AWARE

ACHIEVING HUMAN-MACHINE COLLABORATION WITH ARTIFICIAL SITUATIONAL AWARENESS

PROJECT OBJECTIVES

The principal objective of the project was to develop a digital tool in a Human-AI team design (ASA) to support en-route ATC operations. This included building a platform that enabled a solution which embraced Artificial Situational Awareness.

Specific Objective 1: To develop an enhanced **Artificial Situational Awareness** (ASA) system by implementing methods for assessment of ATCO's intent and goals.

Specific Objective 2: To develop a design for an adaptive approach to selection and implementation of actions that support ATCOs, utilizing both ML and non-ML tool, but retaining ATCO control.

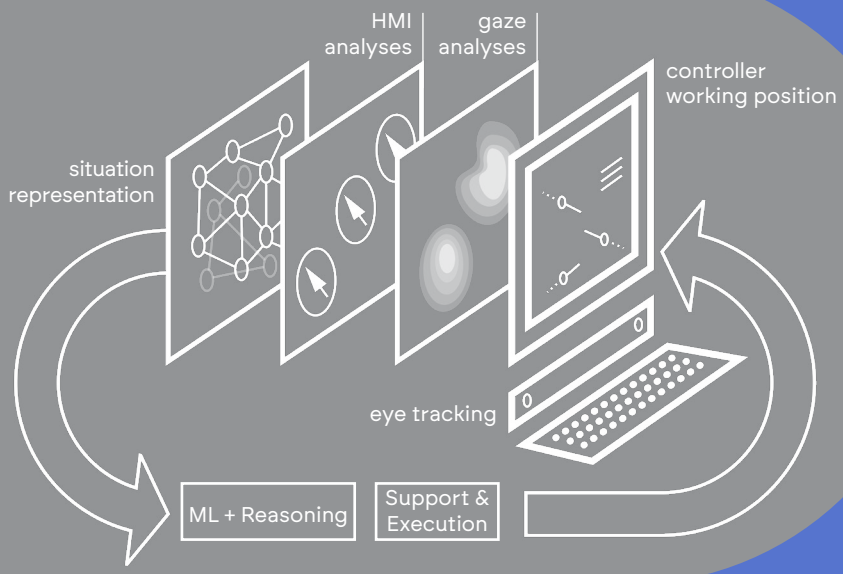
CONCEPT & METHODOLOGY

The ASA system uses knowledge-graph reasoning integrated into controller support tools, as an expression of a design for Human-AI Teaming (HAIT). This includes a human-machine interface where attention-tracking of the controller infers controller intent. During the validation sessions, air traffic controllers worked in medium, high and future traffic densities and scenarios including complexity, with and without digital tool support and simulating only the executive radar controller.

The design ambition of AWARE is to tackle the growth in traffic demand through ASA system design amplifying the ATCOs capabilities through HAIT. One novel dimension of the digital assistant is that it strives to build a view of the traffic situation and context as perceived by the ATCO. ASA tracks the controller's focus of attention and with 'knowledge' of the controller's intent offers support at a level the controller chooses: an advisory mode that suggests actions, or an execution mode that carries out selected routine tasks as a safety layer.

CLOSING THE LOOP: tracking ATCO's human-machine interactions and gaze, putting them into the context of the current traffic situation and environment.

LEVELS OF ASSISTANCE: EASA Level 2A / EASA Level 2B; support and execution around a priority queue.



KEY RESULTS AT A GLANCE

+25%

flights/hour handled in high complexity operations

50-90%

reduction in the frequency of specific safety events in high density and complex traffic samples*

16 ATCOs,

each performing 4 validation scenarios from 4 ANSPs

TRL 2

exit maturity level achieved

A REALISTIC, DEMANDING VALIDATION

The four key results presented above are the outcomes of an experiment conducted through human-in-the- loop real time simulations, with scientific rigour. Undertaken at the LFV Research and Development facility at Malmö Area Control Centre in Sweden over two weeks in April 2026. The research design selected an ATC sector that was an exemplar of a busy and complex en-route sector in the Malmö ACC area of responsibility. Traffic samples were representative of actual operations, taken from real world traffic data but augmented by additional traffic for research purposes.

Sixteen air traffic controllers from four air navigation service providers in the AWARE consortium took part. The ASA system was fully integrated into Polaris, an operational-grade ATM platform. Across one workshop and four real-time human-in-the-loop simulations, controllers worked medium, high and a future +25% traffic scenario, with and without AI support.

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WHAT WE FOUND

Positive indications for safety and capacity performance. With AI support, controllers handled an increased traffic load, starting from 53 flights per hour at medium complexity up to 75 flights per hour in a high traffic density & complexity future scenario. This scenario was designed to explore the utility of the design. AI-supported conditions generally produced fewer safety occurrences than the no-support baseline, with the execution mode generally recording the fewest safety events. This mode was also found by some controllers to support earlier conflict detection and resolution, which can contribute to both capacity and safety performance. Controllers described the system as a potential design for a "teaming partner" for future operations. At this juncture there was a preference for AWARE advisory mode. Successful ATCO-AI collaboration depended less on the level of automation itself and more on the perceived transparency, predictability, and alignment of AI behaviour with ATCO expectations.

Other gains need more work. As expected at this early stage, the fuel and CO_2 benefit (under 1% in these trials) were short of the targets. Controllers' subjective workload was reported as constant, without significant reduction, partly because the ATCOs kept re-checking the ASA system's outputs, which indicates the need for further work on improving trustworthiness and explainability. More work needs to be done' in the context of the ATCO retaining meaningful control in executive mode or even high traffic density in support mode.

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The AWARE project has received funding from the SESAR 3 Joint Undertaking under grant agreement No 101167442 under the European Union's Horizon Europe research and innovation programme. Views and opinions expressed do not necessarily reflect those of the European Union or SESAR 3 Joint Undertaking. Neither the European Union nor the granting authority can be held responsible for them.

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