Supporting Air Traffic Flow Management with Agents

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The airspace of the continental United States is subdivided into 20 disjoint regions, each under the control of an Air Route Traffic Control Center (ARTCC). Each ARTCC has a Traffic Management Unit (TMU) which is responsible for guiding traffic safely through the airspace they manage. This requires continued coordination with the airlines, the TMUs of the other ARTCCs, and the national Air Traffic Control System Command Center.

Even within the domain of a single ARTCC, the situation can be complex. Aircraft generally follow fixed air routes, a sort of “highway in the sky.” Like ground based highways, these air routes have limited capacities. Merging traffic must also be accommodated from other traffic streams as well as contributing airports. Careful planning, coordination, and monitoring is required to maintain safety as well as efficiency in the overall system.

Poor weather conditions (and other factors) may negatively impact the capacity of an air route. In such cases, mitigating actions must be taken by the traffic managers to maintain safety. Ideally, all parties affected by the constraints would be involved in choosing mutually beneficial mitigations, but in the current state of practice, the traffic managers must issue restrictions without considering airline preferences.

Collaborative Decision Making (CDM) is a collaboration between the Government and aviation industry that seeks to address traffic management issues through increased sharing of information and mitigation selections. Tools such as the Common Constraint Situation Display and the Flight Schedule Monitor provide a common situation awareness and are already available. Other elements, such as the sharing of airline preferences and traffic flow manager considerations have yet to be implemented. We are focused on a future concept of operations for the year 2025, where analysts have predicted a two to three times increase in air traffic volume.

We seek to evaluate, and potentially enhance, this future concept of traffic flow management through an agent-based simulation. We are building models of people, tools, environmental conditions and physical entities in we expect them to exist in the future. Initially the simulation will consist entirely of software agents that act as proxies, with human operators participating in their actual roles in later iterations. These experiments will help inform what sort of tools will benefit the human operators in a deployed system. In particular, elements of an agent can be incorporated into an assistant agent or even be used to entirely automate some function originally tasked to human operators.

Challenges
Several challenges must be overcome to develop a useful simulation of the proposed future CDM concept of operations:

- Acquiring domain knowledge
- Accurate models of human behavior
- Representation of actor preferences
- Effective communication modes
- Handling mixed initiative

Future Work
Our simulation is in its earliest stages, and considerable work remains. In addition to addressing the challenges (above), we foresee the following enhancements:

- Modeling people within organizational units
- Increased variety of mitigating actions
- Expanding simulation scope
- Improving fidelity and strategy
- Integrating with FACET (Future ATM Concepts Evaluation Tool)