Urban Air Mobility Use Cases and Technology Scenarios for the HorizonUAM Project

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The HorizonUAM Project at German Aerospace Center (DLR)

- HorizonUAM brings together a wide variety of DLR departments to conduct research on the vision of Urban Air Mobility.

- The project combines research on UAM vehicles, corresponding infrastructure, UAM operations, market development as well as public acceptance of future urban air transportation.

- To coordinate research work, a common basis for the upcoming work was created.

- Basic assumptions were made for:
  - Use cases,
  - Technologies,
  - Infrastructure,
  - Concepts of operation (ConOps),
  - Mission profiles and
  - Vehicle configurations.

Further reading:
- B.I. Schuchardt et al., Urban Air Mobility Research at the DLR German Aerospace Center – Getting the HorizonUAM Project Started, presented at AIAA Aviation 2021 Forum, Virtual Conference, August 2021.
Technology scenarios to capture the development of important technology fields for UAM until 2050

- Technological progress will be reflected by two scenarios.
  - Near-term scenario (~2025)
  - Long-term scenario (~2050)

- The scenarios differ in the technologies for propulsion, autonomy, U-space service level, communication and navigation.

<table>
<thead>
<tr>
<th></th>
<th>2025</th>
<th>2050</th>
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</thead>
<tbody>
<tr>
<td><strong>Propulsion technology</strong></td>
<td>Fully electric or hybrid electric</td>
<td>Electric or Hydrogen (fuel cell or full combustion)</td>
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<tr>
<td><strong>Level of autonomy</strong></td>
<td>Onboard-Pilot / Remote-Pilot*</td>
<td>Highly automated to autonomous</td>
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<tr>
<td><strong>U-space Service Level</strong></td>
<td>U1 (first U-space Services)</td>
<td>U2-U3 (advanced U-space Services)</td>
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<tr>
<td><strong>Communication</strong></td>
<td>Multilink communication approach relying on existing communication infrastructure</td>
<td>Multilink communication approach with specifically designed datalink</td>
</tr>
<tr>
<td><strong>Navigation</strong></td>
<td>GNSS and supporting multi-sensor navigation</td>
<td>Certified multi-sensor navigation including GNSS</td>
</tr>
</tbody>
</table>

* For the intra-city and mega-city use cases an onboard pilot is assumed, and for the use cases airport shuttle, sub-urban and intra-city a remote pilot.
Five Use Cases covering a wide range of challenges for the overall UAM system with special consideration of conditions in Germany
Intra-City Use Case:
Flights within the core area and built-up urban area of a city in Germany

Transport task and characteristics
- Flights within the core area and built-up urban areas of a city in Germany (e.g. Berlin)
- Short transport distances
- High air traffic density
- Environment with high and dense buildings

Vehicle requirements
- Seats: up to 4
- Transport range: up to 50 km
- Speed: 80 – 100 km/h
- Vehicle: VTOL capable
Mega-City Use Case:
Flights within the core area and built-up urban areas in a global Megacity

**Transport task and characteristics**
- Flights within the core area and built-up urban areas in a global Megacity (e.g. Tokyo)
- Short and medium transport distances
- High air traffic density
- Environment with very high and dense buildings

**Vehicle requirements**
- Seats: *up to 6*
- Transport range: *up to 100 km*
- Speed: *100 – 150 km/h*
- Vehicle: *VTOL capable*
Airport-Shuttle Use Case:
Flights between the airport and selected locations in the city

Transport task and characteristics
- Flights between the airport and selected locations in a city in Germany
- Special requirement for integration in the airport environment
- Air travelers with luggage

Vehicle requirements
- Seats: up to 4 with luggage
- Transport range: up to 30 km
- Speed: 100 – 150 km/h
- Vehicle: VTOL capable
Sub-Urban-Commuter Use Case:
Flights between suburbs/surrounding satellite cities and the city center

Transport task and characteristics
- Flights between suburbs or surrounding satellite cities and center of a city in Germany
- Irregular demand:
  - High demand during peak hours
  - Low demand during off-peak hours

Vehicle requirements
- Seats: up to 4 with hand luggage
- Transport range: up to 70 km
- Speed: 100 – 150 km/h
- Vehicle: VTOL capable
Inter-City Use Case:
Flights between two cities or the surroundings of two cities

Transport task and characteristics
- Flights between two city centers or the surroundings of two cities in Germany
- Long transport distances with a long cruise flight segment

Vehicle requirements
- Seats: up to 10
- Transport range: over 100 km
- Speed: over 100 km/h
- Vehicle: VTOL or STOL capable
Two types of vertidromes for UAM networks

• Corresponding ground-based infrastructure is an important part of the UAM system and act as nodes for the transport system

• Two types of ground-based infrastructure will be considered under term of UAM aerodromes:
  • Vertistops
  • Vertiports

Vertidrome configurations

Vertistops
- Footprint: Small
- Technical Equipment
- No Charging
- No MRO Service

Vertiport
- Footprint: Middle - Large
- Technical Equipment+
- Charging
- MRO Services possible
- Hub Operations possible (Hub & Spoke)

Further reading:
• B.I. Schuchardt et al., Urban Air Mobility Research at the DLR German Aerospace Center – Getting the HorizonUAM Project Started, presented at AIAA Aviation 2021 Forum, Virtual Conference, August 2021.

Technical Equipment (weather, communication, navigation, etc.) required for a safe and approved vertidrome operation.

“+” Additional Equipment and Services regarding the vehicle (e.g. charging), the passenger (e.g. shopping), staff-related (e.g. office buildings).
Integrating vertistops significantly influences mission profiles

- As vertistops are cost-effective vertidromes, they can be used to serve locations with low demand and thus to build up a high-density UAM network.

- However, vertistops have no possibility of charging or refueling.

- Therefore, vehicles must be able to carry out intermediate stops without energy supply.

- Hence, for the Intra-city use case a mission profile with two intermediate stops will be assumed as basis for the vehicle design.
Conclusion

• The use cases, technology scenarios and operating concepts form the basis for:
  • the design of aircraft,
  • ground based infrastructure and
  • air traffic management.

• Using a System-of-Systems simulation framework designs for e.g. vehicle, network and operating concepts are evolved and evaluated with regard to safe, efficient, and sustainable Urban Air Mobility.

• Based on modelling and simulation, the HorizonUAM project will conduct a holistic assessment of the opportunities and risks of UAM, which covers a wide range of criteria such as impact on the urban transport system, societal benefit, environmental impact and commercial feasibility.
Thank you for your attention!

Further reading:
L. Asmer et al., Urban Air Mobility Use Cases, Missions and Technology Scenarios for the HorizonUAM Project, presented at AIAA Aviation 2021 Forum, Virtual Conference, August 2021.