

Abstract

Participant-Adapted DAA Buffers and 4D Volume Duration for U-space

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U-space flight plans represent a trajectory as a sequence of four-dimensional (4D) volume segments.

Each segment combines a spatial hull with the interval for which that hull is reserved.

Longer segments require fewer volumes but reserve their hulls for longer; shorter segments release airspace sooner but increase the number of volumes to process.

The proposed evaluation resolves this trade-off in a strict order: detect-and-avoid (DAA) computation fixes the spatial separation buffer, candidate durations are compared by flight-request acceptance, and workload decides only among durations whose acceptance is statistically equivalent to the best observed value.

The Aircraft Encounter Simulator (AirES) supplies the model-derived DAA buffer.

An encounter pair is the ownship and intruder vehicle-performance combination used in an encounter calculation; time to react is the interval between conflict detection and manoeuvre initiation, combining communication latency, sensor-update delay, and sensor-fusion delay.

For each such pair, time to react, and fixed avoidance mode, AirES estimates the initial separation from which a change of direction, altitude, or speed can preserve the specified well-clear region.

The pair-specific buffer is the smallest range across the modelled modes, so at least one tested mode remains feasible; a corridor-wide buffer would instead take the maximum of these pair-specific minima across all encounter pairs.

Keeping the pair-specific value avoids applying that global worst case to every encounter.

The strategic conflict check uses the applicable pair-specific buffer as the required separation between two spatial hulls whenever their reservation intervals overlap.

It does not require an independently optimised protected-volume geometry.

A request is accepted only if it passes every pairwise check and the capacity constraint; segment duration never reduces the DAA buffer.

Because AirES tests fixed manoeuvres rather than an optimal advisory policy, the result is a feasibility-based range within the model, not an unconditional safety guarantee or a globally minimal DAA range.

Additional uncertainty margins lie outside this calculation.

With that spatial constraint fixed, the evaluation compares durations by how often the same deconfliction policy accepts a request.

Acceptance is the fraction of submitted requests accepted by strategic deconfliction, and it is estimated against occupancy: the already reserved 4D volume relative to capacity in the request's airspace and time window, read when the request is submitted.

Candidate durations lie within a finite operational interval; for each candidate the proposed evaluation replays the same ordered requests, and after every acceptance reserved occupancy is updated before the next request is evaluated.

The replay therefore includes the effect of duration on later occupancy and acceptance, and the result is the estimated acceptance of requests at each observed occupancy under the fixed requests and deconfliction policy, not a global acceptance optimum.

At each such occupancy, a duration qualifies when its estimated acceptance is statistically indistinguishable from the best observed acceptance.

Durations that reduce acceptance are too long for that occupancy.

Among the qualifying durations, the policy selects the longest, thereby using the fewest segments without relaxing the model-derived DAA buffer or the acceptance criterion.

The proposed evaluation will report acceptance first and then segments per submitted flight-hour.

A lower segment rate counts as reduced workload only when the acceptance criterion is satisfied.

The talk therefore proposes this ordered evaluation as a way to lengthen 4D reservations, and thereby cut segment-processing work, without relaxing performance-adapted DAA separation or the acceptance estimated against occupancy.

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Biography

Enno Nagel



Enno Nagel studied mathematics and earned his PhD at the University of Münster. Since 2024, he has worked as a researcher on flight guidance for unmanned aircraft systems at the DLR Institute of Flight Guidance.