Improving Air Traffic Performance Using System-Wide Coordination of Flight Speeds

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Background

In the U.S. National Airspace System today there is little coordination of the speed of individual flights, e.g., a flight might speed up or take “short cuts” only to arrive near its destination airport to be put into a hold pattern. Speeds can be set and adjusted to achieve strategic airline and system performance objectives. Coordination is required among FAA traffic managers, airline operational control centers, and the flight crews. Operational systems and trials are addressing this challenge:

- ATBA used at Atlanta, MSP, and Charlotte by Delta Airlines
- London Heathrow: System allows airborne holding close to airport to be exchanged for reduced speed during cruise (United Airlines estimates potential to save 45 kg fuel per flight)
- Airservices Australia (ALOFT) used speed control at Sydney saving 1 million kg of fuel in 2008
- The Terminal Area Precision Scheduling and Spacing System (TAPSS)
- The Airline Based En Route Sequencing and Spacing tool (ABESS)

Motivating Work

Prior work, e.g., Knorr et al 2011, has shown that substantial fuel is wasted dealing with arrival congestion in the airspace adjacent to busy airports.

- Maneuvers, such as vectoring, “tremsboning” and circular holding patterns, are highly inefficient especially when performed at a low altitudes.
- Operational systems and trials are addressing this challenge:
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Concept and Background

- During ground delay programs (GDPs) flights managers assign a controlled time of departure (CTD) to flights
- Assigning controlled times of arrival (CTAs) in lieu of CTDs may offer a more attractive means of delay assignment
  - Provides carriers more flexibility in planning
  - Allows for system-wide trade-offs
- Replace CTDs with CTAs in GDP planning and control
- Remove the exemptions radius
- Allow en route speed adjustments by carriers
- Allow carriers to make decisions on flight delay through substitutions and cancellations
- Propose new flight operator planning model for substitution and cancellation
  - Model matches carrier flights to assigned capacity
  - Hedges for the possibility of early clearance

Operational Context

Modeling Approaches

- Adopted two approaches for estimating queuing delay
  - Scenario Based Approach
  - Functional Approximation Approach
- Can we achieve comparable performance using a functional approximation?

Simulation Framework

- Computational Performance was evaluated in Python
  - Intel Xeon 2.6 GHz quad core processor with 12 GB of RAM
  - GUROBI solver was used
- FA model achieves comparable accuracy but runs orders of magnitude faster

Delay Transfer Performance

- All models transfer some amount delay near the airport to the en route phase of flight
- Scenario based model yields strong delay transfer performance
- FA model formulation performs marginally better

Average Fuel Burn Savings

- Delay transfer yields noticeable improvement in fuel burn
- Average savings exceeds 54.65 kg of fuel per flight regardless of speed

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