A Concept for Air Traffic Management Performance Balancing in Trajectory-Based Operations with Collaborative Decision Making

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Greater predictability from Trajectory-Based Operations will allow Air Traffic Management to move beyond first-come first-served resource allocation and actively balance performance aspects while allowing stakeholder input through Collaborative Decision Making. However, at present it is unclear how this would be achieved in operations. In this paper, we outline a proposal to develop a framework to explore this issue that applies a previously-developed genetic algorithm to generate Pareto-efficient tradeoffs between flights for oceanic airspace entry that would be then selected by CDM, balancing performance and improving equity and efficiency.

Key Words: Air Traffic Management, Collaborative Decision Making, Demand-Capacity Balancing, ATM Service Delivery, Performance Balancing

1. Introduction

Trajectory-Based Operations (TBO), in which flight trajectory information is shared amongst Air Traffic Management (ATM) system stakeholders, will improve predictability, making it possible to carry out resource allocation further ahead in time. This will allow decision-making to move away from first-come first-served (FCFS) allocation and consider ATM performance aspects, increasing efficiency and equity.

Allocating resources between stakeholders that have different priorities and objectives fairly while balancing their needs and against societal needs is a difficult problem with no true-false (right-wrong) solution. This is similar to *wicked problems* encountered in social policy and planning, for which one strategy is collaboration: all the stakeholders are engaged to find the best possible solution for all. This can be reflected in ATM as Collaborative Decision Making (CDM). Although ICAO calls for performance-based ATM and for CDM, it avoids being prescriptive – it is up to states or regions to develop resource allocation and performance balancing mechanisms to support their policies.

2. CDM and Performance-Balancing Framework

To explore these issues, we are aiming to demonstrate TBO-based near-tactical resource allocation incorporating performance balancing using a CDM-based concept for stakeholder input to decision-making. We aim to develop an operational concept, evaluate its feasibility, identify issues, and estimate trajectory prediction performance requirements and benefits that will support the business case for TBO. We focus on the allocation of entry conditions into Fukuoka FIR oceanic airspace. Oceanic airspace is a non-radar control environment, and flights must enter through gateway points with their trajectories deconflicted for several hours ahead. Concentrations in the demand for gateways and cruise altitudes occur, and flights that cannot obtain their planned cruise altitude at oceanic airspace entry can be sometimes prevented from climbing by other traffic for several hours, with a fuel penalty. With FCFS allocation, overflight traffic take priority over departures from Japan, which is inequitable and does not necessarily give the "best" solution. Our previous study developed a genetic algorithm to generate trade-offs of oceanic entry times and altitudes, and found it could achieve greater equity and overall efficiency than FCFS[1)].

CDM be automated as far as possible and incur low workload, but also allow meaningful participation in decision-making. Transparency is also essential for participants to have trust in the system. Pareto-efficient solutions generated by the above algorithm will be presented as options to stakeholders along with the estimated effect on each flight and also system performance metrics, with an "ATM performance optimum" solution as a default that would be selected if consensus cannot be reached within the CDM time frame. We propose leveraging computerised decision-support for human operators, but the negotiation mechanism would need to incorporate social sciences as well as traditional operations research to achieve consensus on questions of balancing fairness and utility, and economic incentives such as credits while avoiding "perverse incentives" such as flying empty aircraft to preserve slots.

Our presentation will outline the concept of operations, topics for research, and expected results.

References

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