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

Lukas Asmer, Henry Pak, Prajwal Shiva Prakasha, Bianca I. Schuchardt, Peter Weiand, Frank Meller, Christoph Torens, Dennis Becker, Chen Zhu, Karolin Schweiger, Andreas Volkert, Roman Jaksche

Corresponding author:

Lukas Asmer
DLR Institute of Air Transport and Airport Research
German Aerospace Center
lukas.asmer@dlr.de

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.

– HorizonUAM –

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

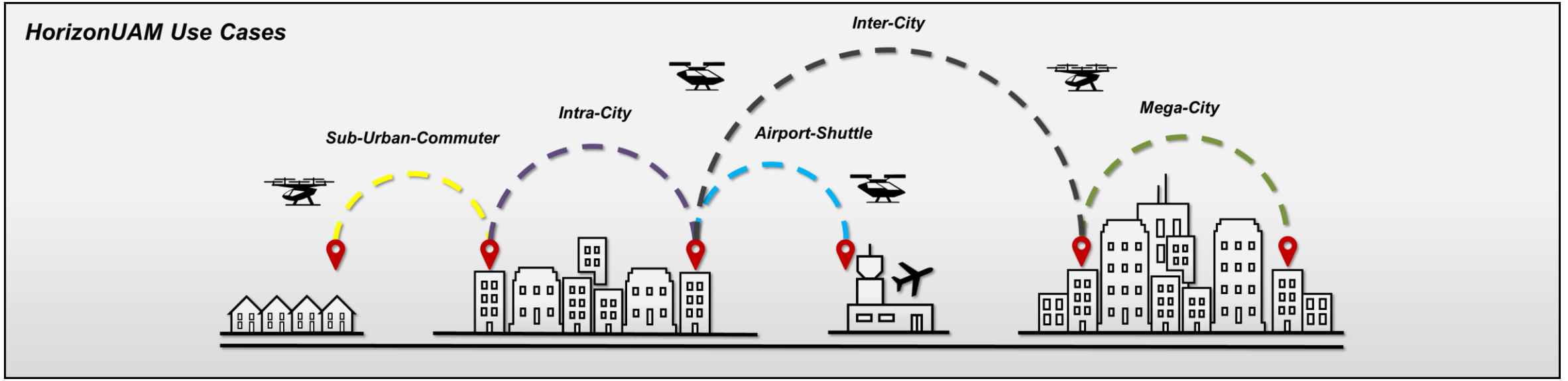
- Technological progress will be reflected by two scenarios.
  - Near-term scenario (~2025)
  - Long-term scenario (~2050)

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

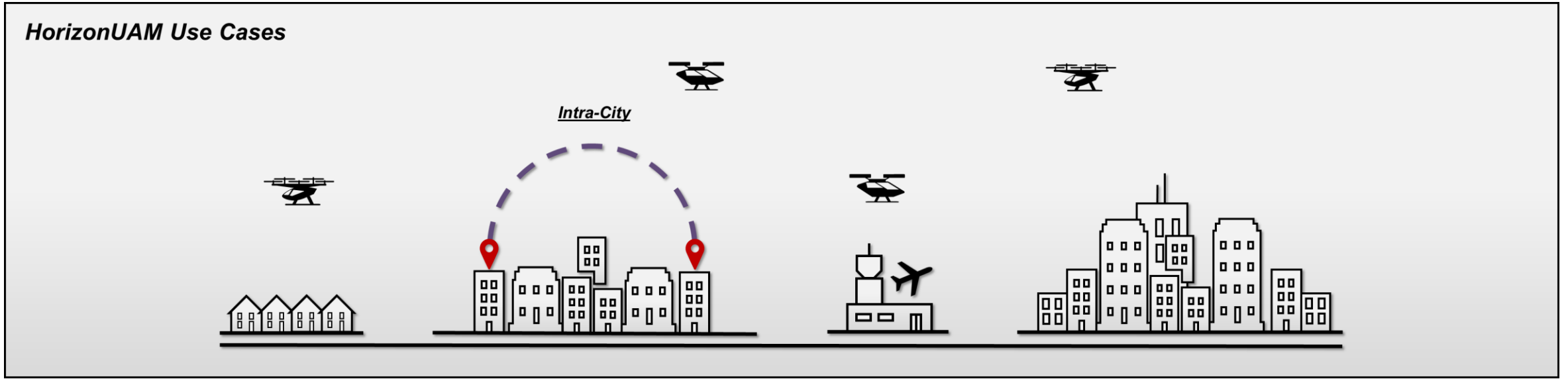
	2025	2050
Propulsion technology	Fully electric or hybrid electric	Electric or Hydrogen (fuel cell or full combustion)
Level of autonomy	Onboard-Pilot / Remote-Pilot*	Highly automated to autonomous
U-space Service Level	U1 (first U-space Services)	U2-U3 (advanced U-space Services)
Communication	Multilink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

* 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



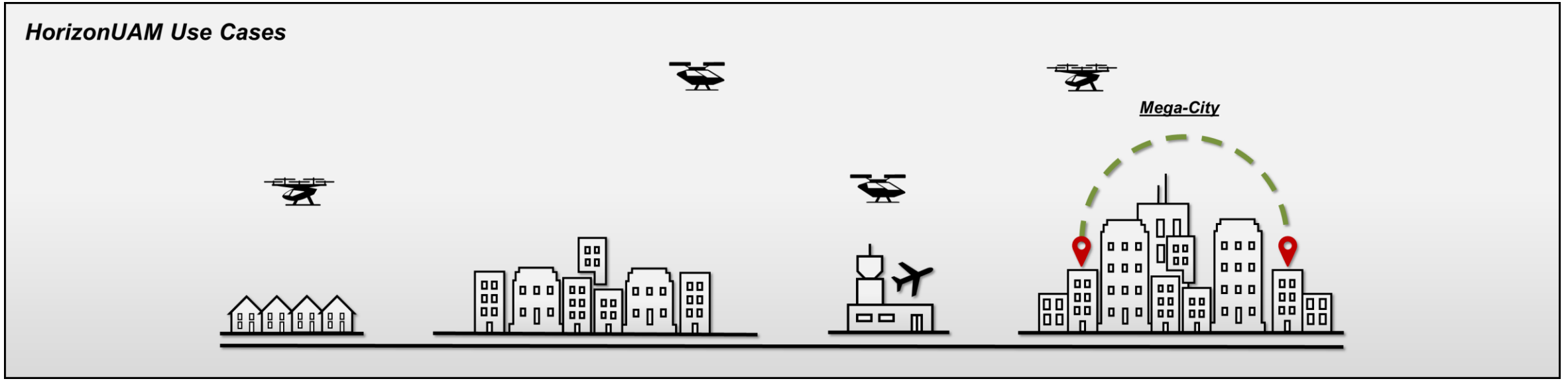
Transport task and characteristics

- 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



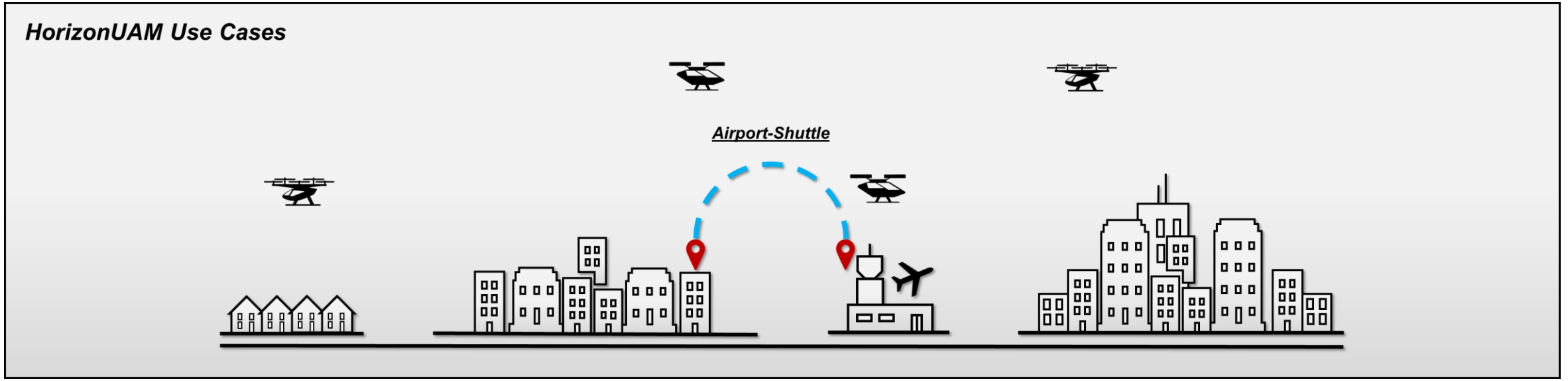
Transport task and characteristics

- 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



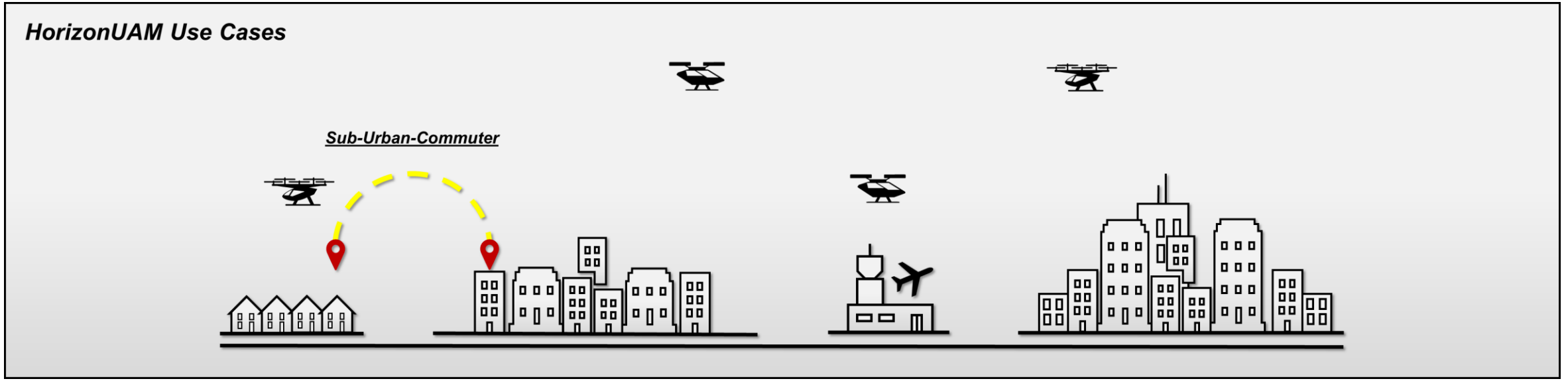
Transport task and characteristics

- 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



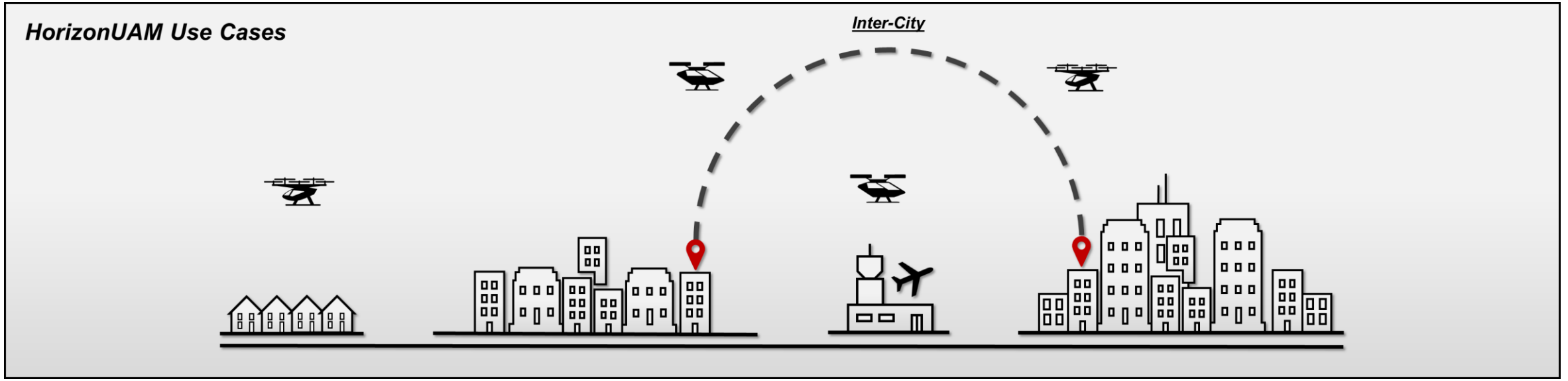
Transport task and characteristics

- 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	Vertiport
- Footprint: Small - Technical Equipment - No Charging - No MRO Service	- Footprint: Middle - Large - Technical Equipment+ - Charging - MRO Services possible - Hub Operations possible (Hub & Spoke)

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

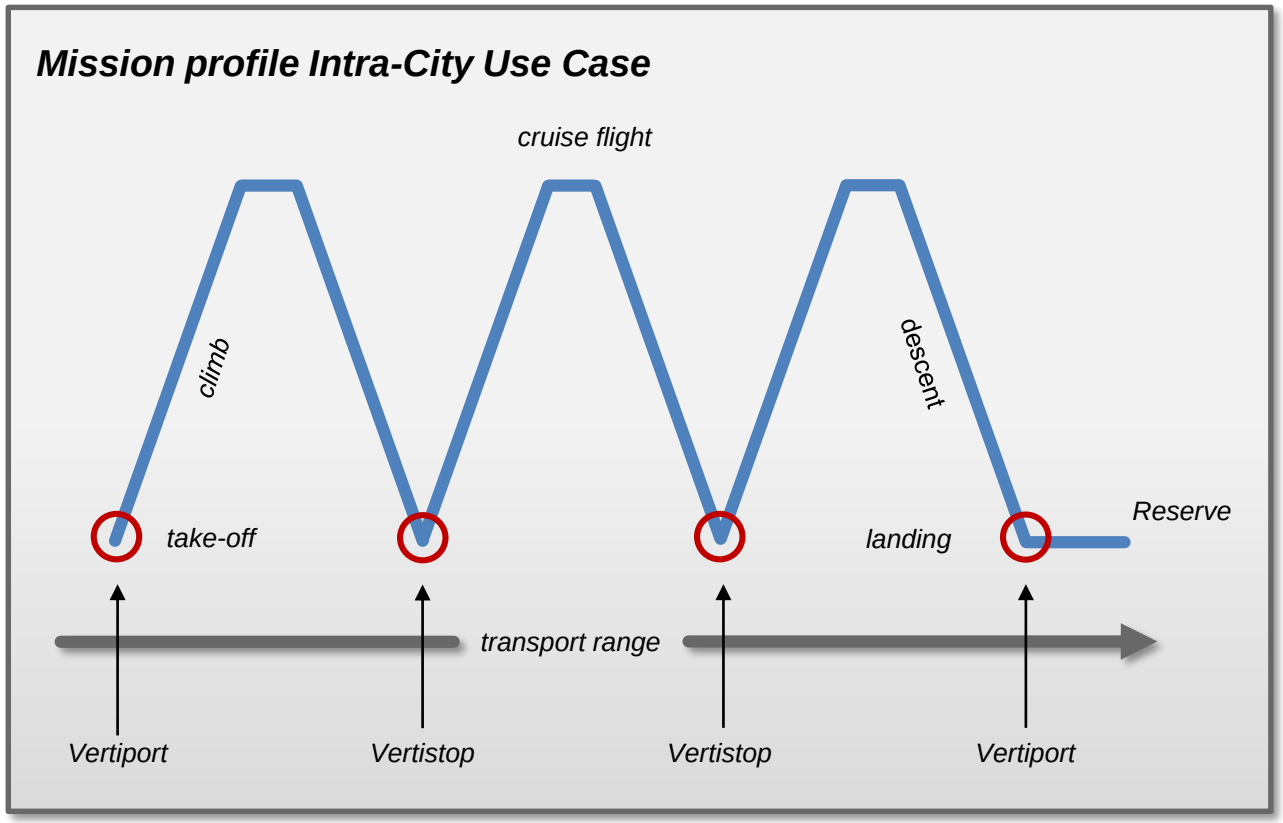
“+” Additional Equipment and Services regarding the vehicle (e.g. charging), the passenger (e.g. shopping), staff-related (e.g. office buildings).

Further reading:

- K. Schweiger et al. UAM Vertidrome Airside Operation: What needs to be considered?, presented at the Delft International Conference on Urban Air-Mobility (DICUAM), Virtual Conference, May 2021.
- 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.

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.

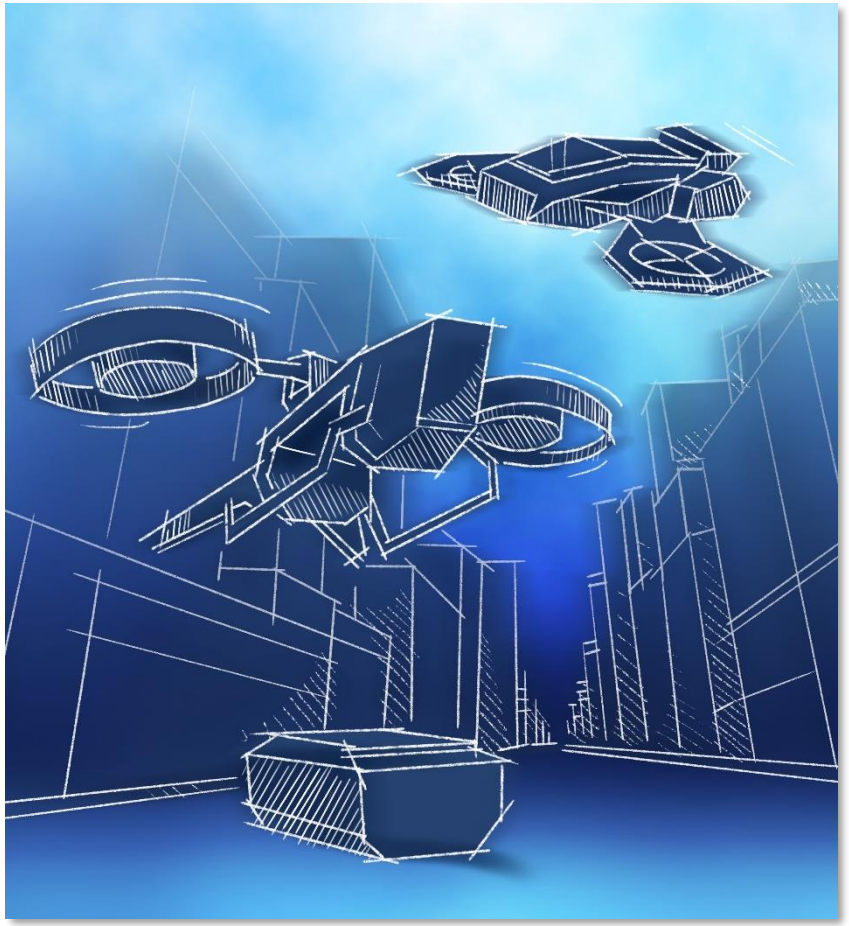


Conclusion

- 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.