AURORA

sAfe Urban aiR mObility
for euRopeAn citizens

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Towards sustainable urban air mobility

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Abstract

This report summarizes the lessons learned, collected from the project partners. Based on these, a number of recommendations were formulated towards stakeholders' involvement in the implementation of UAM.

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About AURORA

Urban Air Mobility (UAM) has the potential to overcome challenges like congestion and a lack of surface transport whilst saving infrastructure costs and time. However, making it safe, secure, green, quiet and accepted is challenging due to many factors, such as environment, regulations, and safety-critical technologies. Focusing on emergency-related applications, where UAM brings added value on top of current mobility solutions, the EU-funded AURORA project aims at connecting technologies and key actors to foster the adoption of UAM. The project works on development of artificially intelligent, urban autonomous flight solutions for Unmanned Aerial Vehicles (UAVs) and self-piloting passenger-carrying UA (Vertical Take-Off and Landing) aircraft with flight path planning capability using vision and radar environment perception sensors, including autonomous selection of emergency landing sites and landing capability, interactable with Very Low Level Air Traffic Management and Smart City elements, and utilizing GALILEO High Accuracy Service. The overall research and technological development makes use of a digital twin paradigm, effectively combining the physical world with its digital model for the purpose of safety-critical flight testing of autonomous flight solutions for UAM operations. To find out more: http://aurora-uam.eu

Project partners

Legal disclaimer

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1 AURORA project partner survey

As a conclusion of the AURORA project, all project partners were invited to contribute their lessons learned to the project. Information was collected on the basis of the Transition Framework, as each lesson was attributed to the relevant stage of the Policy Life Cycle, to the relevant theme in the Solution Space and to the relevant Mobility Indicator.

An important conclusion at this stage was that the lessons learned were still more general and hardly related to specific sustainable mobility indicators. As a result, the framework is reduced to the initial dimensions from the REVEAL framework.

In global, most of the recommendations relate to the Ideation and Design stages. Thematically most recommendations relate to the 'User needs' and 'Governance & Financing'. These findings are not surprising as the use-cases are mainly situated in these stages and the project and project partners strongly focus on these two themes.

In chapter 2, the individual responses are summarized into 10 lessons learned. In chapter 3, some recommendations are formulated towards stakeholders involved in UAM.

2 Conclusions: Lessons learned in AURORA

The lessons learned by the project partners can be summarized as follows:

1. Integrating UAM into existing transport systems is a complex task. UAM infrastructure, including charging points and landing sites needs to be planned within current legal frameworks and existing urban context, taking into account aspects of safety, privacy and data management, environmental impacts, … which negatively affect public perception of UAM. The Sustainable Mobility Indicators form a handhold to monitor the impact of UAM.

2. For several Sustainable Mobility Indicators, the impact of UAM is still unclear or highly depending on regulations and operational design. Strengths of UAM may be restricted by regulatory limitations. Parameters of the UAM system (fleet size, charging infrastructure, location and density of landing locations, etc.) can heavily influence the performance of the UAM as a whole.

3. Interest in and knowledge of UAM is often concentrated in specific sectors with strong ties to UAM. Creating awareness, preparing cities and sharing practices can help to broaden the support for UAM. Real tests and practical demonstrations of UAM concepts were found to be highly effective in helping people understand and engage with the technology. This hands-on approach significantly contributed to comprehension and would in turn help with societal acceptance. In discussions, a balance is needed between technological and societal-driven discussions to ensure that diverse perspectives are considered.

4. Involve citizens (from the beginning) in all phases of UAM development to address societal concerns and gain public acceptance. Be aware that the world of UAM is quite unknown, and that it's important to communicate and disseminate about UAM before to develop solutions. Citizens started with scepticism and fear due to privacy problems, environmental impacts, etc. Correct information allows them to move on to see the true usefulness of the system. The AURORA engagement activities highlighted the importance of continued efforts to educate, inform and involve the public about UAM.

5. Engaging a diverse group (in terms of age, gender, disability, economic status, educational level, etc.) of people provides valuable insights into different communities' perspectives. This diversity allows for a more comprehensive understanding of public perception regarding UAM.

6. Define complete and specific use-cases, tailored to the region-specific needs and opportunities. Set clear final objectives of each test/experiment, underlining and designing in detail the operational in-depth analysis of the single application field. Formulate both technical and non-technical goals, demonstrating the technical challenges and solutions, as well as the provided mobility services (smart city applications, logistics, emergency services, etc.). Involving local stakeholders can contribute to more individualized scenarios for the local context, addressing real user needs.

7. For the technical development, setting up a system architecture is the essential framework to attribute and align all partners' tasks and responsibilities. Define Minimum

Viable Product (MVP) for each TBB and ensure that providers deliver these before going to the next implementation. Take into account (possible) future technical evolutions, e.g. integrating different sensors into the system can considerably enlarge the UAM service world.

8. Drone use seems to be inevitable and drones are already being used. Therefore, having strong regulations is key, due to the unique nature of these aircraft and their operations. Since 2020, the European Union drones' legal framework has been subjected to uniform regulation by the European Union Aviation Safety Agency (EASA). Anticipating further developments, it is necessary to stay informed about these evolving regulations and to keep track of the developments and changes while fostering innovations. Further, it is important to define clear guidelines and roles in relation to enforcing these UAM regulations, and to be aware of the different regulations at national level with different possibilities and freedom to experiment with the use of drones between individual EU countries.
9. The role of Artificial Intelligence (AI) in the current UAS operations in the European Union (considering the first approvals of the AI/ML are in 2025 according to AI roadmap regulation) makes it necessary to stay informed about AI regulatory developments and to ensure the AI solutions adhere to safety and privacy guidelines being ready to adapt accordingly. Research and innovation activities in the domain of AI and autonomous systems need a dedicated regulation framework so that they do not need to fall under commercial level requirements for operations, but support lower level TRLs testing and experimentation.
10. The emerging UAV market is highly dependable on the existing socio-economic situation and market fluctuation in the domain of electronics, avionics and aviation. When engaging into UAV related research it is good to take this into account as we have seen prices surging over the past years.

3 Recommendations to stakeholders involved in UAM

1. Autonomous flight is the key enabler of the AAM, and its sub-category, UAM. AURORA recommends that EASA engages the aviation industry, standardization entities and other regulatory bodies, to adopt the autonomous flight in the current regulatory framework, instead of a complex step-by-step approach, currently remote piloting-oriented one.

2. AURORA recommends that city planners investigate the aspects of Sustainable Mobility Indicators in relation to regulations and operational design as for several Sustainable Mobility Indicators, the impact of UAM is still unclear or highly dependent on regulations and operational design. In this context, the strengths of UAM may be restricted by regulatory limitations. Parameters of the UAM system (fleet size, charging infrastructure, location and density of landing locations, etc.) can heavily influence the performance of the UAM as a whole and in combination with aspects of safety, privacy and data management, environmental impacts, might negatively affect public perception of UAM. The Sustainable Mobility Indicators form a handhold to monitor the impact of UAM.

3. AURORA recommends advocating and coordinating community efforts towards EASA to define a regulatory framework for the experimental category of unmanned aircraft, that applies to their development phase. Currently, it is not possible to test autonomous flight-capable unmanned aircraft in realistic environments because national aviation authorities want them to be already certified on a commercial basis even in the process of their development. Such analogy does not exist in manned aviation and seriously hampers wider innovation and the introduction of the main enabler of UAM and AAM, which is autonomous flight.

4. AURORA recommends that city planners and use case developers create awareness, prepare cities and share practices in order to help broaden the support for UAM and avoid concentration of interest in and knowledge of UAM in specific sectors with strong ties to UAM. Real tests and practical demonstrations of UAM concepts were found to be highly effective in helping people understand and engage with the technology. This hands-on approach significantly contributed to comprehension and would in turn help with societal acceptance. In discussions, a balance is needed between technological and societal-driven discussions to ensure that diverse perspectives are considered.

5. AURORA recommends that policymakers involve a diverse group (in terms of age, gender, disability, economic status, educational level, etc.) of citizens to provide valuable insights into different communities' perspectives in all phases of UAM development and to address societal concerns and gain public acceptance. Be aware that the world of UAM is quite unknown, and that it's important to communicate and disseminate about UAM before developing solutions. Citizens might start with scepticism and fear due to privacy problems, environmental impacts, etc. and correct information allows them to move on to see the true usefulness of the system while the diversity allows for a more comprehensive understanding of public perception regarding UAM. The AURORA engagement activities highlighted the importance of continued efforts to educate, inform and involve the public about UAM.

6. AURORA recommends that use-case designers, for the development and innovation of autonomous flight UAM applications, engage national aviation authorities early in the process.
7. AURORA recommends that UAM service providers build system-agnostic interfaces with consumers and providers of UAM services that allow seamless vertical integration of existing ground-based services with aerial-counterpart. AURORA has shown that using available standards and norms, interfaces can be implemented for automation purposes and thus vertical integration.
8. AURORA recommends that the UAM industry, for the scope of technical development, sets up a system architecture as an essential framework to attribute and align contributions from versatile groups of stakeholders and define a Minimum Viable Product (MVP) for each development. In line with this, it is recommended to take into account (possible) future technical evolutions, e.g. integrating different sensors into the system can considerably enlarge the UAM service world.
9. AURORA recommends that the UAM industry and use-case developers continuously monitor the emerging UAV market, as it is highly dependable on the existing socio-economic situation and market fluctuation in the domain of electronics, avionics and aviation. When engaging in UAV related research it is good to take this into account as we have seen prices splurging over the past years.
10. AURORA recommends that the European Commission creates a user-friendly, one-point-based, easily accessible overview of the different UAM-related regulations at national levels to enable different possibilities and freedom to experiment with the use of drones between individual EU countries and transferability of lessons learned. In this context, the role of Artificial Intelligence (AI) in the current UAS operations in the European Union (considering the first approvals of the AI/ML are in 2025 according to AI roadmap regulation) makes it necessary for all stakeholders to continuously stay informed about AI regulatory developments and to ensure the AI solutions adhere to safety and privacy guidelines and are ready to adapt accordingly. Research and innovation activities in the domain of AI and autonomous systems need a dedicated regulation framework so that they do not need to fall under commercial level requirements for operations, but support lower level TRLs testing and experimentation.