

Abstract

Defining the Problem: An MBSE Approach to Stakeholder and Use Case Identification for Innovative Air Mobility as a System-of-Systems

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Innovative Air Mobility (IAM) is expected to complement the existing transportation system effectively by offering fast and safe travel options for passengers and cargo and providing benefits to citizens and communities. Enabled by recent technological advances - such as new concepts for VTOL-capable aircraft (VCA), advanced automation and increasing battery capacities - IAM aims to be an aerial addition to intermodal mobility networks, particularly in urban, suburban, and regional contexts. [1-4]

However, the successful integration of IAM requires more than just technical feasibility. A structured, system-oriented approach is essential to understand potential fields of application (use case), development pathways for IAM, and societal as well as technological impacts. For that reason, IAM is analyzed as a system-of-systems (SoS) [5], in which the different transport modes operate as integrated yet distinct constituent systems.

This contribution presents a methodological approach based on MBSE (Model Based Systems Engineering) that systematically frames the system-of-systems problem, with a particular focus on identifying use cases and development pathways for IAM. MBSE uses a formalized approach to define the problem space, explore and evaluate potential solutions, and provide continuous support throughout all phases of the system lifecycle. [6] The presented approach focuses on the user and their preferences, which serve as the basis for the user-centered development of IAM systems. The goal is to design systems that address the specific needs of potential user groups and can be seamlessly integrated into existing transportation systems. A key step in this process is systematically identifying relevant stakeholders and their specific needs. This considers not only the user perspective, but also the core IAM stakeholders who are significantly involved in development and implementation, as well as associated stakeholders who could be directly or indirectly affected by the new mode of transportation. Based on this identification, potential user groups are differentiated according to their mobility needs and reasons for travel to gain a comprehensive understanding of their requirements. These findings are used to derive user journeys that map various usage scenarios and transport-related requirements in detail. These user journeys then serve as the basis for deriving technical requirements for both the overall system-of-systems and its constituent systems. This ensures that technological development continuously aligns with identified user needs. The methodological framework is supplemented by the systematic analysis

of potential development pathways for IAM. These development pathways describe possible technological solutions for fulfilling specific transport tasks and designing IAM systems.

The developed use cases and scenarios provide the foundation for an agent-based simulation [7] that depicts the system-of-systems. This simulation environment aims to analyze the complex interactions between aerial vehicles, ground-based infrastructure, air traffic management, and user behavior. Such simulations allow us to evaluate different IAM configurations, operational strategies, and regulatory framework. By modeling these elements together, we aim to generate robust insights into the scalability, interoperability, and impact of IAM on existing transport systems and the society.

In summary, the MBSE-driven SoS approach enables a holistic understanding of the IAM landscape. It bridges the gap between visionary concepts and practical implementation by systematically analyzing user needs, operational requirements, and the overall system behavior. The simulation results support IAM-stakeholders, city planners and policymakers in making informed decisions about the design, introduction, and scaling of IAM systems that are technically feasible, economically viable, and socially accepted.

References:

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Biography

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Lukas Asmer completed his Master's degree in Transport and Logistics at Ostfalia University of Applied Sciences in 2017. Since 2018 he has been working as a research associate at the DLR Institute of Air Transport in the department of Air Transport Development. Lukas Asmer is part of the unmanned aerial vehicles research group, which is investigating use cases and market potential for passenger and freight transportation using eVTOL aircraft. As part of various research projects, he is involved in estimating the potential global and regional demand for IAM and determining the systemic, technical and social factors that influence market development and the integration of UAM into intermodal transportation systems.