Traffic Flow Management Background

Traffic Flow Management (TFM) in the National Airspace System

The core group of internal FAA users includes traffic managers at different facilities, including the Air Traffic Control System Command Center (ATCSCC), Air Route Traffic Control Centers (ARTCCs), Terminal Radar Approach Control facilities (TRACONs), and airport Air Traffic Control Towers (ATCTs) (see Figure 1). Each type of facility has a different area of focus within the National Airspace System (NAS), and therefore a different scope of TFM decision-making. The TFM-AID Challenge focuses on displays to support ATCSCC traffic management decision-making. Here, we summarize the roles and responsibilities of traffic management personnel at multiple types of facilities to provide a sense of how traffic managers must coordinate across facilities to achieve “a safe, orderly, and expeditious flow of traffic while minimizing delays” [1, pp. 18-1-1].

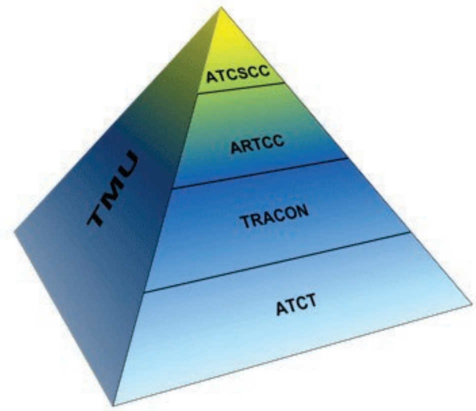


Figure 1: Relative Organization of ATC Facilities

ATCSCC traffic managers, including a National Operations Manager (NOM), multiple National Traffic Management Officers (NTMOs), and multiple National Traffic Management Specialists (NTMSs) “direct the operation” of TFM in the NAS [1, pp. 18-2-3], interacting with facilities where there are authorized traffic management personnel (see Figure 2). The ATCSCC is the focal point for traffic management in the NAS and is the final approving authority for Traffic Management Initiatives (TMIs) that impact multiple ARTCCs. ATCSCC traffic managers coordinate with ARTCC, TRACON, and ATCT traffic managers and NAS users as appropriate to [1]:

- Monitor NAS components and weather to determine when and where capacity is likely to be reduced and TMIs will be required.
- Reroute flows of traffic as needed.
- Implement national TMIs including time-based metering (TBM), Ground Delay Programs (GDPs), Airspace Flow Programs (AFPs), and Collaborative Trajectory Options Program (CTOPs).
- Evaluate TMIs proposed by facilities throughout the NAS for appropriateness.
- Monitor TMIs issued throughout the NAS for effectiveness.

- Manage airspace relevant to space launch and reentry operations.

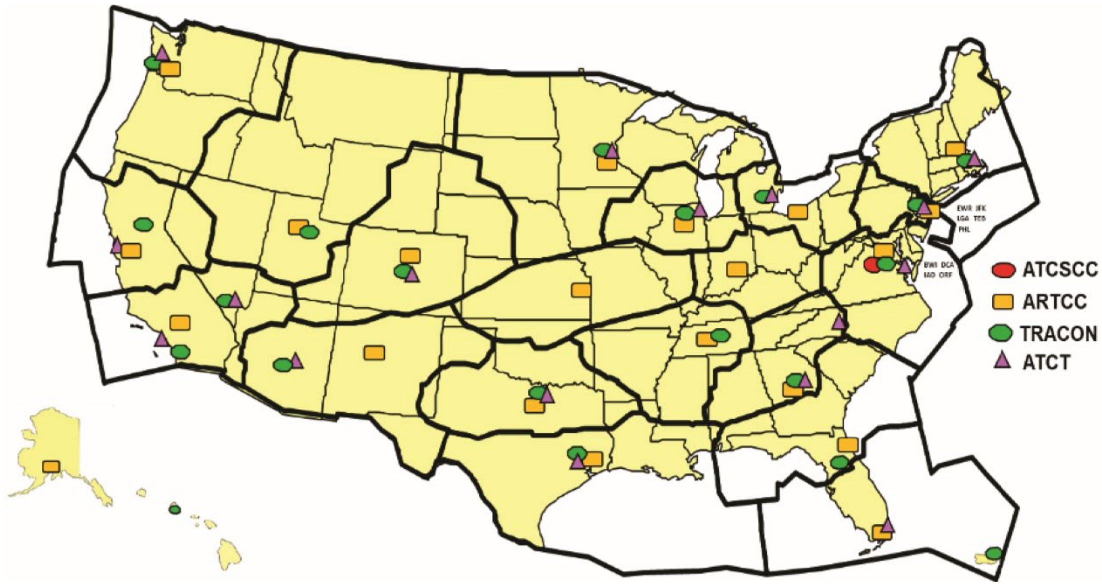


Figure 2: TFM Facilities Across the NAS

Meanwhile, ARTCC traffic managers, including a Supervisory Traffic Management Coordinator (STMC), multiple TMCs, and the Center Weather Service Unit (CWSU), “monitor and balance traffic flows within their areas of responsibility in accordance with [TFM] directives” [1, pp. 18-1-4]. Their responsibilities include [1]:

- Implementing TMIs “in conjunction with, or as directed by the ATCSCC” [1, pp. 18-2-4].
- Ensuring that the ATCSCC is advised of all changes within the ARTCC’s area of responsibility that could significantly impact the system and all agreements with other facilities related to TMIs.
- Coordinating TFM actions with adjacent facilities through the ATCSCC.
- Implementing TMIs to manage traffic within the ARTCC’s area of responsibility.
- Logging all TMIs and TFM actions.
- Coordinating with TRACON traffic managers to develop strategies to manage arrivals and maintain airport arrival capacity.
- Reporting delays according to FAA policy.
- Managing civil aviation traffic in the vicinity of active Special Activity Airspace (SAA).

Some large TRACONs have traffic management units (TMUs) that are organized similarly to those at ARTCCs, whereas small TRACONs and ATCTs have at least one staff member responsible for acting as a TMC for their facility. They coordinate with relevant ARTCCs (typically the ARTCC overlying their facility), neighboring TRACONs, and the local ATCT(s) to balance traffic flows with capacity. They coordinate with ATCTs to manage airport and airspace configurations.

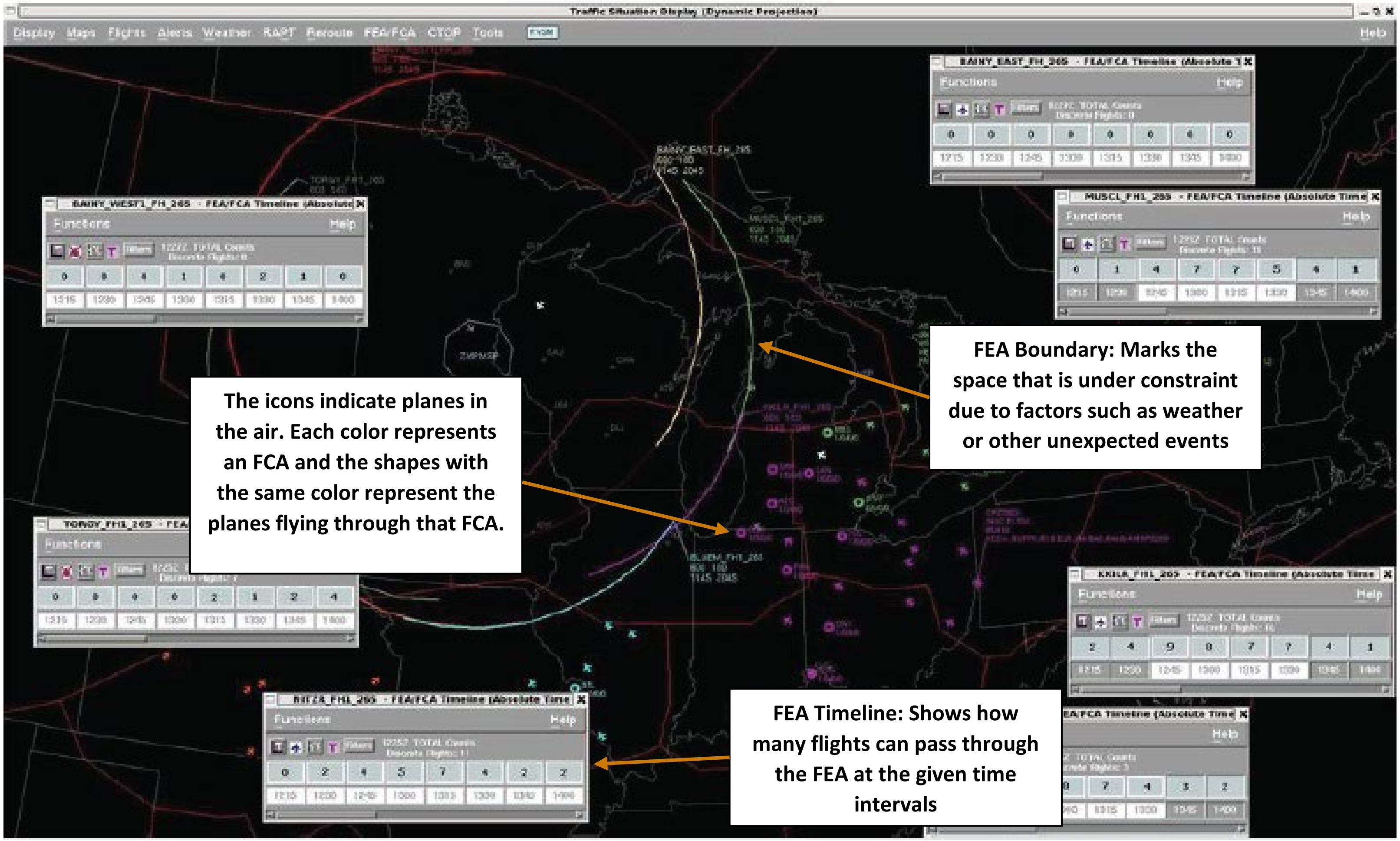
Current Traffic Flow Management System Capabilities

This section describes the functions of the current system that are most relevant to the ATCSCC users targeted in the TFM-AID Challenge. Note that the discussion here represents only a subset of the functionality provided by the current system.

Traffic Situation Display (TSD)

The TSD displays aeronautical, flight, and weather data on a map. It also provides tools that traffic managers can use to acquire information about flight demand. For example, traffic managers use the TSD to create Flow Evaluation Areas (FEAs) and Flow Constrained Areas (FCAs)[1] that they use to monitor demand for specific regions of airspace and flights of interest within the traffic flow over time. Figure 3 shows a screen shot of one traffic manager's TSD with multiple FEAs (shown as semi-circles). The display also shows icons representing aircraft locations in the airspace; the aircraft and FEAs are color coded to match the flights with the FEA. Each chart on the display is a timeline showing the number of aircraft expected to cross one of the FEA boundaries in each 15-minute period over the next 2 hours. This allows the traffic manager to anticipate when the demand for the airspace indicated by the FEA will be high enough to warrant a TMI.

[1] Only ATCSCC users can create FCAs.


Traffic Situation Display (Dynamic Projection)
Display Maps Flights Alerts Weather RAPT Reroute FEA/FCA CTOP Tools
Help
The icons indicate planes in the air. Each color represents an FCA and the shapes with the same color represent the planes flying through that FCA.
FEA Boundary: Marks the space that is under constraint due to factors such as weather or other unexpected events
FEA Timeline: Shows how many flights can pass through the FEA at the given time intervals

When the traffic manager creates an FEA/FCA, they have many options for filters to include only flights of interest in the traffic counts, as shown in Figure 4. For example, they can filter flights based on their altitude (e.g., FL160 to FL380), aircraft type (e.g., jets only), departure/arrival airport, routes traversed, airline, and more. If the ATCSCC traffic manager uses an FCA to control an AFP or CTOP, the filters they create for the FCA provide the first layer of control for the flights that will be included in the AFP/CTOP. Note that in the current system, if the ATCSCC traffic manager wants to use an FCA for an AFP, they have to specifically make the FCA available to the application that controls AFPs.

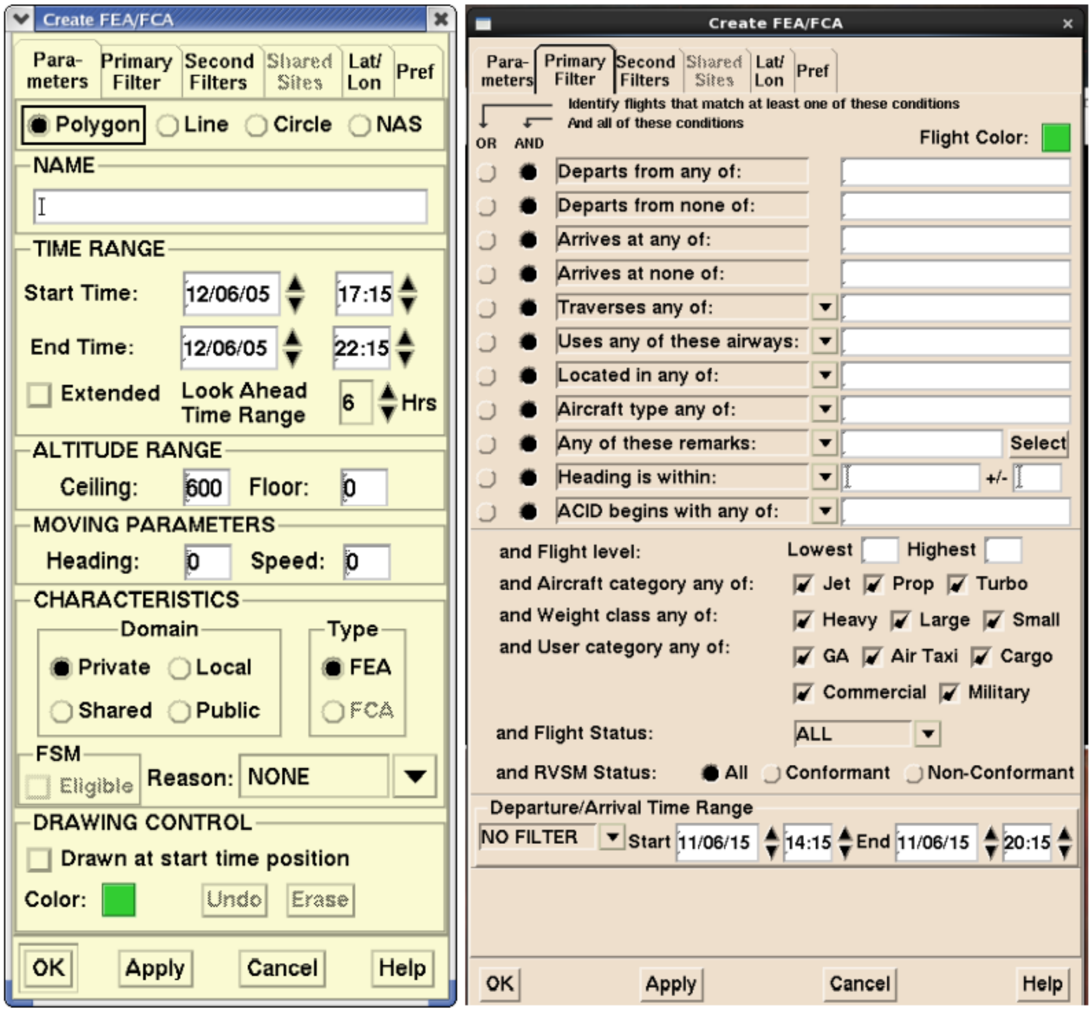


Figure 4: Existing Dialogs for Creating an FEA/FCA

Flight Schedule Monitor (FSM)

The FSM shows demand and capacity at airports and FEAs/FCAs and is used by traffic managers to model and issue AFPs, GDPs, and Ground Stops. This document focuses on tools for creating, modeling, and issuing an AFP because it is of most interest to the TFM-AID Challenge.

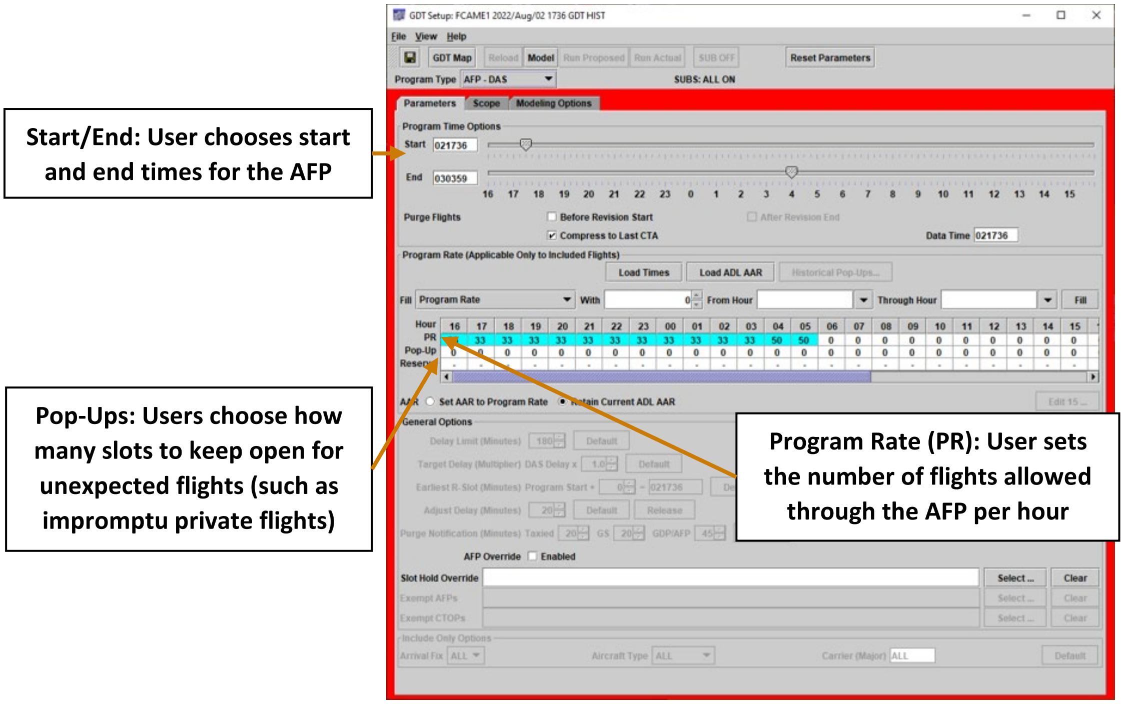


Figure 5: Ground Delay Tools

The third main program parameter is the program scope, shown in Figure 6, which will be reflected in the map shown in Figure 4 above. The program scope defines which departures will be included in the AFP. In the example shown in Figure 6, departures from airports in all ARTCCs (indicated by their 3-letter codes starting with “Z”) are included. Some programs also include departures from airports in Canada, whose facilities are denoted by their 3-letter codes starting with “C” in Figure 6. Users also can choose to exempt flights based on their departure or destination airport, departure facility, or even individual airlines or flights, depending on the specific situation.

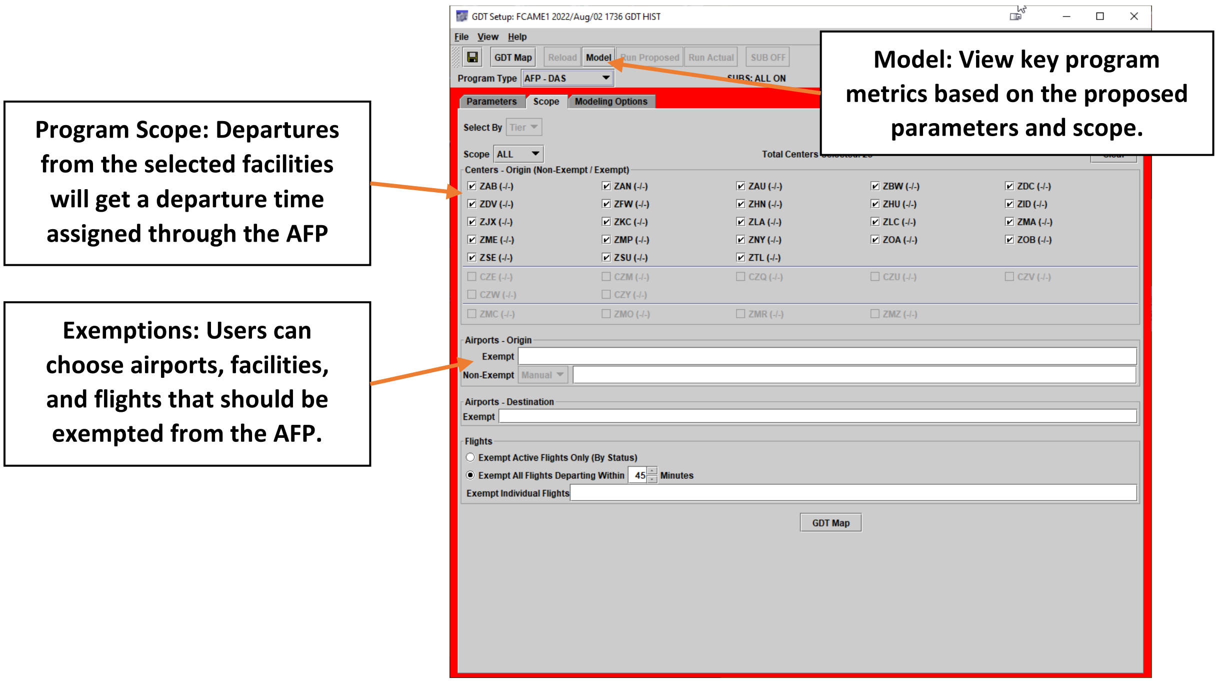


Figure 6: Selecting Program Scope

The user can model a program after entering program parameters and program scope, but before issuing it. This provides multiple results, including a bar graph similar to Figure 7 showing the modeled program rate (white dashed horizontal line), the start and end times (brown vertical lines), and modeled demand during each time interval (60 minutes is the interval shown in Figure 7). Solid bars represent the estimated current demand data and hashed bars show the modeled data. The bars are color coded according to the status of the flights included in the count.

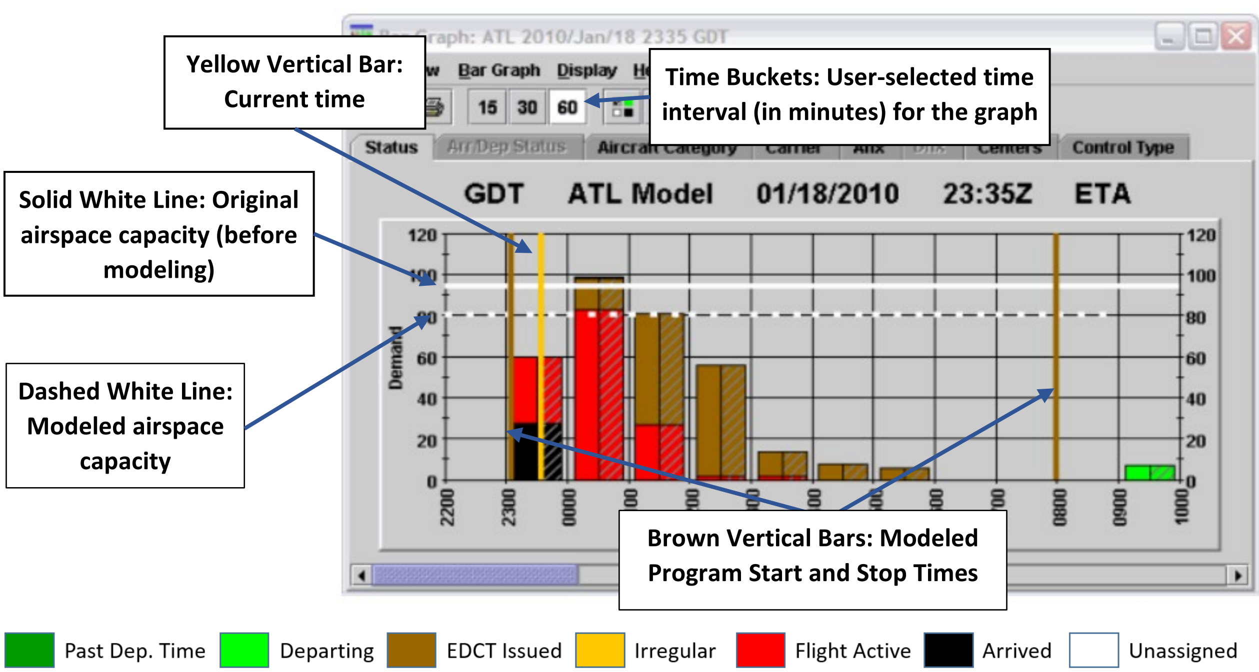


Figure 7: Example Bar Graph

After modeling the program, the user can view the model results, with the key metrics shown in Figure 8. The most important metrics are the minimum, average, and maximum delay that would be assigned to flights if the modeled program were to be implemented. Traffic managers need to find the program parameters that will slow down traffic enough so it is manageable despite the constraint they are trying to mitigate, while being equitable in distributing delay among the many flights that want to use the airspace.

Flight Metrics

Metric	Number of Flights
Total Flights	180
Total Affected Flights	93
Flights in Stack	0

Delay Metrics

Metric	Before	After	Difference
Minimum Delay (Minutes)	0	0	0
Average Delay (Minutes)	59	31	-28
Maximum Delay (Minutes)	336	268	-68
Total Delay (Minutes)	5504	2887	-2617

Figure 8: Example Model Results

Traffic managers can also view delay metrics for each 15-minute period over the course of the program, as shown in Figure 9.

ENTRY		Delay		Demand	Slots	Program Rate		Pop-Ups		Reserved	
Day/Hour	Time	Avg.	Tgt.	Orig	Unassigned	Qtrly.	Hrly.	Qtrly.	Hrly.	Qtrly.	Hrly.
03/1500	00 - 14	[illegible]52	-	0	-	13	50	0	0	-	-
	15 - 29	139	-	0	-	12		0		-	
	30 - 44	128	-	0	-	13		0		-	
	45 - 59	118	-	0	-	12		0		-	
03/1600	00 - 14	110	-	0	-	13	50	0	0	-	-
	15 - 29	104	-	0	-	12		0		-	
	30 - 44	98	-	0	-	13		0		-	
	45 - 59	93	-	0	-	12		0		-	
03/1700	00 - 14	88	-	0	-	13	50	0	0	-	-
	15 - 29	83	-	0	-	12		0		-	
	30 - 44	77	-	0	-	13		0		-	
	45 - 59	73	-	0	-	12		0		-	
03/1800	00 - 14	69	-	0	-	10	37	0	0	-	-
	15 - 29	66	-	0	-	9		0		-	
	30 - 44	63	-	0	-	9		0		-	
	45 - 59	61	-	1	-	9		0		-	
03/1900	00 - 14	58	-	1	-	10	37	0	0	-	-
	15 - 29	56	-	7	-	9		0		-	
	30 - 44	53	-	10	-	9		0		-	
	45 - 59	51	-	14	-	9		0		-	
03/2000	00 - 14	49	-	6	-	10	37	0	0	-	-
	15 - 29	47	-	7	-	9		0		-	
	30 - 44	45	-	12	-	9		0		-	
	45 - 59	43	-	5	-	9		0		-	
03/2100	00 - 14	41	-	9	-	10	37	0	0	-	-

Close

Figure 9: Sample of Metrics by 15-Minute Period

After the traffic manager finds a set of parameters that they believe appropriately balances the demand with expected capacity and equitably distributes the delay, they implement the program by publishing an advisory such as the one shown in Figure 10. The advisory states the control element (the FCA for an AFP), the flights included, the start and stop times, hourly program rate, the key metrics, and the reason for the AFP.

ATCSCC Advisory	
ATCSCC ADVZY 060 FCAJX7 06/29/2022 CDM AIRSPACE FLOW PROGRAM	
MESSAGE:	CTL ELEMENT: FCAJX7 ELEMENT TYPE: FCA ALTITUDES INCLUDED: FL200 TO FL500 ADL TIME: 1945Z DELAY ASSIGNMENT MODE: UDP ENTRY ESTIMATED FOR: 29/2030Z - 30/0259Z CUMULATIVE PROGRAM PERIOD: 29/1400Z - 30/0259Z PROGRAM RATE: 80/80/80/80/80/100/100 FLT INCL: ALL FLIGHTS IN FCAJX7 DYNAMIC FLIGHT LIST DEP SCOPE: (ALL) ZLA ZAU ZLC ZTL ZDC ZNY ZHU ZJX ZFW ZOB ZDV ZOA ZSE ZBW ZMA ZKC ZME ZID ZAB ZMP CANADIAN DEP ARPTS INCLUDED: NONE MAXIMUM DELAY: 495 AVERAGE DELAY: 95 IMPACTING CONDITION: OTHER / OTHER COMMENTS: DUE TO ZJX STAFFING COMBINED WITH WEATHER CONTRAINTS
EFFECTIVE TIME:	291946 - 300359
SIGNATURE:	22/06/29 19:46

Figure 10: Sample AFP Advisory

While the AFP is in place, the traffic manager continues to use FSM to monitor how well flight demand is being delivered to the program capacity using a bar graph like the one in Figure 11. Note that it is common for traffic managers to display such bar graphs for multiple FCAs, FEAs, and/or airports at once. The bar graph shows the arrival demand at an airport or FCA being monitored relative to the currently published capacity.

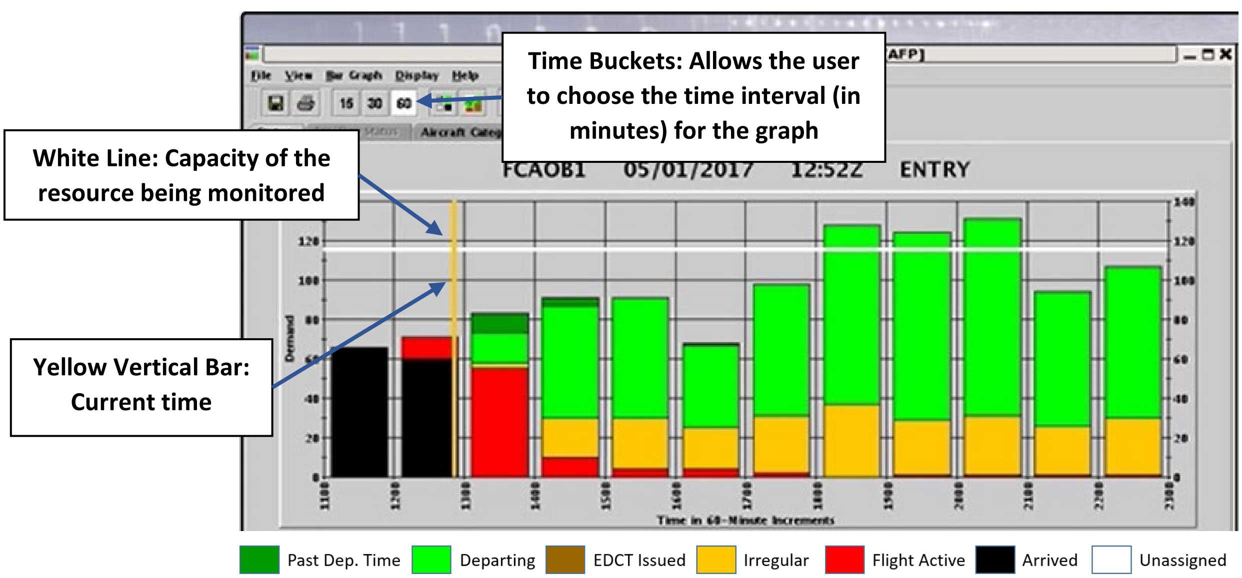


Figure 11: FSM Bar Graph

National Traffic Management Log (NTML)

Traffic managers are required to ensure all their actions are logged for later analysis and discussion, along with any alerts they receive and events that occur in the operation. These functions are supported by the NTML application within the current system. Traffic managers also use NTML to share operational information and to coordinate certain TMIs. Figure 12 shows an example of electronic coordination of TMIs, showing the status of the coordination for each TMI – approved ( ), teleconference requested ( ), action required ( ), in process (?), disapproved by the ATCSCC ( ), or withdrawn (WD). Note that NTML contains many additional functions and interfaces, but coordination using the panel shown in Figure 12 is most relevant to the TFM-AID Challenge.

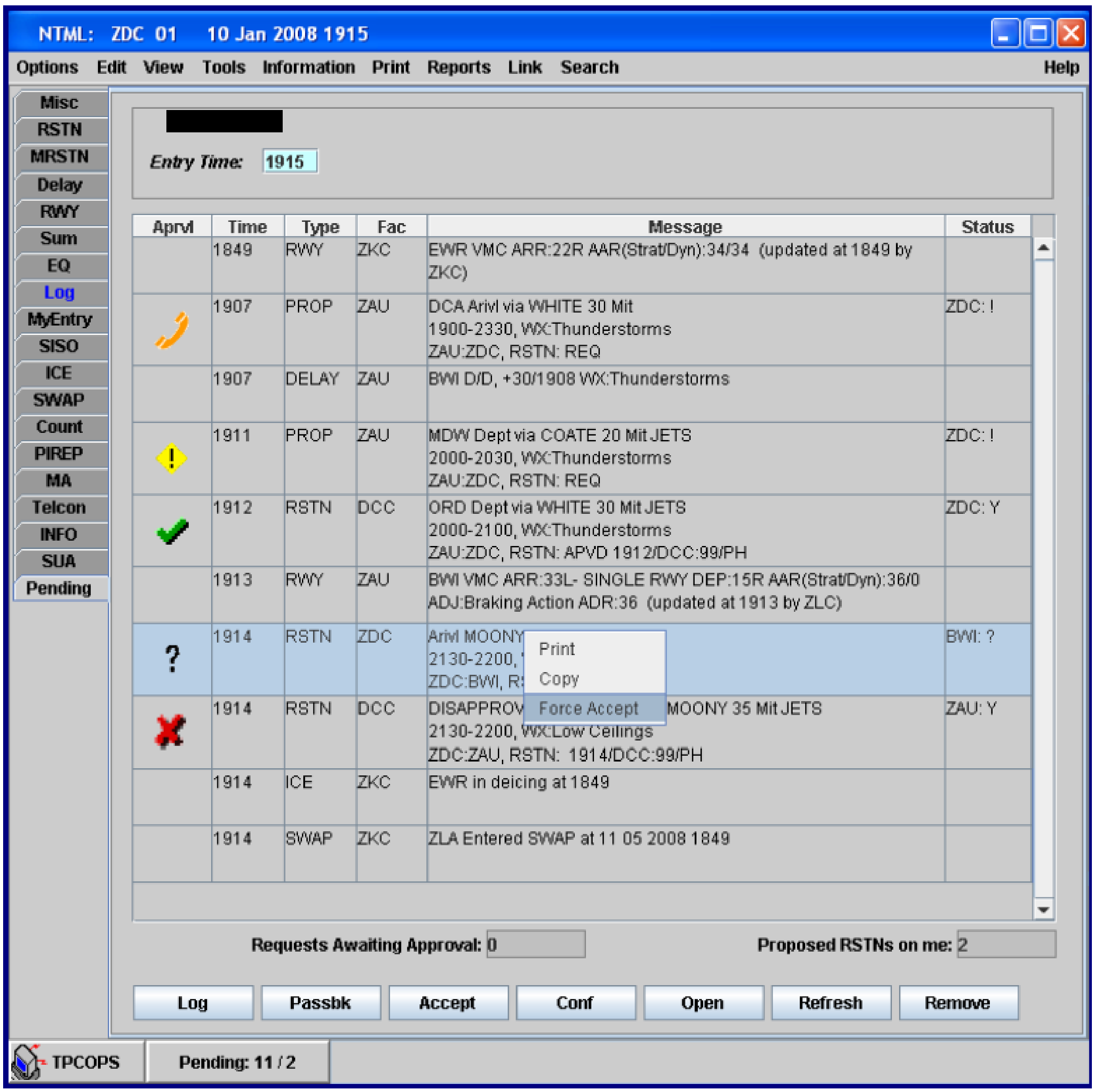


Figure 12: Example TMIs for Electronic Coordination

Further Reading

The reader is referred to the following sources for additional information.

ATCSCC briefing that discusses AFP program rates: https://tfmlearning.faa.gov/media/SE_AFP_Brief_ZJX_2021.pdf There are multiple other briefings and videos available on that site providing a host of information about TFM.

Website describing Collaborative Decision Making (CDM) and CDM tools: https://cdm.fly.faa.gov/. The user guide for the FSM capability can be found there, along with a user guide for a version of the TSD.

Definitions

Traffic management initiatives (TMIs) are techniques used to manage demand relative to capacity in the National Airspace System (NAS). Traffic managers consider the impact of potential TMIs to the NAS and implement only those initiatives necessary to maintain system integrity. They utilize a variety of tools and NAS performance information to implement TMIs that are carried out by air traffic controllers and flight operators to ensure safe and efficient NAS operations.

NAS users are individuals and organizations that operate flights in the NAS. The term includes pilots, dispatchers, other airline personnel, and general aviation or military users who operate aircraft in the NAS, many of whom use existing Traffic Flow Management System (TFMS) applications and data to maintain awareness of TMIs and other constraints.

Collaborative Decision Making (CDM) is a joint FAA and aviation industry initiative aimed at improving traffic flow management (TFM) through data and information exchange among aviation community stakeholders. CDM is both: 1) the philosophy that stakeholders should share operational information and preferences to build a common view of the NAS; and 2) the tools and procedures that support this information sharing to produce TFM decisions and actions that are best for the NAS.

CDM members are NAS users (like airlines) that: 1) provide specific flight data elements to the FAA; 2) receive certain flight data from the FAA; and 3) collaboratively work with FAA traffic managers in responding to NAS demand-capacity imbalances and other system constraints.

Ground Delay Program (GDP) is a TMI where aircraft are delayed at their departure airport to manage demand and capacity at their arrival airport. Flights are assigned departure times, which in turn regulate their arrival time at the impacted airport. GDPs are normally implemented for airports where capacity is reduced because of weather—such as low ceilings, thunderstorms, or wind—or when demand exceeds capacity for a sustained period. GDPs ensure the arrival demand at an airport is kept at a manageable level to prevent extensive airborne holding and to prevent aircraft from having to divert to other airports.

Airspace Flow Program (AFP) is a TMI that identifies constraints in the airspace, develops a real-time list of flights that are planned to fly through the constrained area, and assigns departure times to flights to meter the demand through the area.

Flow Evaluation Areas (FEAs) and Flow Constrained Areas (FCAs) are three-dimensional volumes of airspace, along with flight filters and a time interval, used to identify flights. They are typically drawn graphically and are used to evaluate demand for a resource. An FEA is a region of airspace under study, while an FCA requires action to address a particular situation. Specifically, an FCA is used to identify the flights included in an AFP.

Reroutes are routings other than an aircraft's filed flight plan. They are issued to ensure aircraft operate with the "flow" of traffic; avoid congested airspace, areas of known weather, or where aircraft are deviating or refusing to fly; and/or remain clear of special activity airspace.

Expect Departure Clearance Time (EDCT) is the runway release time ("wheels up") assigned to an aircraft in a GDP, AFP, or Collaborative Trajectory Options Program (CTOP). All aircraft are expected to depart within +/- 5 minutes of their EDCT.

Miles-in-Trail (MIT) is a required distance between two aircraft on the same route of flight going to the same destination. A MIT restriction requires more than the minimum separation criteria, (typically 5 nm in en route airspace), usually requiring 10 nm or more between aircraft.

The ***National Playbook*** is a collection of routes that have been pre-coordinated for use when reroutes are required due to constraints like convective weather or military operations. The Air Traffic Control System Command Center (ATCSCC) issues an advisory when playbook routes are in effect. A route advisory normally specifies the affected traffic flows; e.g., all flights to Chicago O'Hare airport from the west. The ATCSCC also publishes these routes in an Operations Plan. If a pilot files a route through the impacted area, air traffic controllers will issue a reroute to the flight.

Special Activity Airspace (SAA) is any airspace with defined dimensions within the NAS wherein limitations may be imposed upon aircraft operations, such as due to a military exercises or space launch. SAA includes Restricted Areas, Prohibited Areas, Military Operations Areas, and other designated airspace areas. Air traffic controllers prevent unauthorized aircraft from entering these areas when they are active.

Collaborative Trajectory Options Program (CTOP) is a TMI that manages demand through constrained airspace, defined using one or more FCAs. The CTOP seeks to balance NAS users' preferred tradeoffs between route and delay as defined in a Trajectory Options Set (TOS). A TOS may contain multiple trajectory options that differ in route, initial cruise altitude, and/or initial cruise speed. The trajectory options are ranked in the order of NAS user preference, expressed in the number minutes of ground delay the NAS user is willing to accept in order to use each trajectory option. The CTOP calculates the amount of ground delay that would need to be associated with each option (which may be zero) and assigns the most preferred trajectory available.