Abstract
Concept of Operations for a Digital IAM Controller

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Innovative Air Mobility (IAM), particularly in the form of air taxis, has the potential to revolutionize urban and regional transportation by offering a faster, on-demand and more sustainable alternative to traditional transportation means. However, integrating IAM seamlessly within the existing air transport system, especially congested airspaces like control zones (CTR), presents significant challenges. Current air traffic control (ATC) systems are primarily designed for conventional aircraft, and the introduction of IAM vehicles, operating on diverse routes and schedules, can increase controller workload and compromise safety.

Studies conducted within the DLR project HorizonUAM have demonstrated the impact of air taxi integration on ATC. Simulations revealed a 44% increase in controller workload and an 18% decrease in situation awareness when air taxis were introduced into the control zone, operating on a fixed route network between vertiports. This workload increase is unsustainable, especially considering the projected growth in both conventional air traffic and IAM operations, coupled with the ongoing staffing challenges of air navigation service providers.

To address this issue, the DLR is developing a concept for a digital air traffic controller (ATCO) for managing IAM air taxi traffic operating in Visual Flight Rules (VFR) within control zones. This digital ATCO is designed to autonomously perform air traffic controlling tasks in safe, efficient and orderly manner within the predefined scope and can collaborate with human ATCOs.

The main functionalities of the digital controller for IAM are:

- **Conventional VFR services provision:** The digital ATCO will provide all the ATC services for air taxis operating in VFR. This includes issuing clearances for to enter/ exit the control zone, for landing and takeoff at vertiports of Hamburg, traffic information and advisories provision, weather information, guidance and separation for air taxis operating in SVFR.
- **Air taxi traffic monitoring**: The digital ATCO shall ensure that air taxis always have sufficient separation from other aircraft (both, other air taxis and conventional traffic) along their entire flight route. The digital ATCO will have access to real-time data on air taxis' positions, altitudes, speeds, and flight paths so that It can monitor their operation and highlight any deviation from the

clearances, advisories or cleared route. In case of non-conformance to the clearance or non-adherence to the route, the digital ATCO will either solve the issue autonomously or handover the traffic to the human ATCO.

- **Flow management**: unlike commercial airlines, the air taxi services operate on flexible schedules allowing booking on short notice. The digital ATCO shall be then coordinating with the IAM Control Center in order to negotiate the arrival and departure target times for the air taxis on the basis of controller workload in order to enable among other last-minute service. It will be mainly supporting the flow management in tactical phase. The complete air taxi flow management will be performed either by a dedicated or an existing Flow Management Position.
- **Route Change & Specific Services:** changing the air taxi route could be either mandatory to solve a potential conflict or desired to save time or for sustainability reason. Short cuts were also considered when designing the air taxi fixed routes for making the whole traffic more efficient and sustainable. The digital ATCO shall be able to clear a new route for the air taxi as long as it has no impact on the other conventional traffic. It shall also make sure that the human ATCO is aware of it with an appropriate highlight on the air situation display. In case of a potential impact on the conventional traffic, the digital ATCO should handover the related air taxi to the human ATCO with a clear information about the reason of the requested change. The same principle is applicable to any specific service requested by air taxis.
- **Attention guidance:** The digital ATCO shall direct the human ATCO's focus to the most relevant information on their display. This is crucial for maintaining situational awareness
- **Emergency Support:** The digital ATCO is not allowed to handle emergencies. It should only provide the human ATCO with advisories and with appropriate information about the flight and the related situation so that the ATCO save time and effort trying to make a clear picture of what happening. The digital ATCO should sort the relevant information to be displayed to the human ATCO.

This presentation will detail the concept of operations for the digital controller, focusing on its autonomous functionalities and its interaction with human controllers. We will also present the key findings from a workshop conducted with air traffic controllers, which gathered feedback on the digital controller concept and identified critical information needs. Finally, we will outline the planned development and validation activities for the digital air traffic controller, including future human-in-the-loop simulations to assess its effectiveness and safety.

Biography
Lukas Tyburzy

Lukas Tyburzy is a Computer Scientist and Research Associate at the German Aerospace Center, specializing in human-AI interaction for air traffic control. His research focuses on designing user-friendly interfaces for automated systems, improving air traffic controller workflow and safety.