

AN ASSESSMENT OF URBAN AIR MOBILITY (UAM) CNS ARCHITECTURE & INFRASTRUCTURE COST

Abstract:

Advanced Air Mobility (AAM) depends not only on aircraft development and passenger demand but also on the availability and affordability of reliable Communication, Navigation, and Surveillance (CNS) infrastructure. Existing aviation CNS systems were not designed to support high-density aircraft operations at low altitudes over built-up urban areas. This study develops and evaluates a ground-based CNS architecture for Urban Air Mobility (UAM), with particular emphasis on infrastructure cost and economic scalability. The Munich metropolitan region is used as a representative case study.

The analysis covers three connected dimensions: the capability of existing CNS infrastructure, the operational and technical requirements of low-altitude UAM, and the architecture and cost of additional ground-based infrastructure. Reference missions were developed using passenger-demand data, potential vertiport locations, route characteristics, and expected traffic densities. Communication performance was evaluated for different frequency bands, antenna configurations, base-station locations, and aircraft altitudes. Navigation and surveillance requirements were included to develop an integrated CNS architecture.

A techno-economic model was then developed to estimate both capital expenditure and operational expenditure. Different deployment and traffic scenarios were examined to determine how infrastructure density, technology selection, service area, and operational demand influence total cost and long-term economic feasibility. The results indicate that urban blockage, interference, handovers, and concentrated traffic around vertiports can require additional infrastructure beyond existing aviation and public communication networks. While capital investment is important during initial deployment, recurring costs related to operation, maintenance, energy, backhaul, software, and system support become major cost drivers over the system lifetime.

The study demonstrates that CNS performance and infrastructure cost must be evaluated together. The proposed approach connects operational demand, technical requirements, network architecture, and lifecycle cost, providing a framework for assessing the feasibility of future UAM deployments.