

Gaps and Challenges in Automation Assessment to Support Human-Centric Aviation Certification

Domenico Pascarella ^{1,*}, Gabriella Gigante ¹, Paola Lanzi ², Elisa Spiller ³, Edoardo Fornaciari ⁴

¹ CIRA — Italian Aerospace Research Centre, Transversal Research Direction, Via Maiorise, 81043 Capua, Italy

² Deep Blue, Via Daniele Manin 53, 00185 Rome, Italy

³ D-Flight, Via Salaria 716, 00138 Rome, Italy

* Correspondence: d.pascarella@cira.it

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In the forthcoming years, the role of advanced automation technologies, including Artificial Intelligence (AI) powered technologies, is going to increase at a fast pace in complex socio-technical systems. This fully applies to the Air Traffic Management (ATM) domain, where advanced automation is a key to reduce the workload of Air Traffic Controllers (ATCOs) in future-proofed ATM solutions. Anyway, in mid- and even long-term time horizons, cognitive aspects should be pursued, where ATM systems gain a high level of autonomy while remaining human-centric. As a consequence, research is needed to develop a more agile and holistic approach to support certification, suitable for the new generation of advanced-automation ATM solutions, based on a human-centred view.

The HUCAN (Holistic Unified Certification Approach for Novel systems based on advanced automation) project is an exploratory research, funded by the Single European Sky ATM Research (SESAR) program to develop a methodology and a set of guidelines to conceal the research in advanced automated ATM solutions to the certification framework since the early stages of concept design. The project adopts a case-study-based approach. In detail, four case studies have been selected: (i) to map the possible challenges that are associated with certification issues; (ii) to feed and validate the HUCAN theoretical research; (iii) to test the proposed certification approach in HUCAN; (iv) to validate the HUCAN guidelines for certification.

This work deals with the first part of the aforementioned approach. It firstly describes the selected case studies, which cover several aspects of the on-demand capacity concept, addressing different kinds of airspaces, such as, middle airspace, Terminal Manoeuvring Area (TMA), U-space. The case studies are also based on different technologies and kinds of algorithms, both deterministic and non-deterministic AI-powered ones.

In detail, one of the case studies applies an AI-powered Digital Assistant (DA) in TMA. It is related to the ATCO's task of maintaining safe separation between aircraft, which is going to become more demanding as the day-by-day higher levels of traffic bring an increase in potential conflicts. The complexity of the traffic situation increases every day, not only due to the increasing traffic, but also due the diversity of both ground-based and airborne technology, which adds new issues to be considered by ATM services. This case study presents a DA supporting the ATCO in aircraft sequencing by providing suggestions for next waypoints, speed adjustments and altitude holdings. The suggested paths are such to preserve safety by ensuring the prescribed minimum separation, while also promoting environmental benefits, reducing landing times, and improving the runway throughput. The case study exploits multipath planning, for which a global optimisation technique is used in conjunction with reinforcement learning to resolve conflicts. Moreover, it introduces very high impact for human factors and key software, since it represents a new advanced tool supporting ATCOs' perceptions for conflict resolution, with a novel specific interface.

The proposed work highlights the level of automation and the human-factor impacts of the reference ATM solutions in the aforementioned case studies. For the assessments of the level of automation, the analysis has applied a functional automation-related approach for each case study, with the identification of the reference functions and the evaluation of the "local" automation level to be assigned to each reference function. Lastly, the work presents some preliminary arguments underlying general gaps and challenges within the current classification of advanced-automation levels, based on the outcomes of the case-study assessments. Such arguments mainly imply ambiguities in solutions involving automated decision support and automated detection-recognition-prediction according to the adopted Level Of Automation Taxonomy (LOAT). As an example, for the AI-powered DA, different interpretations arise with respect to its functions for conflict detection, sequencing & scheduling optimisation, and conflict resolution. Indeed, several mappings are possible between the scope of the functions and the LOAT capabilities, with different task allocations to the human operator and the machine.