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Monotony in Air Traffic Control

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Monotony has been studied in areas such as assembly lines, power plant control rooms and driving vehicles yet these findings are not easily transferable to air traffic control. A simulator experiment with a generic sector design, and a field study in an ATC operations room was therefore conducted to examine the effects of traffic repetitiveness and traffic complexity on monotony as an operator state, applying subjective measures of attention or alertness levels (including fatigue, workload, attentiveness, concentration), together with physiological and performance indicators. The results suggest that an operator state of monotony is a consequence of repetitive conditions, reinforced by low dynamic density periods and dependent on individual factors. Combining some of these indicators, we propose a composite indicator for an operator state of monotony. We describe potential impacts of monotony and recommend both concept development strategies to minimize monotony in future ATC systems and corrective actions to alleviate monotony in existing operational environments.

Maximum Flow Rates for Capacity Estimation in Level Flight with Convective Weather Constraints

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We study the problem of computing maximum flow rates for capacity estimation of an airspace at a constant flight level in the presence of convective weather constraints, under various operational conditions. Our problem statements are for future Air Traffic Management (ATM) operations where jetway routing is removed and aircraft routes may conform with the geometry of weather constraints. We consider several ATM flow organizations: All Altitudes (aircraft flying in any direction), Alternating Altitude Rule (aircraft flying with headings from 0° to 180°, versus 180° to 360°), Monotonic Rule (aircraft flying in from the west), and Unidirectional (aircraft flying from west to east). We investigate both decentralized Free Flight scenarios and centralized Packed scenarios under each flow organization. For each flow organization, we compute the maximum flow rates for the airspace through experimental analysis based on simulated demand for travel through the airspace and routes computed using an algorithmic solution. We compare the throughput, observed in simulations, to the theoretical upper bounds we compute using network flow theory adapted to the geometric problem domain. We also compute a complexity metric to evaluate the solutions computed under each flow organization. Experiments are based on both real and synthesized weather data.

Central East Pacific Flight Routing

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This paper examines the potential benefits of transitioning from the fixed Central East Pacific routes to user-preferred routes. A minimum-travel time, wind-optimal dynamic programming algorithm was developed and utilized as a surrogate for the actual user-provided routing requests. The results of both nominal and wind-optimal routing simulations over a five-day period are presented, and analyzed in terms of four aggregate-level airspace complexity measures, two time-varying airspace complexity measures, the time savings, and the fuel savings associated with the wind-optimal routes. The airspace complexity measures were selected to characterize the relative increase or decrease in airspace complexity associated with adopting alternative routing strategies in the Central East Pacific. Based on the analysis of 15, 24-hour simulations, the relative density of flights, the number of simulated conflicts, and the distribution of flights within a sector were found to vary significantly over the five-day period. For the time-varying complexity measures, the variations in the number of flights within a sector was found to strongly influence the correlation between the nominal and wind-optimal routing results. Finally, the average potential time savings for the wind-optimal routes was found to vary between 4.8 min and 9.9 min per flight depending on where the wind-optimal routing was allowed to begin and end. Similarly, the average fuel savings was found to vary between 192 kg and 347 kg per flight.