Abstract
Research questions on the design and operation of vertiports: Possible applications for the DLR Vertiport Demonstrator

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The presentation provides an overview of research topics that are well suited to being addressed by the DLR Vertiport Demonstrator, which is currently under development. The DLR Vertiport Demonstrator can be regarded as an experimental process environment that can be utilized to simulate and investigate the interaction between aircraft, infrastructure, and processes at a vertiport under various conditions.

A vertiport is a specialized type of airfield designed for the operation of novel aircraft types that do not fall within the conventional categories of fixed-wing aircraft or helicopters, among others. These novel categories of aircraft, designated as eVTOLs, encompass a diverse array of vehicles capable of vertical takeoff and landing (VTOL), with the capability of operating in unmanned mode where applicable. In addition to the prevailing perspective that a vertiport is intended for the takeoff and landing of VTOL-capable aircraft, it can be regarded as a component of further systems. Therefore, a vertiport is a component of not only the UAM/IAM transport system, but also of the ground and conventional air transport network, as well as its environment. The ground, air, and UAM/IAM transportation systems collectively constitute the overall transportation system.

Vertiports are comparable to conventional airports or airfields in terms of their purpose and their transportation and operational functions. From the higher perspective of the overall transport system, vertiports function as links between the ground and air transport systems and the UAM/IAM transport system. From the perspective of an UAM/IAM system, vertiports function as both sources and sinks of UAM/IAM traffic, thereby constituting an essential system component for flight operations. The central function of vertiports is to provide the necessary organizational, technical, and operational infrastructure in the form of facilities, equipment, and personnel required to carry out flight operations, passenger and cargo handling, and aircraft handling. Consequently, a vertiport can be regarded as a distinct "process environment."

The topographical features in the vicinity of a vertiport and the associated airspace largely determine the possibilities and restrictions for UAM/IAM traffic taking place there. In many cases, the location of the vertiport is associated with specific patterns of traffic demand that place particular demands on the respective vertiport. In particular, vertiports in urban areas and vertiports situated at airports have to operate under challenging conditions due to limited ground and airspace.

The term "vertiport topology" refers to the configuration of pads and stands, as well as their connection via designated taxi routes. When designing a vertiport topology, the objective is to provide a specified capacity with the lowest possible land consumption and to achieve the highest possible capacity for a given area, respectively. Vertiport topology, operating mode, and processes together have a major impact on vertiport capacity.

The design of the airside is significantly influenced by binding regulations based on technical specifications, standards, and recommendations from national and international aviation authorities. Initial drafts for the design guidelines for vertiports with pilots on board were presented by the Federal Aviation Administration [1] and EASA [2]. There is a need to review these guidelines under practical conditions and to develop them further if necessary.

The vision of UAM/IAM includes new types of aircraft that can also be operated without a pilot on board. The absence of pilots on board requires the establishment of additional regulations organizational frameworks. To ensure the seamless integration of Uncrewed Aerial Systems (UAS) into the airspace, a high degree of automation and digitalization is paramount. To accomplish these tasks, U-space [3] and xTM (Extensible Traffic Management) [4] are being developed in Europe and the US. These concepts are designed to facilitate the integration of cooperative operating environments within the existing framework of traditional air traffic services (ATS). The implementation of these concepts necessitates the development of novel technologies and procedures for flight operations to ensure the safe and orderly operation of both unmanned and manned aircraft in parallel.

Based on the analysis of current design guidelines, future operational concepts, and the environmental, capacity, and space requirements for vertiports, five domains for research in the context of vertiports were identified, for which the DLR Vertiport Demonstrator can provide valuable services (Figure 1). The relevance of these domains is explained, and examples of specific research questions and studies are provided. The DLR Vertiport Demonstrator can be used as a valuable tool for reviewing design guidelines and adapting them to the aircraft's technical capabilities, testing communication, navigation and surveillance (CNS) technologies — especially for unmanned operations — and examining flight operations processes in more detail with regard to the vertiport's safety, capacity and space requirements.

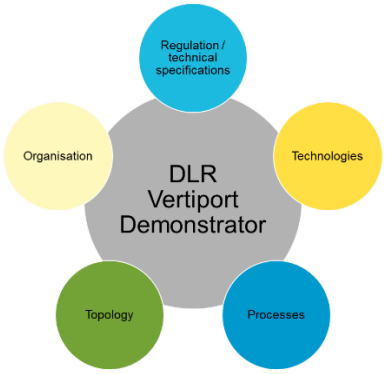

Figure 1: Domains of vertiport research

References

[1] Federal Aviation Administration, *Vertiport Design, Supplemental Guidance to Advisory Circular 150/5390-2D, Heliport Design*, in *Engineering Brief*. 2024, Federal Aviation Administration.
[2] EASA, *Vertiports: Prototype Technical Specifications for the Design of VFR Vertiports for Operation with Manned VTOL-Capable Aircraft Certified in the Enhanced Category (PTS-VPT-DSN)*, EASA, Editor. 2022.
[3] CORUS-XUAM, *U-space ConOps and architecture (edition 4)*. 2023.
[4] Federal Aviation Administration, *Urban Air Mobility (UAM): Concept of Operations*. 2023.

Biography

Henry Pak

Henry Pak graduated from RWTH Aachen University in 1988 with a degree in mechanical engineering. He joined DLR in 1991. Since 2002, he has been working at the predecessor institute of the Institute of Air Transport. He has been working in the field of unmanned air systems and urban air mobility since 2016. His research focuses on the analysis of the UAM/IAM system, use cases, and the market potential for passenger transport.