Traffic Flow Management for Trajectory Based Operations: Supporting Effective Predeparture Reroutes

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TRAFFIC FLOW MANAGEMENT FOR TRAJECTORY BASED OPERATIONS: SUPPORTING EFFECTIVE PREDEPARTURE REROUTES

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There are a number of tools and procedures identified as applicable to initial Trajectory Based Operations (iTBO). This includes Strategic Planning and Traffic Flow Management such as the use of Ground Delay Programs, Airspace Flow Programs and Collaborative Trajectory Operations Program initiatives (CTOPs). It also includes a focus on route management (including the Pre-Departure ReRoute (PDRR) and AirBorne ReRoute (ABRR) tools and airport surface management (as part of the Tower Flight Data Management program or TFDM). This paper focuses on enhancements to support the effective use of the Pre-Departure ReRoute tool (PDRR). These enhancements emphasize the importance of integration between the Traffic Flow Management System (TFMS) and TFDM.

PDRR provides access to displays which allow the traffic manager to view the flight lists (demand) associated with the different departure fixes for an airport. While this information on departure fix demand is very important, the decision about which flights to reroute and about which flights to reroute first requires real-time information about which flights have already pushed back and about the current lineup in the departure queue.

Multi-route Trajectory Options Sets (TOSs) provide a mechanism for the flight operator to communicate constraints on the reroutes that a particular flight is prepared to accept. By submitting a TOS for each flight, the flight operator is able to provide the FAA (through TFMS) with a prioritized set of alternative routes that a flight is prepared to accept. The dispatcher has reviewed this set prior to submission and the flight crew has a list on the flight release.

Thus, this TOS can provide the FAA traffic manager with information about what tactical reroutes (within 45 minutes of departure) a flight is prepared to accept without the need to further coordinate with dispatch or to return to the gate for additional fuel.

The availability of multi-route TOSs for FAA traffic managers offers the potential to reduce coordination and communication demands for the Air Traffic Control Tower (ATCT) controller, the flight crew, the dispatcher and the traffic manager. An additional benefit is that flights are less likely to have to return to their gates for additional fueling (or cancelation).

This paper describes an operational concept based on these considerations which has been recommended to the FAA by the Collaborative Decision Making Program Flow Evaluation Team (FET) and The Collaborative Decision Making Program Steering Group (CSG).

Operational Concept

This concept focuses on the integration of PDRR and TFDM (FAA, 2018) so that traffic managers can easily see the actual line-up of traffic on the airport surface in order to prioritize the order for making reroutes. It allow traffic managers to simply select a flight shown on the airport surface display in order to access information on the alternative routes in theTOS associated with that flight.

The scenario below assumes that multi-route TOSs are being submitted by the flight operators for pre-departure reroutes that can be made by a traffic manager at the Cleveland ARTCC (ZOB) using PDRR. (In the future, these reroutes might be made locally by the ATCT/TRACON at the affected airport Detroit (DTW) instead.

The goal of this scenario is to illustrate the functionality and procedures necessary to support effective use of PDRR to manage departures. The focus is an airport (DTW) using RNAV SIDS with departure fixes dedicated to that airport (see Figure 1).

Figure 1. RNAV SIDS for departures out of DTW.

This scenario deals with a weather event in which a frontal system extends from just south of the Southgate departure fixes for DTW (see Figure 1) down into the Indianapolis ARTCC (ZID) airspace. This weather is moving from west to east and progressively impacts the Southgate departure fixes. Later it impacts departures to the southeast via LIDDS. During this period, storm cells to the south also are affecting ZID traffic, resulting in Miles-in-Trail (MIT) restrictions on the DTW departure fixes feeding ZID (JWELS, HUUTZ and PHAUL).

1800Z. Based on a forecast that this frontal system will impact Southgate departure fixes and the southern-most Eastgate departure fix sometime between 2000Z and 0030Z, ATCSCC sends out an FYI SWAP advisory for this time range indicating:
SOUTHGATE DEPARTURES OUT OF DTW (JWELS, HUUTZ and PHAUL) AND EASTGATE DEPARTURES VIA LIDDS AND CAN EXPECT CDRS/SWAP DUE TO WEATHER. USERS SHOULD FILE NORMAL ROUTES BUT CONSIDER SUBMITTING A TOS INCLUDING ALTERNATIVE EASTGATE, SOUTHGATE AND WESTGATE DEPARTURE FIXES (JWELS, HUUTZ, PHAUL, PAVYL, LIDDS and BROZZ) AND FUEL ACCORDINGLY IN ORDER TO EXPEDITE DEPARTURES.

1801Z. As recommended, many, but not all, flight operators begin to submit TOSs to the FAA for use in PDRR for flights included in this FYI advisory. These TOSs contain alternative routes using JWELS, HUUTZ, PHAUL, LIDDS, PAVYL and BROZZ as departure fixes. These flights are fueled for these alternatives that have been reviewed by the responsible dispatchers.

These alternative routes (and associated fuel requirements) are listed on the flight release for the pilots. The TOS that is submitted contains both the CDR (Coded Departure Route) eight

letter code (if the alternative route is a CDR), as well as the full route string for that flight, and the prioritization for these routes is indicated by submitting the Relative Trajectory Cost (RTC) of each alternative route in the TOS for a given flight. For those flights for which no TOS has been submitted, the filed route is used for modelling purposes, but that route will not show up as a route in the TOS and will not appear in the list of TOS options in PDRR. In general, flight plans are submitted 60-120 minutes before the scheduled departure time of a flight.

Note also that, if a CTOP is in effect for a given flight, then the dispatcher is expected to file the route assigned by CTOP (and that route is used to assign ground delay if any). If the dispatcher determines that some other route needs to be filed, the flight is assigned a new delay based on the Flow Constrained Area (FCA), if any, that that route flies through. (Since this scenario assumes only PDRR is using the TOSs and that no CTOP initiative is in effect, the remaining discussion does not cover any additional considerations that could arise in the use of TOSs for CTOP alone or in conjunction with PDRR.)

2100Z. The frontal system moving west to east located just south of the DTW Southgate departure fixes is still west of the departure routes fed by those fixes (JWELS, HUUTZ and PHAUL). However, it is already impacting flights departing JWELS that are filed through SNDRS, resulting in a 15 MIT restriction for flights using SNDRS from 2100-2200Z.

2130Z. Cells associated with the front are beginning to significantly affect airspace in ZID making it necessary for flights to deviate from their routes. This results in a 10 MIT as one restriction initiated by ZOB for flights departing the Southgate departure fixes (JWELS, HUUTZ and PHAUL) from 2130-2230Z. This overrides the SNDRS restriction so it is canceled effective 2130. These fix restrictions are made available electronically to the flight operators in real time via some mechanism (This is a future enhancement that could be added to the National Operations Display or NOD.) PDRR is used by a traffic manager at ZOB to tactically reroute some flights within 45 minutes of departure that have been filed to depart via JWELS, HUUTZ or PHAUL so that they can depart using the a route in their TOS that includes the Eastgate departure fixes LIDDS and PAVYL and the Westgate departure fix BROZZ. To do this:

- The traffic manager looks at a surface management display to see how many flights are filed to depart using the restricted fixes (see Figure 2). This display indicates where these flights occur in the departure timeline and how many flights are included. It also indicates where they are on the surface (still at the gate, in the ramp area or in the active movement area). The traffic manager also looks at the display of departure fix loadings in the PDRR and looks at the timeline in order to help decide which departure fixes to consider for each reroute. The view of departures (organized by departure fix) also provides information on which of these flights have associated TOSs. Based on this awareness of activity on the airport surface and the upcoming demand for the departure fixes, the traffic manager decides which flights (if any) to reroute to LIDDS, PAVYL or BROZZ in order to ensure they are ready to depart when the aircraft reaches the runway threshold. Note that, without access to this surface information, the traffic manager would have had to talk with the Tower in order to determine which flights to reroute first.
- Based on the surface map indicating where flights filed to depart via the now restricted fixes (JWELS, HUUTZ and PHAUL) are located on the airport surface, the traffic manager proceeds to make reroutes as deemed necessary. (Note that just because a flight is filed to depart JWELS, HUUTZ or PHAUL does not necessarily mean it needs to be rerouted.)
- To reroute a flight with a TOS that is filed to depart JWELS, HUUTZ or PHAUL as indicated in PDRR, the traffic manager clicks on that flight on the surface map and opens a display in PDRR to look at its TOS (with the routes ordered in terms of their associated RTCs).

The traffic manager views the TOS route options for that flight that show both the CDR code (if applicable) and the full route string, and as appropriate selects the route using LIDDS, PAVYL or BROZZ as the departure fix. This is submitted to the En Route Automation Modernization system (ERAM) as a route amendment.

- PDRR also is used to reroute flights that do not have a multi-route TOS, but without the benefit of pre-coordination with the responsible dispatchers and flight crews.
- For many, but not all, flight operators, when this route amendment is submitted, the dispatcher receives an alert indicating that this flight will be cleared to depart on this new route. This alert indicates both the CDR code (if applicable) and the full route string. This alert also indicates whether the amended route was contained in the TOS and was therefore included on the release for that flight. In response to this alert, the dispatcher informs the flight crew that they should expect to be cleared by the ATCT controller for departure on this pre-coordinated route. To make it easy for the crew to identify which of the alternative routes on their flight release to expect, the dispatcher indicates the CDR code (if applicable) in this communication.
- The crew checks the fuel and weather conditions to make sure they can still accept this route. Assuming they can, they prepare for departure on this reroute.
- The ATCT controller receives a flight strip with the CDR code (if applicable) and full route string indicated.
- The ATCT controller clears the flight by voice to depart on the new route to depart via LIDDS, PAVYL or BROZZ (depending upon which flight amendment was made). At DTW, at present this likely will be done with a full route clearance. (At EWR, in contrast, 70-80% of the time this will be done using the CDR code for an abbreviated clearance. DTW could consider doing this in the future as well to increase efficiency and reduce workload.) Alternatively, Data Comm is used to electronically deliver the new route to the flight deck. In this case, the message includes both the CDR code (if applicable) and the full route string. The CDR code (if applicable) makes it easier for the pilots to quickly ensure that the cleared route is in fact on their flight release. (If not, they would need to clear it with dispatch.)
- The pilots accept the clearance and depart on schedule via LIDDS, PAVYL or BROZZ (depending upon which flight amendment was made).

This process eliminates the departure delay for those flights that have submitted TOSs that include routes using LIDDS, PAVYL and/or BROZZ. Some of the flights that do not have a multi-route TOS may have to pull over until they can coordinate with dispatch and ATC in order to find an acceptable reroute, or may even have to return to a gate to get additional fuel.

2200Z. The frontal system has moved east quickly enough to directly impact the Southgate departure fixes, resulting in significant airborne deviations for departing flights and responses from pilots prior to departure that they are unable to depart using these fixes due to the weather. Departures via those three fixes are therefore halted. These fix closures are communicated electronically to the flight operators in real time via the NOD or some future equivalent.

As with the previous step at 2130Z, the traffic manager identifies those flights filed to depart via the three Southgate departure fixes and when possible uses their TOSs as displayed in PDRR to make reroutes as appropriate.

Note however that, like today, even if a flight doesn't have a route option for a LIDDS, PAVYL and/or BROZZ departure in its TOS it could still be offered a reroute. However, without the pre-coordination provided by the TOS, there may be a much greater delay to accomplish the

needed coordination involving the flight crew, dispatch and ATC. In some cases, the result for such flights is that they have to go back to the gate for refueling or cancellation.

2200-2300Z. As the weather progressively moves past the three Southgate departure fixes, flights are allowed to depart via each fix as it opens up.

2300Z. The restriction (closure) on the Southgate departure fixes is allowed to expire. Departures via LIDDS are now starting to deviate so a 20 MIT restriction is put into effect from 2300-0000Z. Similar to the management of reroutes at 2130Z, some of the flights filed to depart LIDDS are rerouted to depart via PHAUL using their TOSs in the RAD. This restriction is communicated electronically to the flight operators in real time via the NOD.

2330Z. Departures via LIDDS are halted due to significant airborne deviations for departing flights and responses from pilots prior to departure that they are unable to depart using these fixes due to the weather. Similar to the management of reroutes at 2130Z, some of the flights filed to depart LIDDS are rerouted to depart via PHAUL using their TOSs in PDRR when available. This restriction is communicated electronically to the flight operators in real time via the NOD.

0000Z. The front passes east beyond LIDDS and the restriction on LIDDS departures is allowed to expire.

Notional Display Illustrating the Integration of PDRR with Surface Information

To complement this scenario, below we provide a notional example illustrating how access to surface data could significantly improve performance (reducing communications and coordination between the ATCT and the Center traffic manager who is using PDRR, and streamlining the inputs required of the Center traffic manager using PDRR in order to make a route amendment). This display (shown in Figure 2) makes use of a previously developed prototype surface management simulation (Smith et al., 2012) to provide a concrete illustration using a hypothetical airport (KMJA) that includes associated departure fixes WICKR, WILEY and NOBLR.

The display below shows that two closed fixes to the west, WICKR and WILEY have been highlighted in the Selection Tool (left window). This results in the highlighting of those flights in the flight list (center window) filed to depart via one of the two closed fixes (WICKR and WILEY). Those flights also are highlighted on the surface map. In this display, the traffic manager has noted that the first flight in the departure queue that is filed to depart via one of the two closed fixes is DAL8889. The traffic manager has double clicked on that flight on the surface map and its data has appeared in a PDRR display. The traffic manager can now select the third option (a route using NOBLR, an open departure fix to the north) in order to select that TOS option as the reroute.

Conclusion

The scenario illustrates how, using an airport surface display that is linked to PDRR, a traffic manager can:

- Use a selection tool to highlight flights that were filed to depart using a departure fix that has been constrained by weather . They are highlighted in both the flight list and on the airport surface display (see Figure 2).

- View the impacted flights have been highlighted in the flight list and on the airport surface display.
- Use the visual display of the locations of these impacted flights on the airport surface in order to determine which are in the active movement area, which have pushed back and but are still in the ramp area, and which are still at their gates.
- Use this information to identify the aircraft that is closest to the departure runway.
- Clicking on that aircraft on the surface map (or in the flight list) to view the available pre-coordinated route options in the TOS in a PDRR display (see Figure 2).
- If judged appropriate, using PDRR to select one of these options as the reroute for that flight. (If a flight doesn't have a TOS, or if the route judged most effective by the traffic manager is not in the TOS, the traffic manager can still open up the PDRR display by clicking on the flight on the airport surface map and then making some other route amendment.)
- This process, supported by appropriate enhancements to PDRR and TFDM, offers an approach to significantly reduce the level of effort and coordination time involving the ATCT controller, Center or TRACON traffic manager, pilot and dispatcher when making a tactical pre-departure reroute. It further provides a mechanism to communicate and consider flight operator priorities and constraints when such a reroute is made.

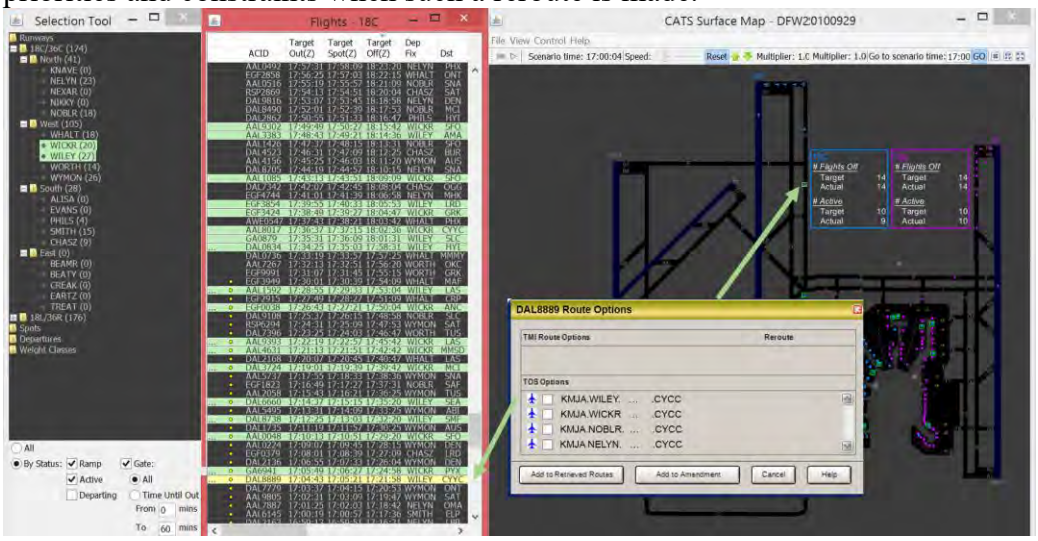

Figure 2. Notional display illustrating the linkage of PDRR with surface management displays.

Acknowledgements

This work was completed in collaboration with the Collaboration Decision Making Program Flow Evaluation Team.

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