IDEAS: Influence of Degraded Environment on Airspace Safety

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Airspace Health measured by ability to operate well under nominal and off-nominal conditions:

Computational infrastructure: Computer and network system down.
Communications: Loss of phone lines or radio coverage.
Navigation: FMS failure.
Surveillance: Radar failure.
Operations: Misreading between controller and pilot.
Vehicles: An intruder jeopardizing airspace safety.
Airport closure: A runway closing due to severe weather.
Increase of traffic volume: More aircraft in a limited airspace.
Weather: Unexpected pop up weather.

The ATM system comprised of many subsystems working together. If one fails, the entire system has to work in degraded mode. Health degrades when this is difficult/impossible.

Recent publications:

M. Gariel and E. Feron, MODERATE: Minimum Origin Destination Schedule Time. Impact of traffic density - safety requirements on system delay. Transfer Problem: How does the minimum time, for safely moving agents between source and destination points, scale as the network becomes large? The optimal solution is a problem of agent. The system is conflict free if |s - d| + |v1 - v2| + |c1 - c2| for all active agents i and, for all i.
The following algorithm leverages inter-agent communication to ensure safety and the asymptotic bound T = O(log(n)).
Algorithm:
1. Let be the center of the largest disk not containing any source/destination points.
2. Two phases. All active mobile units move at an angular offset, w.r.t. to the radial direction, with speed proportional to their distance from c. The first phase ends when all agents are inside the largest initially empty disk.
3. Activation/deactivation (takeoff/landing) times computed in such a way that the boundary conditions are matched.

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Introduction

This research is concerned with evaluating the health and safety of current and projected NAS traffic against environmental degradations. Similar to health monitoring systems present in aircraft, our objective is to develop an effective health monitoring system for the air transportation system, whether it operates under current or future concepts of operations.

Our approach is based on developing appropriate input-output models of closed-loop air traffic operations, where the inputs are chosen to be hypothetical system perturbations to air traffic. The outputs represent quantities of interest to evaluate the reaction of the system. They range from how much control amplitude is required to how much communication bandwidth is required to implement and execute the control actions.

This poster presents various methods developed during Year 1 to evaluate and represent the impact of different parameters on air traffic safety. Those parameters include equipment failures, increase in traffic volume, compliance to procedures, etc. The diagram on the right hand side shows the integration of the tools in the air traffic management/control system. As the project proceeds into Years II and III, the methods will coalesce into an integrated airspace health monitoring tool.

Tools integration in the ATM/ATC environment

Air Traffic Flow Management in the Presence of Uncertainty: How does the minimum time, for safely moving agents between source and destination points, scale as the network becomes large? The optimal solution is a problem of agent. The system is conflict free if |s - d| + |v1 - v2| + |c1 - c2| for all active agents i and, for all i.
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