# IMPROVING EFFICIENCY OF DEPARTURE RELEASE COMMUNICATIONS FOR EN ROUTE OVERHEAD TRAFFIC FLOW MANAGEMENT

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## Abstract

Departures from some airports have to receive an approval by traffic management coordinators before their release. Such approvals are necessary to ensure that the departing aircraft will be accommodated in the overhead stream, which may have a miles-in-trail or some other traffic flow management restriction. Presently, such approvals are received by voice communications between tower controllers and traffic management coordinators. However, under busy periods, multiple tower controllers wait to talk to the traffic management coordinator. Such waiting time and the actual communications time to obtain the clearance create inefficient operations for both tower controllers and traffic management coordinators. This paper presents a proposed capability for electronic communications between the tower controllers and en route traffic management coordinators. This capability reduces the waiting and communications time between the tower controllers and traffic management coordinators.

## Introduction

An internal departure airport is one that resides under the airspace controlled by an en route Air Route Traffic Control Center (ARTCC). Scheduling internal departures into an overhead stream is one of the main functions of the Traffic Management Coordinators (TMCs). The internal departures are those departures that depart within the boundaries of an ARTCC. For example, internal departures for Cleveland ARTCC could include aircraft departing from Cleveland, Detroit, Rochester, Pittsburgh, Buffalo, etc. In certain cases, at specified times during peak traffic, the TMC requires the tower controller to request the departure release of a specific flight (which is called APREQ – approval request). The TMC reviews the request and mentally assesses the impact of the potential departing aircraft on the flow that is already operating with a miles-in-trail (MIT) restriction. The APREQ consists of a release time. The TMC examines where and when the aircraft will join the overhead MIT stream if it departs on the APREQ time. If there already is space, then the TMC approves the request as is. However, if there is no space available in the overhead stream to match the aircraft's requested departure time, the TMC has to identify a gap where the departure could be accommodated. Once a gap is identified, the TMC determines the leading and trailing aircraft within which the departure could be inserted. The TMC determines how long the leading or trailing aircraft will be at the place where the internal departure would join the overhead stream. Based on runway, winds, and departing aircraft performance characteristics, the TMC selects and issues a departure time that will ensure a desired MIT spacing. This process is very manual and could take considerable time if the overhead stream is already full and traffic volume is very high. Usually, based on the airport, the departing aircraft has a departure window, which the TMC has to take into account. For example, the aircraft departing from Cleveland airport has a four-minute window (i.e., two minutes before release time, one minute actual release time/wheels-up time, and one minute after the release time). The release time window is based on airport factors, runway configuration, typical winds, control actions, and the TMC calculation buffer. Based on the conditions of the overhead stream, the TMC can also issue an "at or before time" or an "at or after time" for internal departure releases. Therefore, when an overhead traffic stream within the ARTCC airspace is busy, the controller is required to request a clearance to release the departing aircraft into the overhead stream. Such a clearance ensures that the departing aircraft will be accommodated in the overhead stream without unduly increasing the workload of the en route controllers. Current operational methods face significant challenges as congestion grows, perhaps most significantly the limitation imposed by serial voice communications (one tower at a time) required for APREQ operations. In busy times, the TMC may not be able to respond the tower's voice call for APREQ in a timely manner, thereby creating delays in tower operations (or vice versa). During busy periods, many tower controllers need to communicate with the same en route TMC. Such "many-to-one" communications result in waiting time for multiple tower controllers since only one tower controller can communicate with the TMC at a time. Kopardekar, Green, Roherty, and Aston (2003) describe limitations of the current miles-in-trail operations, including the workload associated with tower and TMC communications. This paper describes a proposed Departure Release Communications (DRCS) capability being developed for proof of concept that is aimed at making the communications for internal departure releases more efficient. The DRCS provides an electronic means of communications between the towers and the ARTCC TMCs. The DRCS reduces the waiting and communications time for TMCs and tower personnel thereby reducing their workload. This article provides a few sample computer-human interfaces of the DRCS. Early informal discussions with users have shown promise.

## Motivation

Field observations of the traffic management unit operations at Cleveland ARTCC and Cleveland Tower, and discussions with TMCs and tower controllers, indicated that they spent a lot of time in voice communications. In addition, they also spent considerable time, during rush periods, waiting for other parties to answer. Such waiting times reduce the overall efficiency of the operations and may contribute to aircraft delay. Therefore, the researchers are developing electronic communications capability with additional features to alleviate the communications waiting time. With electronic communications, neither the tower user nor the TMC have to wait on the phone for a response. Additionally, providing information related to approval request needs (e.g., approval requested are needed, not needed, or call back needed after some time) unnecessary communications are reduced.

## Functional Requirements

The following functional requirements were developed based on field observations of the current APREQ process and an understanding of the proposed integrated APREQ environment.

- The DRCS shall provide instantaneous, asynchronous communications between the tower controllers and the center TMCs for APREQs and airport configuration information.
- The communications shall be recorded for review.
- The communications shall be flexible (e.g., allow for negotiations for situations like alternate routes).
- The communications shall be one to many (broadcast general information-type messages, such as restrictions and airport configuration changes) and/or one to one APREQs.
- In the future, DRCS shall be able to interface with other systems to obtain flight data and get results from decision aids.

## Proposed DRCS Design

The DRCS prototype is a standalone system with three types of users: TMC, tower controllers, and a system administrator. This is shown in the context diagram (Figure 1).

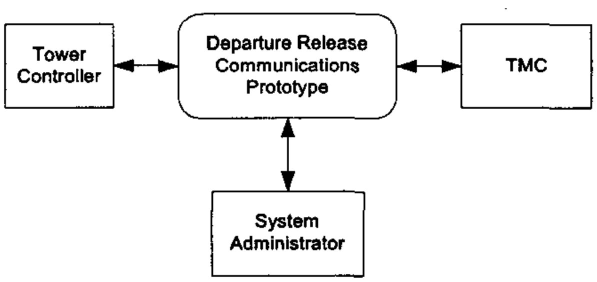


**Figure 1. DRCS Prototype Context Diagram**

The DRCS prototype has a web-based software architecture that is illustrated in Figure 2. The clients are web browsers that display HTML generated by various server programs. The web server is Microsoft Internet Information Server (IIS). The server programs are Active Server Pages (ASP) written in a combination of Javascript and VBScript. The database is a simple relational database implemented using Microsoft Access. The SQL (Structured Query Language) queries are embedded in the ASPs since Microsoft Access does not support stored procedures. The ASPs and database are developed items. The remaining software components are commercial-off-the-shelf (COTS) products.

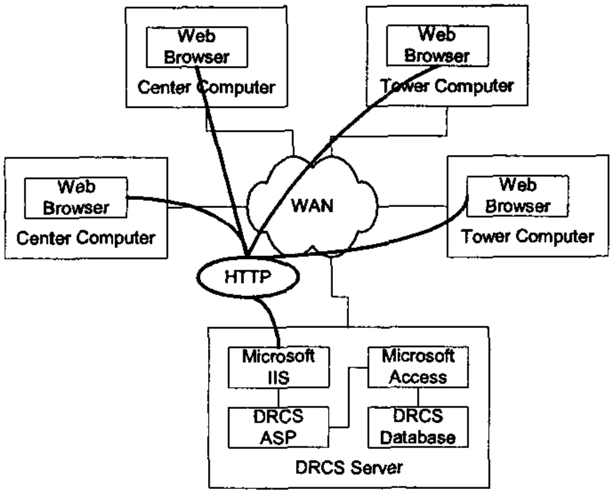


**Figure 2. DRCS Prototype Software Architecture**

This architecture was chosen for the prototype primarily because it supports rapid development of a system with multiple clients and uses hypertext transfer protocol (HTTP) for client/server communications. The HTTP is generally easy to put through a firewall, which is a desirable feature since the Wide Area Network (WAN) connecting the towers with the centers is an unknown.

The DRCS user interface displays information that is updated based on events in the system. This leads naturally to using a notification mechanism in the system. Since a notification mechanism is not part of the software architecture, the web pages poll to refresh every few seconds with new or modified information displayed.

One key component of the database model is the relationship between user positions and arrival-departure airport pairs. For example, the Detroit Tower user may be interested in flights that depart from Detroit and arrive at Chicago and Philadelphia, while a Cleveland Center user may be concerned with flights that depart from Cleveland, Detroit, and Pittsburgh Airports and arrive at Philadelphia. The DRCS system administrator initially sets these relationships. A future enhancement will allow users to modify these relationships dynamically, at least at the Center positions. Since all flight data and APREQs are viewed through these relationships, each position sees a unique view of the APREQs and flight data.

The APREQ can have the following statuses:

- Awaiting Approval – Indicates that the APREQ is awaiting approval. This is the initial status for all APREQs.
- Approved – APREQ approved by TMC as requested. Can be displayed as "Approved/Modified" when the APREQ has been approved with modifications (e.g., the requested time does not equal the approved time).
- Cancelled by TMC – APREQ cancelled by TMC.
- Cancelled by tower – APREQ cancelled by tower.
- Standby – TMC is advising the tower to standby for a response. Can have additional text with it.
- Acknowledged by tower – Approved APREQ acknowledged by tower.

The APREQs transition from one state to another through various user actions. At times, the status of the APREQ limits the functions that can be performed on the APREQ.

## Potential Benefits

The DRCS has the following benefits:

- It reduces the waiting time for tower operators as well as TMCs since the communications can no longer become bottleneck. Particularly at busy times, the waiting time increases, which further reduces the efficiency of operations.
- It reduces the total communication time between tower operators and TMCs.
- The tower controller does not need to wait on the phone line while the TMC identifies a gap in the overhead stream where the departing aircraft could be accommodated.

- It eliminates unnecessary APREQ-related communications from tower to TMC thereby reducing the tower operator and TMC's workload. The reduced communications time could lead to quicker clearances to aircraft by the tower controller and may contribute to reducing delays.
- The TMC can approve departure releases based on the efficiency rather than first come first served, which is not always efficient.
- It improves the accuracy of on-time performance reporting and will make it easier for the tower controller to generate the delay report.

## Challenges for DRCS

The main challenge for the DRCS is to determine how to integrate it with existing decision support tools that ARTCC TMCs and tower controllers use.

## Human-Computer Interaction Examples

Figure 3 shows the tower position screen viewing proposed flights. In the prototype, the proposed flights are entered from the DRCS system administrator position. In the future, the proposed flight data could come from an interface to an external system.

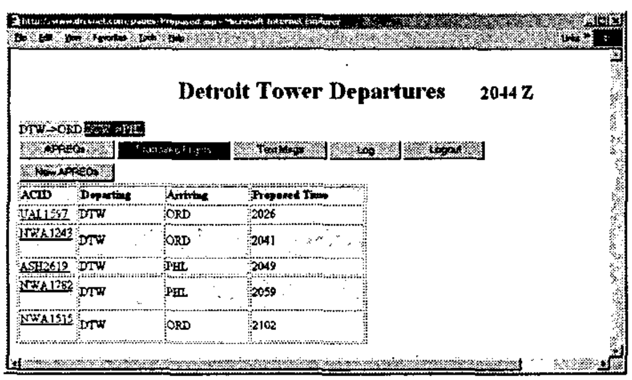


**Figure 3. Tower Position Proposed Flights Screen**

Looking at the screen, the top line shows the position, location, and Zulu time. The next line is the APREQ signals line. It indicates whether APREQs are appropriate at any time. This screen shows that APREQs are required for DTW-to-ORD flights (Detroit Metro to Chicago O'Hare) (yellow) and are not required for DTW-to-PHL (Philadelphia International) flights (green). Red (not shown) is used to indicate that APREQs will not be granted at this time for the specified airport. The appropriate TMC user controls these APREQ signals. For example, the Center position responsible for ORD arrivals controls the color of the "DTW->ORD" block. The next line is a row of buttons that function like tabs. That is, when the user clicks on a button, a different screen with different data is displayed. The tabs are:

- APREQs – Displays the APREQ screen, enabling the user to view and modify the status of current APREQs.
- Proposed Flights – Displays the proposed flights, enabling the user to APREQ the proposed flights.
- Text Msgs – Displays the current text messages, and allows the user to send a text message.
- Log – Displays the APREQ log.
- Logout – Logs the user out of DRCS.

The flights displayed are proposed flights that depart from, and arrive at, airports relevant to the user. In this case, flights originating at DTW and arriving at ORD and PHL are displayed. The flights are sorted by proposed time. The screen displays a "window" of proposed flights, the window being 30 minutes before and 90 minutes after the current time. The user can click on the ACID (Aircraft Identifier) to APREQ a proposed flight. The user can also use the "New APREQ" button to APREQ a flight that is not in the list of proposed flights via the blank APREQ screen that is displayed.

Figure 4 shows the tower position screen viewing APREQs.

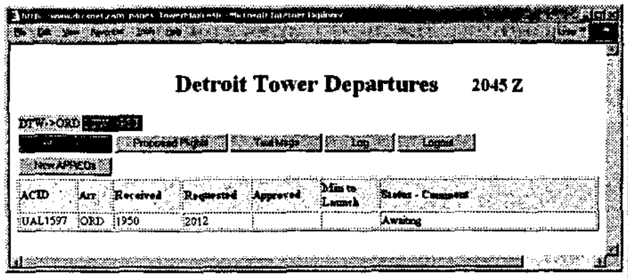


**Figure 4. Tower Position APREQ Screen**

The tower screen shows all current APREQs that have not been specifically removed by the user. The columns contain the following data:

- ACID – The aircraft identifier.
- Arr – The arrival airport International Air Transportation Association (IATA) code.
- Received – The Zulu time that the APREQ was initially filed.
- Requested – The requested wheels-up time.
- Approved – The approved wheels-up time.
- Min to Launch – The minutes to launch (only displayed for approved APREQs).
- Status-Comments – The APREQ status, along with any comments that were included with the APREQ or the response.

Figure 4 shows an APREQ for flight UAL 1597 (United Airlines), requesting a wheels-up time of 2012. The "Awaiting" status means that the APREQ is awaiting action by the TMC. The APREQs are displayed sorted by the proposed time, with the most recent APREQs displayed first. They are also grouped by ACID so changes related to a specific ACID are easier to observe. Depending on the status of the APREQ, the ACID may be underlined, indicating that the user can select the ACID link. This link displays a tower APREQ response screen, which allows the tower user to acknowledge or modify the APREQ.

Figure 5 shows the center position screen viewing APREQs. The center APREQ screen is similar to the tower screen, with the addition of the departure airport column, since each center position can handle multiple departure airports.

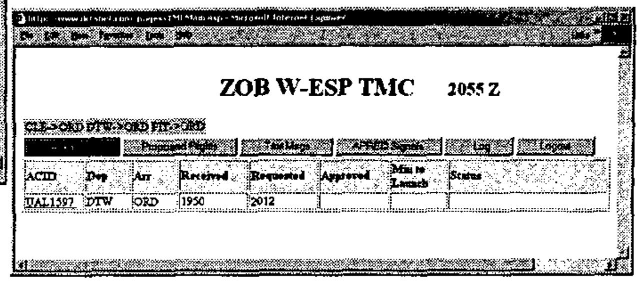


**Figure 5. Center Position APREQ Screen**

The APREQs are displayed sorted by the proposed time, with the most recent APREQs displayed first. Depending on the status of the APREQ, the ACID may be underlined, indicating that the user can select the ACID link. This link displays the center APREQ response screen, which allows the center user to approve, modify, cancel, or otherwise respond to the APREQ.

Figure 6 shows the center position APREQ signals screen.

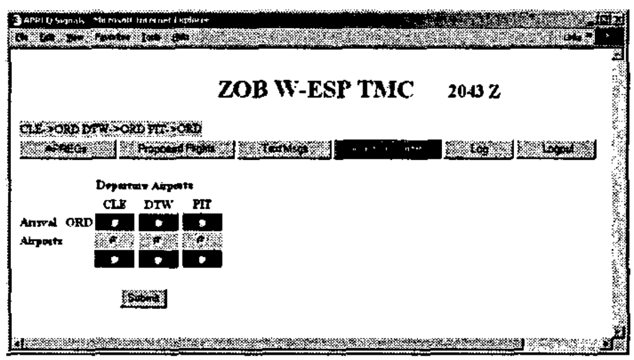


**Figure 6. Center Position APREQ Signal Screen**

This screen is used to set the APREQ signal status for the airport pairs shown. The actual airport pairs displayed depends on the airport-pairs assigned to this center position. The DRCS administrator controls the airport pairs assigned to each position.

The colors have the following meanings:

- Red – Do not APREQ and do not launch aircraft for the airport pair. No APREQs will be approved at this time.

- Yellow – APREQ aircraft for this airport pair.
- Green – Launch aircraft without APREQ for this airport pair.

The center user must use the submit button for the APREQ signal changes to take affect. The APREQ signals are advisory; that is, the system does not limit or enforce DRCS user behavior in any way.

## Architectural Alternatives

As the requirements for the DRCS prototype evolve, the current architecture may need to evolve to meet those requirements. For example, in the area of computer-human interaction, there have been requests to display APREQs in separate windows, arranged by arrival airport and/or arrival fixes at the center position. These requirements, along with requests to drag and drop between the windows for aircraft that are rerouted from one arrival fix to another, exceed the capabilities of a web browser displaying HTML pages. The requirements can be met with a custom desktop client communicating with the DRCS server.

The DRCS prototype currently supports one center, which can be supported with the clients polling the database periodically, looking for changes. The current database polling mechanism cannot scale indefinitely. At some point, some type of notification service may be needed (e.g., to decrease latency, to decrease communications bandwidth needs, to increase response time). This is not supported by the current architecture and would require a change or addition to the current architecture to include some type of middleware.

## Summary

The DRCS allows the tower controllers and en route TMCs to use electronic communications and reduces the communications bottleneck between multiple tower controllers and one TMC. The proposed DRCS capability will enhance the efficiency of communications between the tower controllers and the TMCs for APREQs.

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## References

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