Airport Departure Flow Management (DFM): Findings from Field Trial Testing

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In this paper, we discuss the field testing of a Departure Flow Management (DFM) capability that has been developed by the FAA to reduce manual airport Call For Release (CFR) coordination requirements and workload, while increasing airport departure throughput and reducing delays. This field test consisted of shadow and operational phases and utilized both qualitative and quantitative methods. This study took place February and March 2008 at the Los Angeles (ZLA) Air Route Traffic Control Center (ARTCC) and Burbank (BUR), Las Vegas (LAS), Los Angeles (LAX), Ontario (ONT), and San Diego (SAN) airports. This test provided insights into how this tool changes roles and responsibilities, and how specific design features and functionality influenced the performance of the human operators. Human factors design improvements are discussed, along with the broader implications of the results of this case study for the introduction of new tools and automation into a distributed work environment.

In today’s National Aviation System (NAS), flights from different airports within an ARTCC often compete for slots at a departure fix, in an overhead stream, or at a destination airport. This requires coordination in terms of the sequencing and timing of departures in order to efficiently utilize shared resources. Today, airports accomplish this mainly through a manual and time consuming approval request (APREQ) process. Note that the ZLA facility uses the term Call for Release (CFR) rather than APREQ.

The CFR process involves a phone call from a controller in the airport Tower to the overseeing ARTCC in order to request a departure release time for any flight included in a traffic management initiative (TMI) such as a miles-in-trail (MIT) restriction. The Tower controller provides the earliest time that the flight in question can depart. The ARTCC traffic management coordinator (TMC) fielding the phone call uses the tools at their disposal, including the radar display, to determine whether the departure time being requested by the Tower is feasible given the TMI and the current situation. This decision making process includes consideration of a variety of factors including local and downstream airspace and arrival airport restrictions. In today’s environment, this manual CFR process is very time-consuming for the ARTCC TMC, requires significant collaboration, and does not produce optimal efficiency.

The DFM Capability

DFM automates the calculation, communication, and assignment of departure release times from multiple airports over shared NAS resources and into overhead traffic flows via
improved display, decision support and digital communication capabilities. DFM introduces significant enhancements in the ARTCC and Air Traffic Control Tower (ATCT) environments including digital communications via both ARTCC and ATCT displays. Further, DFM pushes the decision making to the Towers by providing them all the information required to assign release times without the need to communicate with the ARTCC. These enhancements significantly reduce the hundreds of daily phone calls currently required to coordinate airport departure management.

Today, ATCT users manage CFR procedures with little information regarding the availability of slots in the overhead flows of traffic. They communicate with an ARTCC TMC who has this information in order to coordinate the release of certain departures - often a significant number of departures on any given day (400-500 at ZLA and around 900 at ZOB).

The DFM capability represents a significant change in the distribution of airport departure release time decision-making and workload. The DFM ATCT display automatically populates with all flights requiring CFR, identifies available departure times, and displays these departure slot availabilities to the ATCT user responsible for obtaining release times. The ATCT user can then request (in the case of Manual approval mode) and/or assign (in the case of Automatic approval mode) departure times at their facility via the DFM interface. The DFM ARTCC display in turn displays all departure release time requests to the ARTCC traffic manager who is responsible for either approving release time assignment (in the case of Manual approval mode) or simply monitoring assignments (in the case of Automatic approval mode).

Below, we focus on functionality and human factor issues related to the DFM interface, operational environment and user roles and responsibilities. Recommendations and findings regarding specific functional requirements and display capabilities are based primarily on insights gained through our observational studies and feedback from the participants. These findings are organized into four basic categories:

- Supporting situational awareness
- Decreasing ARTCC and ATCT communication workload, response time and head-down time (as it relates to departure release time approval and management)
- Increasing usability of the DFM interface
- Resolving Automatic approval mode issues

**Supporting Situational Awareness**

The shift in responsibility introduced by DFM must be supported through effective situational awareness for ATCT and ARTCC users, as well as shared situational awareness across these two groups. Specifically, the ARTCC traffic manager must be supported in maintaining an adequate mental model of air traffic in order to know when to intervene or change a release time, particularly in the case of automatic release time assignments. In addition, the ATCT traffic manager (or supervisor) must be supported in selecting appropriate and effective departure release times. Note that one of the findings of the ZLA field test is that because DFM does not include information regarding arriving traffic or airport surface constraints the ATCT user will likely require information outside of that currently provided
within the DFM display. This is particularly important with single runway operations, such as SAN ATCT, where departure release time availability is subject to arriving traffic.

In order to support situational awareness, DFM includes the use of both visual display vocabularies and audible alerts. There are several events that require ARTCC and/or ATCT user notification that should be supported by this functionality including:

- ATCT requesting a Manual approval release time from the ARTCC
- ATCT requesting a Manual approval release time from the ARTCC within 5 minutes of requested departure time
- ARTCC change to requested and/or assigned release time to ATCT (including the removal of a release time request or assignment)
- ARTCC approval of release time assignment to ATCT
- Flight delayed by more than 15 minutes due to TMI
- Earlier slot open for a delayed flight

Note that careful consideration must be given to determine the types of events best indicated through audible indications. The best design limits the number of different versions of audible alerts, to indicate to the DFM user that something important has happened, and to then rely on the visual display of information for specification. In addition, it is unlikely that a final design would rely solely on audible alerts to indicate all of these various events.

**Decreasing ARTCC and ATCT Communication Workload, Response Time and Head-down Time**

Phone calls to perform CFR procedures often dominate the time and attention of ARTCC and ATCT personnel, hence the desire for automation. One critical design feature of DFM is the ability to effectively inform the user whenever an action or acknowledgment is required. Interface design methods must focus on limiting the amount of time that it takes DFM users to notice and react to events and must limit the head-down time required to interact with the system.

The majority of ZLA participants noted that they may not notice DFM events without some audible cue to draw them to the display. Implementing audible alerts, as discussed above, allows the ATCT user to step away from the DFM screen while waiting for a response from the ARTCC and decreases the length of time spent looking at the screen waiting for a response thus mitigating head-down issues. In addition, using DFM to reduce the amount of time that the ATCT spends on the phone with the ARTCC has the side benefit of increasing the amount of time the ATCT user can stay on frequency communicating with flight crews.

**Increasing Usability of the DFM Interface**

Both ARTCC and ATCT DFM displays use data tag color coding to indicate a variety of flight states including: Automatic Approval flight (cyan), Manual Approval flight (yellow), Flights from airports without DFM (purple), Manual Approval flight pending approval (inverse yellow), Manual Approval flight pending approval and within 5 minutes of release time request (inverse orange), flight with a release time assignment (green), flight 2 or more minutes past its departure release time (red) and en route flights (grey). In addition, whenever a Manual approval
request is made or when a release time request or assignment is changed, the data tag will include both a release time acceptance button (represented by a checkbox) and a release time rejection/undo button (represented by a looped arrow). In addition, data tags contain ACID, originating airport, requested release time, assigned release time and aircraft type.

The DFM ARTCC Display (Figure 1) consists primarily of Flow Timelines. One of the more significant interface enhancements made between the ZOB and ZLA field tests was changing the timelines from representing Traffic Management Initiatives (TMI) to representing a specific flow. ZLA participants remarked favorably on this approach.

Specifically, each Flow Timeline is double-sided and contains those flights that are expected to depart via the designated flow. The left side of the ARTCC timeline contains flights without a departure release time while the right side contains those flights that have requested a release time (pending approval), flights with a release time and en route flights. The timeline itself is color coded to represent available slots within the flow (green), unavailable slots (black) or to indicate that there is no TMI requiring CFR (blue).

In terms of managing the CFR process, the ARTCC traffic managers main interaction with the display is approving or rejecting release time requests by either clicking the approve or reject buttons provided within the flight data tag or changing the release time request or assignment by dragging the flight to a different release time within the timeline.

The DFM ATCT display (Figure 2) consists of a single one-sided timeline that automatically updates the display of slot availability depending on which flight (or, more specifically, which flow(s) associated with the flight) is selected. To the left of the timeline display is a list of all flights subject to CFR without a release time assignment (the Need Release
Times table); to the right of the timeline is a list of all pre-departure flights that have requested a release time (pending approval) and flights with a release time (the Have Release Times table). The ATCT user (traffic manager, supervisor or controller) requests a departure release time within this display by dragging flights from the Need Release Times table to the desired departure release time in the timeline.

**Figure 2. ATCT DFM Display**

Human factors and functional recommendations derived from the field test include:

- Increase display font size to support the user’s ability to glance at the display from a distance and discern that an action is necessary and to minimize head-down time, particularly in the ATCT environment
- Provide a “snap to” functionality to promote better accuracy when users drag flights to the timeline to make release time requests and assignments
- Provide display configurability in terms of font size, data tag elements, timeline duration (including the ability to see a history), displaying 2-digit vs. 4-digit times, flight filtering, and other features.

- Provide a “swap release time” capability to allow the exchange of release times between two flights
- Consider the integration of data from other tools such as ETMS and TMA
Resolving Automatic Approval Mode Issues

As described above, DFM supports two different kinds of departure release time modes: Automatic and Manual approval. In the case of an Automatic release time request, the ARTCC traffic manager simply monitors departure and en route demand to ensure that no flight receives reportable delay. In the case of a Manual request the ARTCC traffic manager must explicitly approve the request. In both cases, the ARTCC traffic manager has the ability to override or change any release time assignment or request at any time and the DFM uses a variety of visual and audible aids to maintain situational awareness.

In terms of Automatic approval mode, the assumption is that DFM can indicate available gaps because it has a sufficiently complete model of the situation. This then allows the ATCT user to select effective release time assignments. In many cases, it is likely that DFM will have a sufficiently complete model of the situation in order to identify available gaps. However, when there is an exception, features such as audible and visual alert functionality and the inclusion of meta-knowledge will support ARTCC traffic manager decision-making. These types of capabilities support the ARTCC traffic manager’s ability to manage by exception, rather than having to monitor every flight. Such meta-knowledge would support the identification of cases where DFM may not know enough to assign an effective release time.

Conclusions

The ZLA field test validated the overall DFM capability concept, and provided insights for enhancements related to functionality, interface and human factors issues. ARTCC and ATCT users showed overwhelming acceptance of the concept and eagerness to see the capability put to operational use. In particular, users commented that they believed the capability supported greater situational awareness, operational flexibility and planning and created more time for managing other tasks and responsibilities. Kurt Rammelsburg, LAX STMC stated, “After the Field Trial, DFM was rated for functionality, usefulness and effectiveness. No one gave it a rating less than 80-100% positive rating in any area. Unheard of for a first field system trial.”

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References