Dynamic Sequencing and Speed Control of En Route Flights

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Rising fuel costs and a growing desire to curb the environmental impact of aviation coupled with a need to accommodate the growing demand for air travel has spurned an increased interest in the development of efficient Air Traffic Management (ATM) practices. In particular, a growing body of evidence suggests that using Continuous Descent Arrivals/Optimized Profile Descents (CDA/OPD) maneuvers in lieu of traditional arrival and approach procedures at airports yields noticeable fuel and emissions savings and reduces noise levels in surrounding communities. Despite its benefits, however, the enactment of CDA has been limited due to safety concerns. As flights approach the terminal the potential for flight conflicts imposes daunting challenges on existing ATM resources particularly in the presence of heavy congestion. In this environment flights often rush to terminals only to be delayed because the arrival airports do not have the capacity to accommodate them.

In this paper, we propose two integer program based algorithms designed to reduce the amount of delay in the terminal phase of flight. These algorithms assign arrival times to flights en route and thereby control the flow of aircraft into the terminal. We describe a process for assigning these arrival times to flights by transferring information between aircrafts, controllers and information systems. Our algorithms dynamically resequence the flight arrival times of en route flights to both transfer and eliminate delay. Each algorithm incorporates a weighted criterion of fuel savings, throughput and airline equity but accounts for varying degrees of intervention from air traffic controllers. The algorithms were tested using a set of flight data collected at Hartsfield/Jackson Airport. A queuing model was constructed to better understand the effect of controlled arrivals. Analysis suggests that both algorithms have the potential to transfer delay from the terminal and save fuel.