Traffic Complexity Measurement Under Higher Levels of Automation and Higher Traffic Densities

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An understanding of the complexity factors that affect controller workload under higher levels of automation for conflict detection and resolution and under higher traffic densities is critical for future operations. This paper examines traffic complexity variables under higher levels of automation where the human controller is still in the loop, but is being supported by advanced conflict detection and resolution automation. The study involved two conflict resolution automation modes (i.e., trial-planning automation and advisory automation) and three traffic densities (i.e., 1X, 2X and 3X). The results indicate that under the 1X traffic condition, controller workload was the lowest with advanced levels of automation. The complexity and workload increased progressively for the 2X and 3X traffic conditions. Results also showed that several variables such as horizontal proximity, aircraft density, separation criticality index, and two degrees of freedom indices appear to be relevant complexity measures for higher traffic densities. The degrees of freedom index for aircraft in conflict appears to be a relevant measure for higher levels of automation. Regression results show that automation resolution mode, number of aircraft, number of conflicts, separation criticality index, and degrees of freedom for aircraft in conflict represent complexity and correlate with controller workload under higher densities.

New York Flow Control with Deterministic En Route Capacity Constraints

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This paper systematically explores the impact of deterministic en route capacity constraints on traffic flows in the New York area and the eastern portion of the United States. A binary integer programming model calculated optimal departure controls to mitigate demand and capacity imbalances induced by these constraints. By varying cost function parameters in the model, three distinct solutions allowed exploration of the differences between how traffic flows are managed under current day operations and possible future operations. The first solution penalized New York flows utilizing capacity constrained airspace. The second solution gave preferential treatment to New York flows, while the last solution equally distributed delays across all flights. To test these models, 120 different scenarios in which the intensity of the constraints, the geographical location of the constraints, and the prioritization of the traffic flows through the constraints were explored. The results indicate that prioritizing major traffic flows arriving and departing from New York through capacity constrained airspace can result in New York delay reductions up to 20% without significantly increasing system delays or the number of delayed flights.
Can Airport Congestion Be Anticipated? A Case Study of the Three Largest New York Airports

Tony Diana

Congestion is likely to arise whenever an airport fails to bring under control its mutually interdependent operational sub-systems. This research attempts to achieve several objectives: First, it details a methodology to identify congested hours. Secondly, it examines how delays in some key airport operational variables may affect the odds of congestion. Finally, a count data regression seeks to identify the factors most likely to predict the number of delayed airport departures and arrivals. The study is based on summer 2007 traffic data at Newark Liberty International (EWR), John F. Kennedy International (JFK) and LaGuardia (LGA) airports. EWR and JFK were more likely to be congested when they both operated in instrument approach conditions. At LGA, congestion was more prone to taxi delays. The study suggests that airport’s management of taxi operations and total available capacity are instrumental in minimizing the existence of congestion. While it is difficult to forecast congestion, the use of logistic and probabilistic models makes it easier for analysts to anticipate its occurrence.

Collaborative Virtual Queue: Benefit Analysis of a Collaborative Decision Making Concept Applied to Congested Airport Departure Operations

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Since most major US airports schedule operations close to their maximum capacity, departure operations are very sensitive to uncertainties. Consequently, the stochastic nature of airport departure operations induces long runway queues and congestion on critically saturated taxiways. In this paper, we show how collaborative management of congested departure operations from the ready-to-push-back time to the wheels-off time can potentially yield significant benefits to airlines and the providers of air traffic services. The Collaborative Virtual Queue (CVQ) concept proposes to create departure pushback slots to enable departure flight swapping and prevent overloading the taxiway system. Currently ground congestion, caused by a pushback rate exceeding departure capacity, precludes any flight swapping. The CVQ will redistribute pushback slots fairly while respecting the laissez-faire competitive environment. Results are evaluated using a departure system model which is validated using current data and previous studies. A collaborative concept of operations, such as the CVQ, which holds aircraft away from runway queues when possible not only increases taxing time predictability, it also enables last minute intra-airline flight swapping. This gives airlines the flexibility to reorder their flight sequences to conform with their priorities in real-time. These swapping capabilities are illustrated by the trade-off between minimizing the average passenger waiting time and minimizing the inequity between aircraft of the same airline.