2005

Coordinated Contingency Planning in the Face of Uncertainty in the National Aviation System

Philip J. Smith

Amy Spencer

Charlie Billings

COORDINATED CONTINGENCY PLANNING IN THE FACE OF UNCERTAINTY IN THE NATIONAL AVIATION SYSTEM

Philip J. Smith, **Amy Spencer** and **Charlie Billings**
The Ohio State University
Columbus OH

One of the major challenges for strategic planning in aviation concerns uncertainty about weather and traffic constraints, as traffic managers often have to disseminate reroute advisories 2 hours before an expected constraint impacts an airport, and dispatchers file flight plans 60-75 minutes before a flight's departure. When the predictions used to for these plans are wrong, significant inefficiencies (unused airspace and runway capacity from a traffic manager's perspective and delayed flights from a dispatcher's perspective) often result. To make operations more adaptive, new procedures have been developed. These procedures involve using predefined Coded Departure Routes, and are now being extended to include the dissemination of strategic plans that explicitly deal with uncertainty. Through this process, the decision about what departure route to actually use for a flight can be delayed until it is ready to depart, avoiding the need to make an early (and potentially poor) commitment to a departure route that may be unavailable at the time the flight taxis out for departure, while still keeping the dispatcher in the loop.

Background

In order to deal with cognitive complexity, the operation of the National Airspace System (NAS) is distributed among many organizations and individuals. The architecture for this distributed work system can be characterized in terms of the allocation of control and responsibility, and also in terms of the distribution of data, knowledge, processing capacities, goals and priorities. Within this distributed system, one of the most significant challenges is how to coordinate and adapt plans in the face of uncertainty, given that the level of uncertainty changes over time (Smith, Beatty, Spencer and Billings, 2003).

At present, most procedures to use traffic flow management in order to improve coordination must oversimplify consideration of this time-varying uncertainty. This is done by making predictions about the most likely scenario and developing a resultant single plan. Figure 1 is an example of an advisory describing such a plan.

In this paper, we explore enhanced communications between traffic management and the NAS users which allow them to deal more effectively with uncertainty in weather and traffic constraints. Instead of a process that communicates a single plan, a process that is currently being implemented by the FAA traffic managers and dispatchers will make it possible for both traffic managers and dispatchers to communicate constraints and contingency plans. By communicating within this more expressive framework, data and knowledge are shared in an efficient manner at an appropriate level of abstraction, in order to allow both traffic managers and dispatchers to plan the actions under their control in a more informed and realistic manner.

New Solution

Coded Departure Routes (CDRs) are a set of predefined alternative routes for flying between particular city pairs. They were developed by ATCSCC and ARTCC staff in cooperation with the NAS users under the auspices of the FAA's Collaborative Decision Making Program (Beatty and Smith, 2000; Smith, et al., 2001; Smith, Beatty, Campbell, et al., 2003).

These prespecified routes were developed for two reasons. First, there is an 8 letter abbreviation associated with each CDR, making computer entry and communication of that route much faster for FAA and dispatch staff (thus reducing workload and expediting route changes). Second, these CDRs were designed to support a collaborative process for selecting an alternative departure route for a flight when the user preferred route is not available due to a weather or traffic constraint.

More specifically, the initiative that led to the development of CDRs had several underlying motivations. The first was to increase efficiency in communicating changes in the departure route for a flight, speeding up such communication and reducing the associated workload. The second was to develop a collaborative process that was intended to:

- Provide Airline Operations Centers (AOCs) and other NAS users, along with traffic managers at ATCSCC, ARTCCs, TRACONs and Towers with a process for working collaboratively to develop earlier plans for dealing with predicted constraints in the NAS.
- Provide a set of pre-specified alternate departure routes for specific city pairs that had been approved by all of the involved Centers in terms of the impact

on typical traffic flows and constraints.
- Give traffic managers greater flexibility in responding to the often rapidly changing picture regarding available airspace during weather and traffic events, so that departure delays could be reduced.
- Keep dispatchers in the loop through the early identification of the alternate departure routes that might be selected at the time of departure from an airport.

As an illustration, see Figure 2, which shows a scenario involving uncertainty about when a storm cell will close off departures out of DTW via CAVVS, making it desirable to have the CDR from DTW via WINGS available as an alternative departure route. Figure 3 shows an analogous situation for departures out of New York, with weather potentially impacting departures via ELIOT, with COATE as an alternative departure fix. As indicated in the table in Figure 3, the flight was filed by the dispatcher for departure via ELIOT at 1734Z, but was re-cleared for departure via COATE by a traffic manager at New York Center at 1856Z (Smith, et al., 2005). This reroute allowed the flight to depart on time instead of having to wait for the weather to clear.

In terms of making communications more effective, and in reducing coordination time among FAA facilities, CDRs have been quite successful (Smith, 2003). However, the desired improvement in coordination and preplanning between traffic managers and AOCs and other NAS users has not been as effective. As one traffic manager indicated (for his Center's airports):

"The CDRs are usually issued on the taxiway. The pilot then has to contact his dispatcher to see if the flight meets FAR criteria. We have had them taxi back to the ramp to take on more fuel or unload baggage."

While there are Centers and airlines that have developed methods for preplanning when CDRs should be used, this is still the exception and, when it is done, it requires a great deal of effort because communication and coordination is done by phone. Thus, one of the major factors that has limited the effective coordinated use of CDRs has been the lack of software support for communication between traffic managers and the AOCs and other NAS users.

Preplanning For Alternative Departure Routes

To deal with this issue, a number of steps are being taken to improve pre-coordination concerning the use of CDRs for departures from a given airport. Specifically:

- Strategic planning telecons are held every 2 hours, with traffic managers from ATCSCC, ARTCC, TRACON involved, along with air traffic control coordinators representing the NAS users.
- During these telecons, the traffic manager for an ARTCC that anticipates a potential but uncertain constraint (where the uncertainty can be in terms of its timing or location) is asked to provide a prediction about the potential timing and location of the constraint, as well as recommended alternative solutions depending on how the constraint develops. Given the nature of CDRs, such predictions generally focus on potential weather or traffic constraints that are likely to block a given departure direction out of an airport (see Figures 2 and 3).
- The ARTCC traffic manager is also asked to use the FAA's Traffic Situation Display (TSD) to draw a flow constrained area (FCA) indicating the route that may be blocked. For the weather constraint in Figure 2, this area would be drawn directly south of DTW, indicating that the normally preferred routes departing via CAVVS may be blocked by the constraint. For the weather shown in Figure 3, this FCA would be drawn around ELIOT.
- The traffic manager also indicates which alternative routes (CDRs) are expected to be used to expedite departures if and when the constraint does develop.
- This FCA, along with a prediction model for flight trajectories, is then used to identify the flights that are expected to traverse this FCA during the time when that airspace may be constrained.

This information is then included as part of the strategic plan, which is distributed to all FAA facilities and to the NAS users. Specifically, this information includes a graphic indicating the airspace that may be impacted by the constraint, the timeframe during which this could occur, and the recommended alternative routes for which flights should be prepared (if possible). It also contains a list of the flights that are likely to be affected. Below is an example of the information contained in such a strategic plan regarding preparation for an alternative route.

"For flights departing ZNY and ZBW 1600-2200Z, file on J36/J95/J60 if desired, but prepare for possible use of CDRs on J64 and J80 (see FCA004 for flight list)"

Assuming this strategic planning information is received by the dispatcher before preparing the flight plan for a flight (typically 60-75 minutes before departure), the dispatcher must decide whether it is safe to file a route that assumes the constraint will not impact the flight. (In the scenario illustrated in Figure 2, in such a case the dispatcher would file a departure via CAVVS; in Figure

3 the dispatcher would file a departure via ELIOT.) The fact that the strategic plan has an attached flight list further means that only the dispatcher with an affected flight needs to review this advisory.

Given the strategic planning information, the dispatcher would proceed to evaluate that flight for departure using a CDR via WINGS for the scenario in Figure 2 or via COATE for the scenario in Figure 3. If the dispatcher determined that such an alternative route was safe and effective for the flight should the weather impact CAVVS (Figure 2) or COATE (Figure 3) at departure time, then the flight could be pre-approved for and fueled for this alternative route. This information would then be included on the flight release, letting the flight crew know that they could accept a clearance on the filed (user preferred route) or the pre-approved alternative.

Just prior to departure, a traffic manager would then evaluate the situation, leaving the flight on the user preferred route if that was available for a timely departure, or moving it to the alternative CDR if that expedited its departure. This information would then be sent to the airport Tower controller, who would give the flight a clearance for departure on the originally filed route or the alternative CDR, depending upon what the traffic manager had decided.

Note that, in some cases, the dispatcher might choose to not approve the alternative route for some safety or business reason, in which case the flight would either have to take a delay on the ground or the dispatcher would have to request an exception for some other alternative route from traffic management.

Summary

One of the major challenges faced by traffic managers and dispatchers is dealing with uncertainty regarding weather and traffic constraints. To improve performance in the face of such uncertainty, they have begun to develop a system that allows much more adaptive and agile responses as specific scenarios unfold.

The introduction of CDRs represented one important step in this direction, reducing coordination time among traffic managers and reducing communication times among traffic managers, dispatchers, pilots and controllers. This paper describes the next step in trying to make the system even more adaptive, while ensuring that all of the critical parties remain in the loop. This next step involves the creation and dissemination of strategic plans that identify contingencies for dealing with uncertainty. Under this new procedure, traffic managers share their knowledge by suggesting potential contingencies. Dispatchers input their expertise by determining whether or not to pre-approve these contingencies. Through this process, the decision about what departure route to actually use for a flight can be delayed until it is ready to depart, thus avoiding the need to make an early (and potentially poor) commitment to a departure route that may be unavailable at the time the flight is ready to depart. This makes it possible to clear the flight on a route that expedites its departure, while still ensuring that the dispatcher has been involved in evaluating the safety and efficiency of the final route.

Acknowledgements

This work was supported by the FAA Collaborative Decision Making Program and the FAA Human Factors Research and Engineering Division.

References

Beatty, R. and Smith, P.J. (2000). *Design Recommendations for an Integrated Approach to the Development Dissemination and Use of Reroute Advisories*. Institute for Ergonomics Technical Report #2000-13. Ohio State University, Columbus OH.

Smith, P.J. (2003). *Benefits from the Use of Coded Departure Routes.* Institute for Ergonomics Technical Report #2003-15. Ohio State University, Columbus OH.

Smith, P.J., Beatty, R., Campbell, K., Murphy, M., Jezerinac, J. and Behbehani , T. (2003). Design and evaluation of tools for creation, dissemination of and response to reroute advisories to enhance coordination in traffic flow management. *Proceedings of the 2003 Aviation Psychology Symposium*, Dayton, OH.

Smith, P.J., Beatty, R., Spencer, A. and Billings, C. (2003). Dealing with the challenges of distributed planning in a stochastic environment: Coordinated contingency planning. *Proceedings of the 2003 Annual Conference on Digital Avionics Systems*, Chicago, IL.

Smith, P.J., Klopfenstein, M., Jezerinac, J. and Spencer, A. (2005). Distributed work in the National Airspace System: Providing feedback loops using the Post-Operations Evaluation Tool (POET). In B. Kirwan, M. Rodgers and D. Schaefer (eds.), *Human Factors Impacts in Air Traffic Management*. Ashgate.

Smith, P.J., McCoy, E. and Billings, C. (2001). *Issues in the Use of Coded Departure Routes*. Institute for Ergonomics Technical Report #2001-12. Ohio State University, Columbus OH.

Date: 12/23/2004 12:12 Title: ROUTE RQD /FL NAME: SNOWBIRD_7
CONSTRAINED AREA: ZDC REASON: VOLUME

INCLUDE TRAFFIC: ATL/CLT DEPARTURES TO BDL/BED/BOS/HPN/PVD
FACILITIES INCLUDED: ZJX/ZTL/ZDC/ZNY/ZBW
FLIGHT STATUS: ALL_FLIGHTS
VALID: ETD 231208 TO 231630
PROBABILITY OF EXTENSION: MODERATE

REMARKS: AIRCRAFT FILED VIA A761 OR THE ATLANTIC ROUTES ARE EXEMPT
ASSOCIATED RESTRICTIONS: AS COORDINATED.
MODIFICATIONS: ATL/CLT DEPARTURES ONLY.
ROUTES:

ORIG	DEST	ROUTE
ATL	BOS	SPA J14 PXT J191 RBV J222 JFK ORW3
ATL	PVD	SPA J14 PXT J191 RBV J62 J150 HTO JORDN MINNK
CLT	BOS	RDU J55 HPW J191 RBV J222

Figure 1. *Sample reroute advisory assigning specific reroutes instead of preparing for alternative contingencies.*

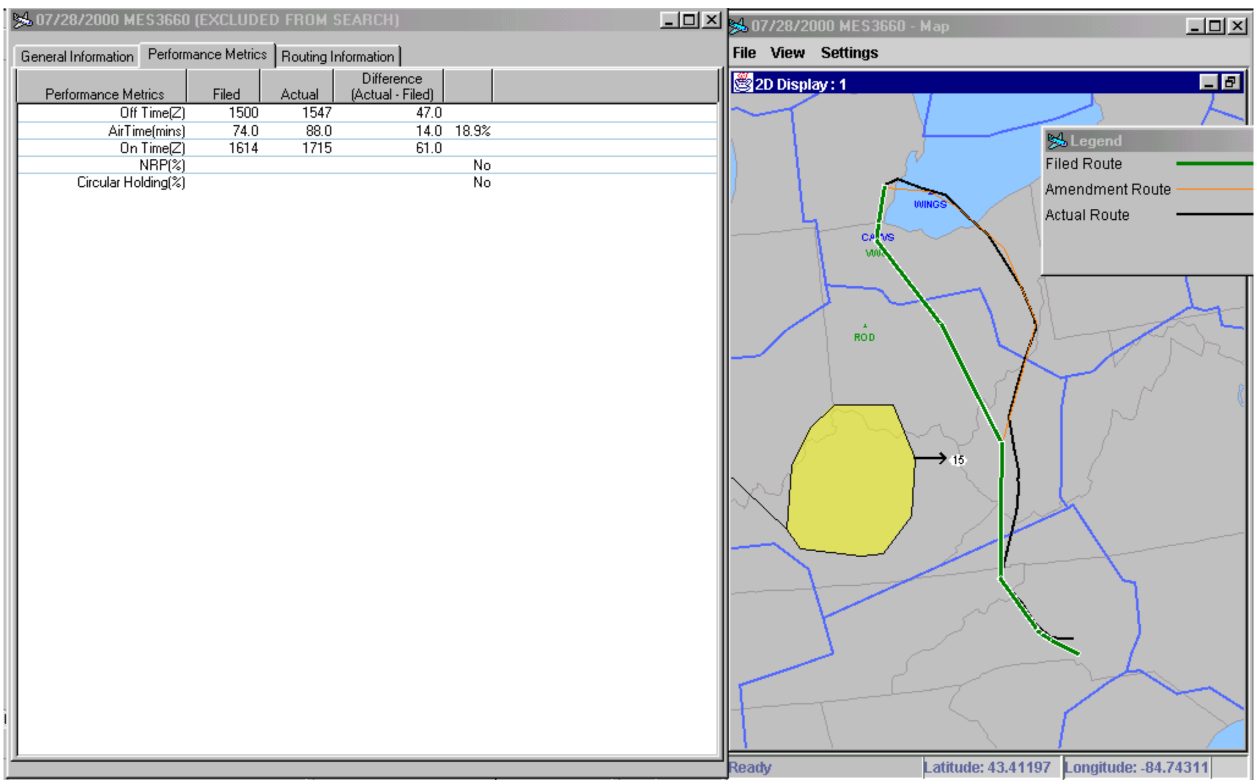

Figure 2. *Initial information on a specific flight.*

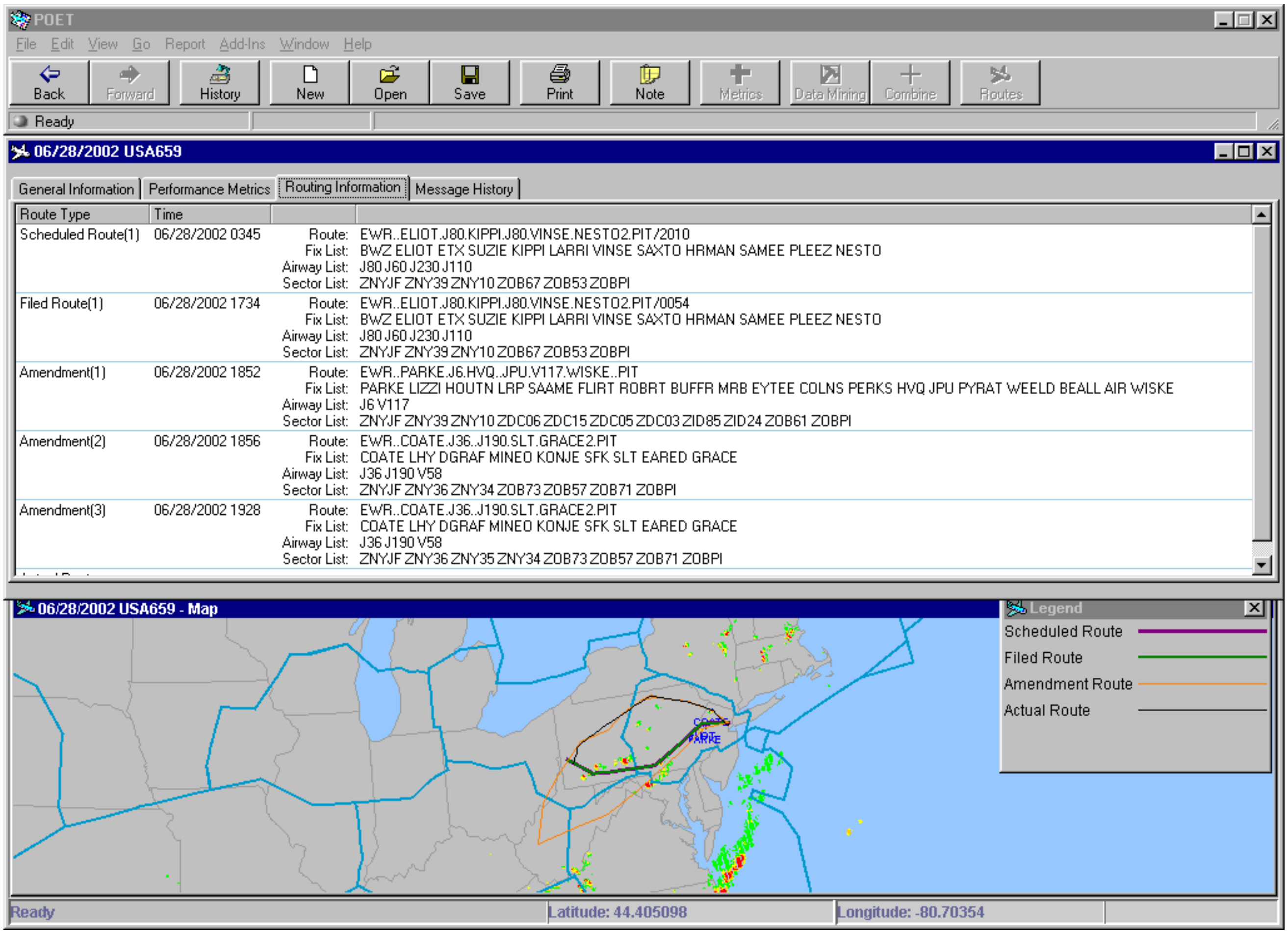

Figure 3. *Flexible routing to expedite departure of a flight from EWR-PIT*