

Mission-Driven Requirements Analysis for Low-Cost Cargo UAS in Humanitarian and Dual-Use Operations

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The development of unmanned aircraft systems (UAS) for cargo transport has the potential to significantly improve logistics in remote regions, disaster response, and other time-critical delivery and/or distributed last-mile scenarios while reducing operating costs compared to conventional aviation. Achieving economically viable cargo operations, however, requires more than a capable aircraft. Successful deployment depends equally on operational concepts that satisfy regulatory requirements and on sustainable business and operational models.

The ALAADy-Demonstrator project (2017-2019) addressed the technological feasibility of low-cost cargo drones by successfully converting a manned gyroplane-derived light aircraft into an unmanned cargo platform and demonstrating the concept in flight. Building on these results, the ALAADy-CC (Automated Low Altitude Air Delivery – Cross Country) project (2021-2023) investigates the operational and regulatory framework required for routine unmanned cargo operations in very low-level airspace (<500 ft) under the European Union Aviation Safety Agency (EASA) regulatory framework. Particular attention is given to cargo delivery by airdrop, which removes the requirement for prepared landing sites and therefore offers significant operational advantages for humanitarian and other logistics. The Wings for Aid program focusses on last-mile air-deliveries for people in remote or otherwise cut-off areas. A cardboard air-delivery box was developed, for precision drops without a parachute while protecting content with a shock-absorber. The system was validated in practice with Red Cross and the UN World Food Programme.

To derive today's operational requirements systematically, a comprehensive mission parameter catalogue has been established. This catalogue covers payload characteristics, transport demand, flight distance, delivery location, environmental conditions, regulatory constraints, operational procedures, economic aspects, and mission-specific risks. These parameters form the basis of a structured mission database from which technical, operational, financial and certification requirements for future cargo UAS can be derived.

Three representative mission scenarios have been analysed. The first is based on humanitarian aid delivery in an African country and uses operational data from a

prototype like real environment deployment conducted in 2025. This mission represents a typical long-range humanitarian supply scenario with payloads of approximately 20 kg over distances of 200–300 km (in and out). The second scenario investigates daily resupply of dispersed frontline units in a contested environment. Typical payloads include food, drinking water, batteries, and ammunition over transport distances of approximately 100–160 km. In contrast to humanitarian missions, this scenario introduces additional operational constraints such as GNSS spoofing and jamming, small-arms fire, FPV drones, surface-to-air threats, and other survivability considerations. The third scenario considers offshore logistics for wind farm maintenance based on previous investigations within the DLR UDW project. Since these operations generally require precision landing rather than aerial delivery, they are considered less representative for low-cost fixed-wing cargo drone concepts and are therefore not further pursued within the current project.

The comparison of humanitarian and military mission profiles reveals a surprisingly strong correlation in many fundamental aircraft requirements. Payload classes, cruise performance, and mission profiles exhibit considerable overlap, suggesting that common vehicle platforms could potentially serve both domains. Humanitarian operations generally require greater transport range, whereas military operations introduce significantly higher survivability requirements due to the contested operational environment.

The poster will introduce the mission analysis methodology, the developed mission database like structure, and the preliminary comparison of representative humanitarian and dual-use cargo missions. A particular focus will be placed on how mission-driven system engineering can support the derivation of future cargo UAS requirements and guide the development of economically viable low-cost cargo drone concepts. The accompanying poster will present the mission parameter framework, representative mission datasets, and the resulting implications for future cargo UAS architectures.

[1] J. C. Dauer, Ed., *Automated Low-Altitude Air Delivery: Towards Autonomous Cargo Transportation with Drones*. in Research Topics in Aerospace. Cham: Springer International Publishing, 2022. doi: [10.1007/978-3-030-83144-8](https://doi.org/10.1007/978-3-030-83144-8).

[2] S. Benders, L. Goormann, S. Lorenz, and J.C. Dauer, “Softwarearchitektur für einen Unbemannten Luftfrachttransportdemonstrator,” 2018, doi: [10.25967/480238](https://doi.org/10.25967/480238).

Biography



Dr.-Ing. **Sven Lorenz** is a Group Lead for the Unmanned Cargo and Passenger Transport research group within the Unmanned Aircraft Department at the Institute of Flight Systems of the German Aerospace Center (DLR) in Braunschweig and Cochstedt. His current work focuses primarily on realizing unmanned cargo drone operations in the EASA specific category by addressing both technical and operational challenges.



Martin Laubner is a Research Scientist in the Unmanned Aircraft Department at the Institute of Flight Systems of the German Aerospace Center (DLR) in Braunschweig and Cochstedt. An avid pilot and passionate aviator, his research focuses on the development of novel solutions for the piloting, testing and evaluation of large and complex UAS configurations in flight, particularly for BVLOS operations.



Barry Koperberg is founder of the Stichting Wings For Aid Foundation and Cargo Internet Development B.V.

At the heart of the Wings For Aid network is a small team of experienced professionals providing the craftsmanship required for innovation. The team works on concept development, testing, funding, and stakeholder management. Always – as required by the task at hand – in a cooperative effort with other actors in the network.