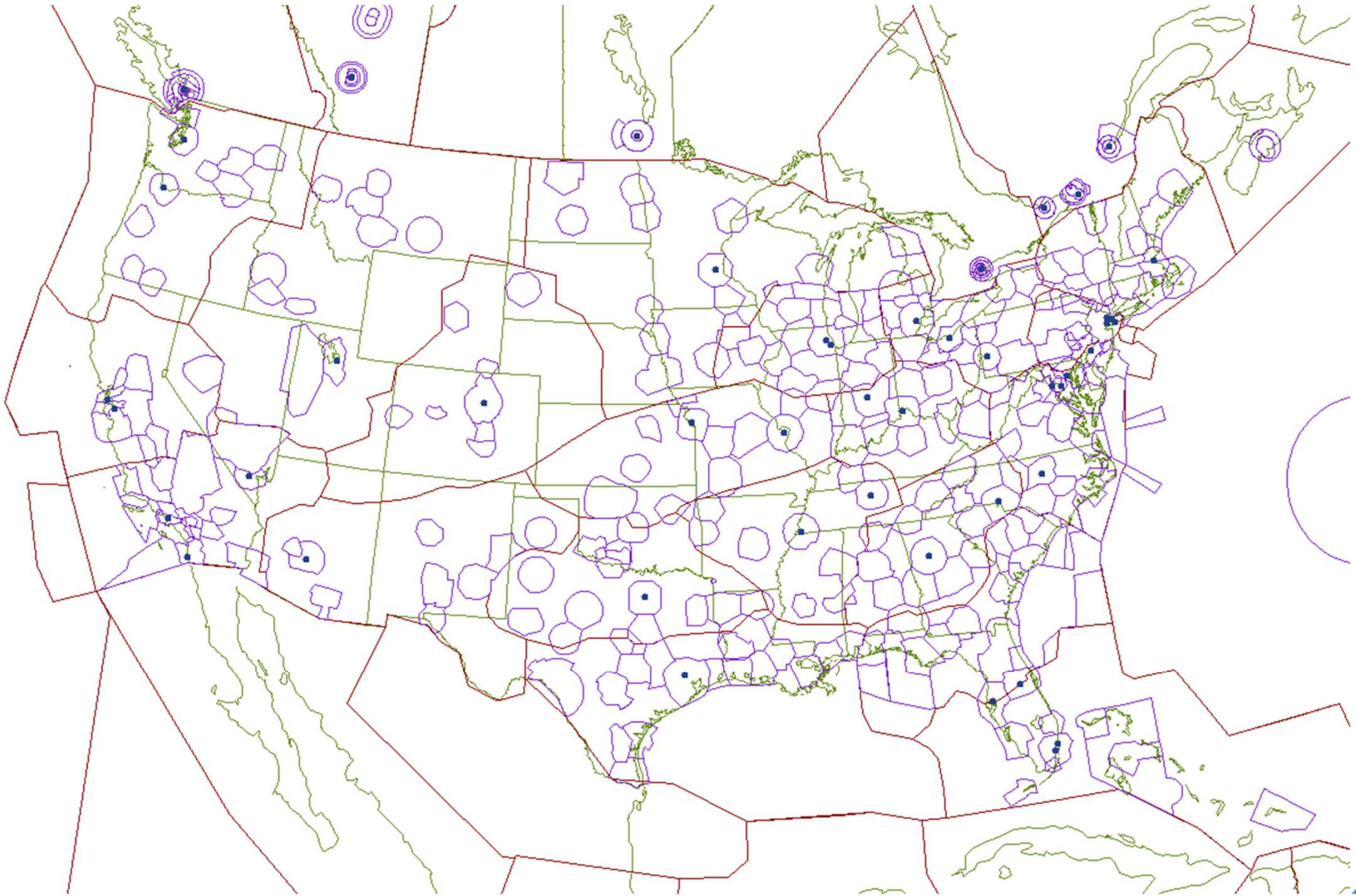
MissionSupport

Air Traffic Management in the US

Local Perspective

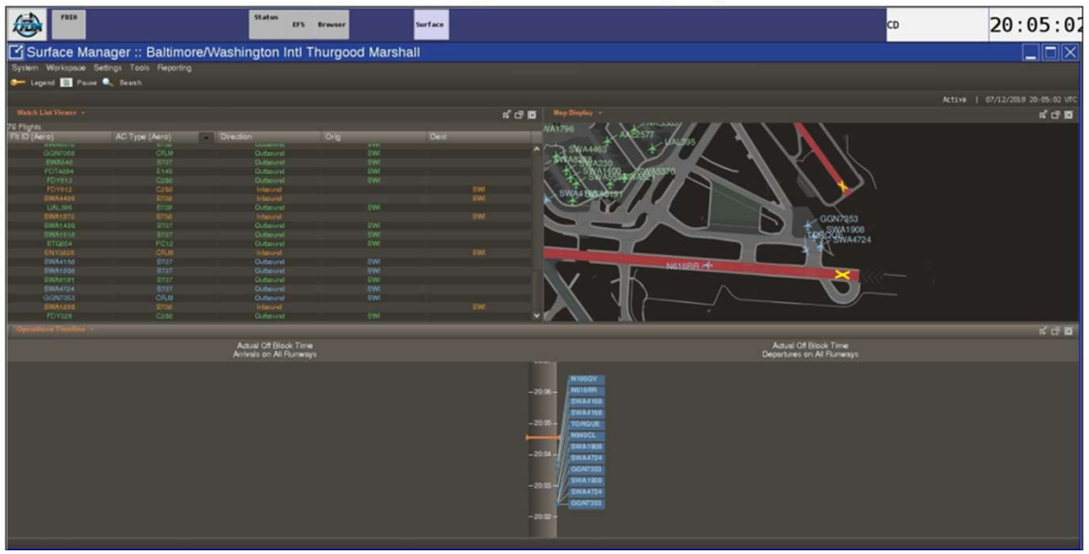
Federal Aviation Administration

Domestic Airspace Facilities
(Major Airports, Terminal Control, ACCs)



TFDM: Surface Management

Surface Management Displays



Electronic Flight Strips

How it works

- Provides Electronic Flight Data to Tower Controllers
- Consolidates data and displays from several legacy systems
- Provides virtual runway queues and surface metering (TBM)
- Enables strategic runway balancing
- Integrates departure release time with TBFM and TFMS (when needed)

Benefit Mechanisms

- Improves surface management
- Improves management of runway queues
- Improves runway balancing for mixed operations

MissionSupport

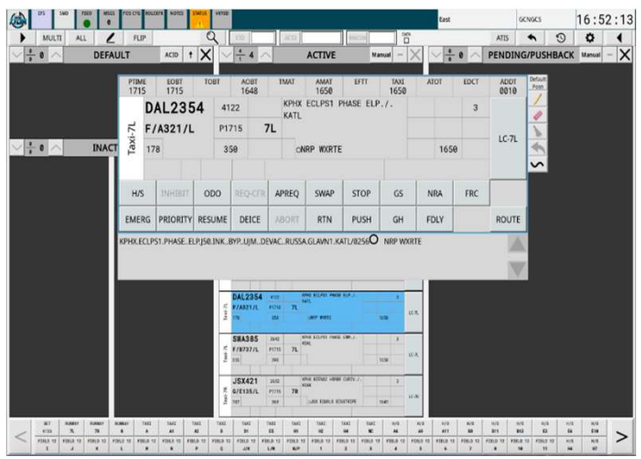
TFDM: Surface Management (A-CDM)

Electronic Flight Data (EFD)

Replace paper flights strips and provides electronic data exchange with FAA systems and non-FAA stakeholders

Utilizes enhanced data exchange from operators (via TFMS)

Integrates:
- Flight data
- Surveillance data
- Traffic Flow data
- Clearance data



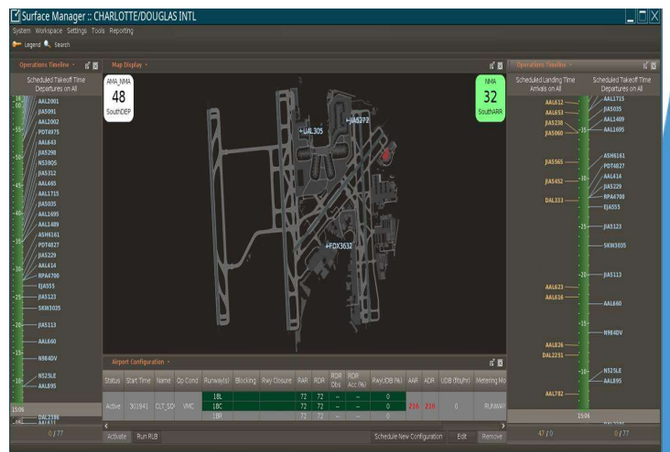
Collaborative Decision Making for the Surface (S-CDM) – Suite of Decision Support Tools

Surface Scheduling

Surface Metering

Runway Load Balancing

Airport Config Mgmt



Traffic Flow Management (TFM)

Integration with TFMS and TBFM to coordinate traffic manage constraints and create and support TBO.

Systems Consolidation

Systems to be consolidated include ARMT, DSP, EFSTS, AEFS.

Planned for 89 sites across the NAS
(27 of those sites with full Surface Management Suite)

MissionSupport

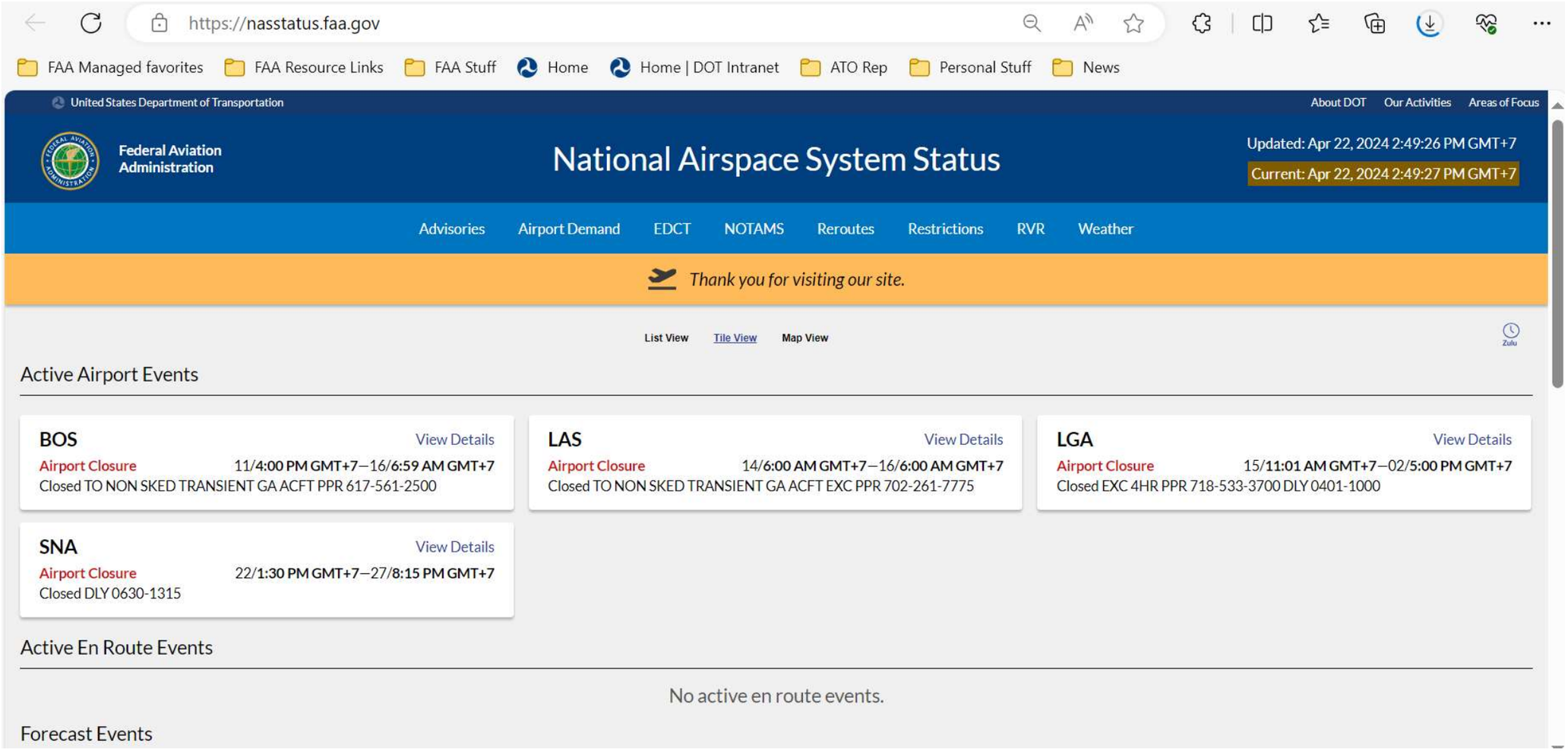
MissionSupport

Air Traffic Management in the US

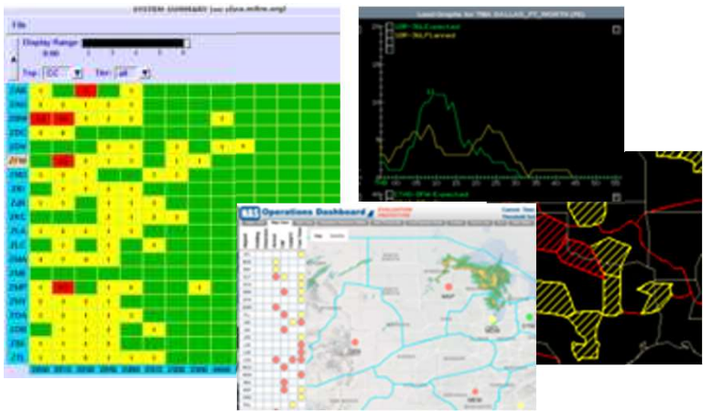
A Few Additional Thoughts…

Federal Aviation Administration

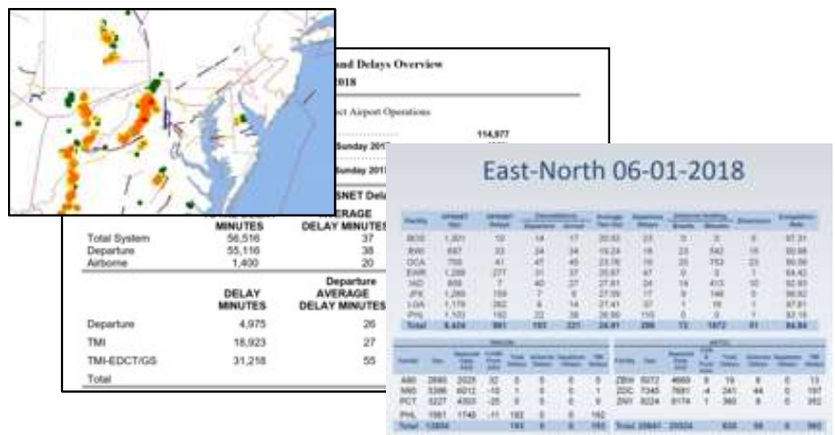
NAS Status OIS — https://nasstatus.faa.gov/



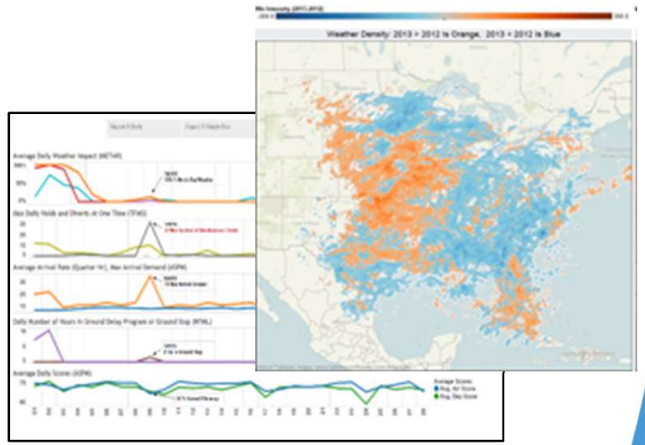
Data Collection and Analysis Timeframes



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

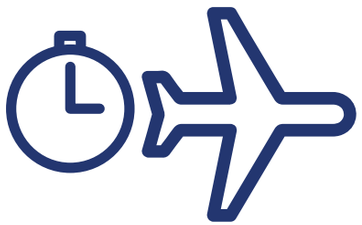
Use previous day performance analysis to improve the current day operations

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

MissionSupport

TBO Overview

TBO is a collection of systems, capabilities, processes, and people working together to achieve operational objectives



Time-Based Management (TBM)

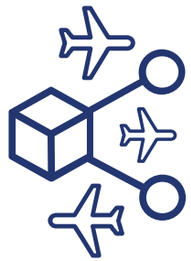
Dep Scheduling, Airborne Metering and Automated Surface Mngmt.
Complemented by Conventional TMIs as Needed

Helps manage trajectories by scheduling and metering aircraft through constraint points

Performance Based Navigation (PBN)

Metroplex
RNP w/RF Turns
Etc.

Enables aircraft to more accurately navigate along their trajectories



Enabling Technologies

SWIM
DataComm
Web-based Planning Tool
Etc.

Expands and automates sharing of common information about aircraft trajectories

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

MissionSupport

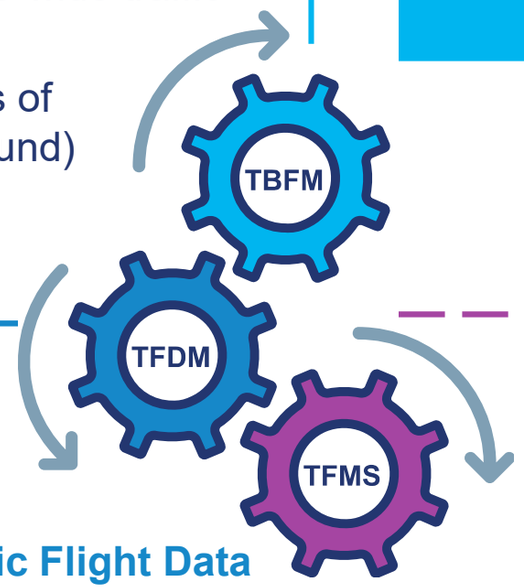
Decision Support Systems *(The 3 T's)*

TBO functionality supported by Integration of 3 T's

- Enhance data-sharing across systems and stakeholders to increase situational awareness and improve data quality
- Integrate management of local and NAS-wide traffic management activities
- Redistribute delays and manage means of delay absorption (speed, vectoring, ground)
- Account for user preferences

Time Based Flow Management (TBFM)
Scheduling and Metering through NAS Constraint Points

Departure Scheduling
Extended Metering
Adjacent Center and Arrival Metering
TSAS
IDAC



In development

Terminal Flight Data Manager (TFDM)
Surface Management and Electronic Flight Data

Electronic Flight Data
Rwy Queue Management
Strategic RWY Balancing
Arr/Dep Management Integration

Pre-departure Rerouting
Airborne Rerouting
GDP, AFP, CTOP

Traffic Flow Management System (TFMS)
Demand and Capacity Management Across the NAS

MissionSupport

Thank You!

Almira Ramadani
FAA Senior Air Traffic Representative APAC
almira.ramadani@faa.gov
+65 8939-9709

Shayne A. Campbell
FAA Senior Air Traffic Representative APAC
shayne.a.campbell@faa.gov
+65 8909-1136

MissionSupport