Flight Deck-based Merging and Spacing Operations

Bryan E. Barmore, Randall S. Bone, and William J. Penhallegon

The advent of Automatic Dependent Surveillance-Broadcast (ADS-B) has opened up a new realm of precise air-to-air surveillance in which flight crews, when properly supported by automation and procedures, will be able to accept new tasks and function at a level in keeping with far-term strategic goals in air traffic management. In pursuit of that goal, MITRE and NASA are participating in a Federal Aviation Administration (FAA)-sponsored group that is developing and testing an early airborne spacing application called Flight Deck-based Merging and Spacing (FDMS). Several human-in-the-loop and Monte Carlo simulations have validated the ability of an aircraft to space itself precisely relative to another aircraft during continuous descent arrivals (CDA). Results indicate that FDMS is viable and that expected benefits should be realized. A limited implementation of FDMS is currently certified and in use in revenue flights by UPS. This is the first fielding of an airborne spacing concept.

Airborne Traffic Situational Awareness: Flight Trials of the In Trail Procedure Project

Johan Martensson and Christos Rekkas

Airborne Traffic Situational Awareness—In Trail Procedure (ATSA-ITP) is a proposed procedure that uses advanced technologies to increase the possibility of flight level changes in procedural airspace, thus enabling fuel burn savings as well as environmental benefits through reduced carbon dioxide emissions.

This paper describes the work performed and the operational results of the ATSA-ITP validation studies carried out in the framework of the CRISTAL ITP project.

The objective for the CRISTAL ITP project was to refine the ATSA-ITP and to ensure that North Atlantic specific constraints and opportunities will be taken into account in the standardisation and industrial development. CRISTAL ITP also aimed to validate operational acceptability and technical feasibility for ATSA-ITP. Moreover, the project developed a benefit model for ATSA-ITP in the North Atlantic environment.

The CRISTAL ITP project is a validation effort using multiple methods (real time simulations, fast time simulations, and a flight trial) to promote implementation of the ATSA-ITP. The project carried out the world’s first flight trial of the procedure.

The paper describes the set of validation activities recently conducted on ATSA-ITP and presents qualitative preliminary results available at the time of this publication. In summary, qualitative results indicate operational acceptability of the procedure. Preliminary results also indicate technical feasibility, i.e. that prototypes and current technical equipment used in the project support the ATSA-ITP. Detailed quantitative, statistical data analyses on the technical performance are currently underway and will be documented in future publications. Finally, the results show benefits in the form of reduced fuel burn and emissions for aircraft using the ATSA-ITP.
Simulated Safety Risk of an Uncoordinated Airborne Self Separation Concept of Operation

Henk A.P. Blom, Bart Klein Obbink, and G.J. (Bert) Bakker

This paper evaluates through Monte Carlo (MC) simulation a model of an airborne self separation concept which has been developed for use under low en route traffic conditions such as encountered over the Mediterranean area. In this self separation concept, each aircraft is equipped with an Airborne Separation Assistance System (ASAS) that proposes uncoordinated changes of its own aircraft path in order to resolve a conflict with the nearest other aircraft. For three encounter scenarios, probabilities for violating minimum separation and for near-mid-air and mid-air events are estimated through rare event MC simulation. The paper presents quantitative risk estimates for several scenarios, and provides an interpretation of these results for the model of the airborne self separation concept considered. This provides novel insight in the efficacy of airborne conflict resolution management, and shows that uncoordinated airborne self separation can be very effective in safely handling low density en route airspace. It also shows that events of multiple conflict clusters may grow in size more rapidly than an uncoordinated airborne self separation may be able to solve. The insight gained shows developers of airborne self separation which issues are key for improvement in order to safely accommodate future high en route traffic densities.

Metrics for Traffic Complexity Management in Self-Separation Operations

Husni Idris, Robert Vivona, and David Wing

Distributed control concepts, where some air traffic management functions are performed by airspace users, have been proposed to help address the rising demand for air travel. For example, delegation of traffic separation responsibility to the flight crew can be enabled by new cockpit automation that supports the separation task for that aircraft. As more equipped aircraft provide their own separation service, it creates the potential to adapt airspace capacity to the increasing demand. However, this distribution of tasks and decision making raises the concern that independent user actions will increase the complexity of the traffic system, possibly leading to a disruption of scheduled operations as safety is maintained. To address this concern, the authors propose the introduction of decision-making metrics for preserving user trajectory flexibility. The hypothesis is that such metrics, when added to trajectory management automation, will make independent user actions naturally mitigate traffic complexity. In this paper, trajectory flexibility is formally and mathematically defined in terms of robustness and adaptability to disturbances. A metric estimation method is developed assuming discrete time and discrete maneuvering-degree-of-freedom changes, resulting in a map of flexibility over the trajectory solution space which can be used by a real-time trajectory planner. Initial insights into the relationship between trajectory planning using this metric map and traffic complexity are demonstrated through analyzing a simple scenario including required time of arrival and traffic constraints. The scenario demonstrates that preserving flexibility results in reducing relative heading between aircraft—one method for potentially reducing apparent traffic complexity.