Advanced Air Mobility National Campaign: Bridging the Gap

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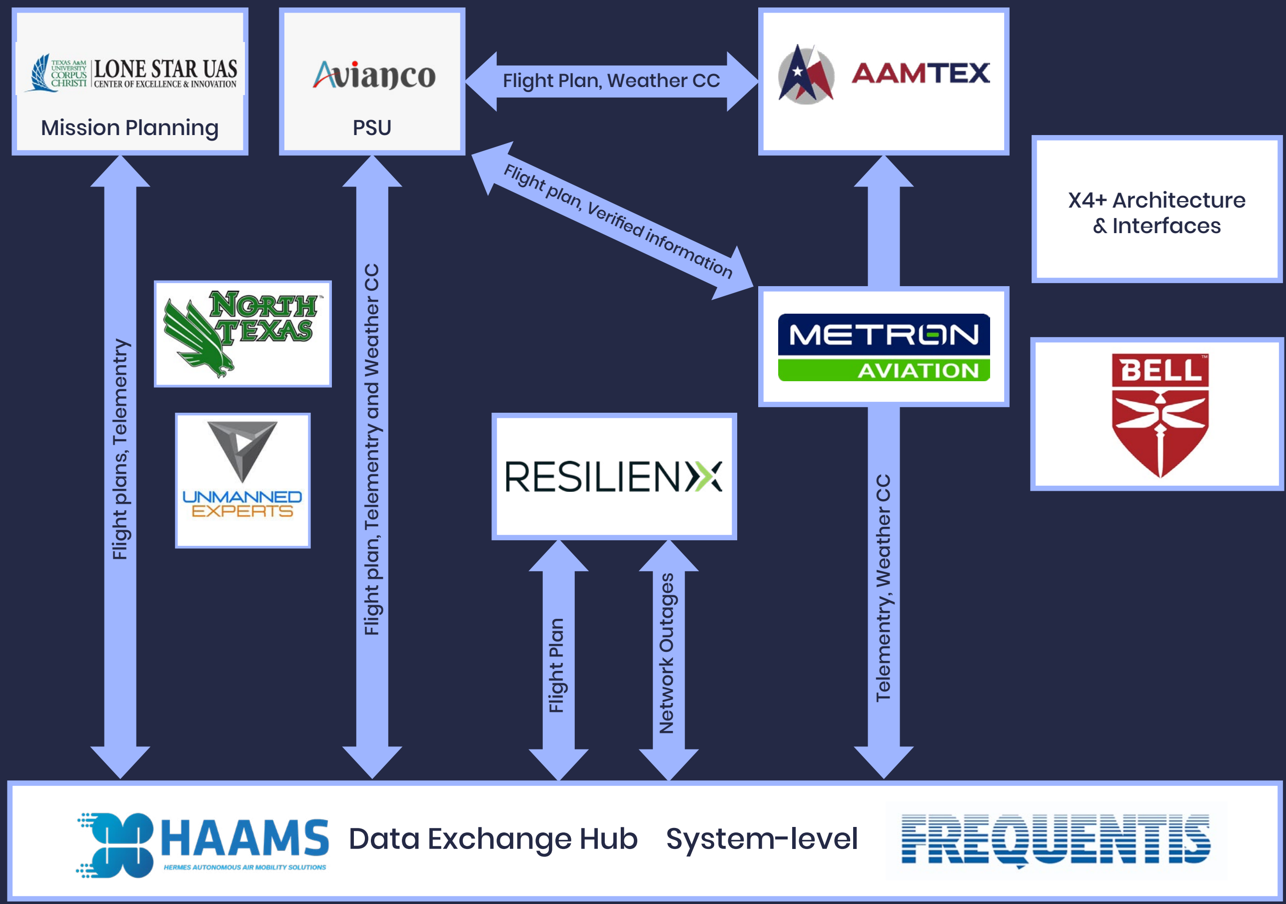

Advanced Air Mobility National Campaign: Bridging the Gap

The rapid advancements in technology have paved the way for revolutionary changes in transportation, particularly air mobility. One such groundbreaking initiative is the Advanced Air Mobility (AAM) National Campaign led by NASA. This campaign aims to integrate advanced air mobility solutions into the existing transportation infrastructure, creating a seamless, efficient, and safe urban air transportation system. By addressing the various challenges associated with urban air mobility, the AAM National Campaign is poised to redefine how we navigate our cities, ultimately leading to reduced congestion, improved accessibility, and enhanced environmental sustainability.

The North Texas Cohort and Project X4+

At the heart of this initiative is the North Texas (NTX) cohort, a unique collaboration of private, public, academic, and government organisations. The NTX cohort has been instrumental in driving the AAM National Campaign forward through its Project X4+. This project, a sequel to the previous X3 and X4 projects, aims to bridge the gap between simulation exercises and real-world flight tests. The project commenced in June 2022 and concluded in December 2022, with a live flight demonstration conducted on October 11, 2022. Project X4+ is designed to test and refine the integration of various subsystems within the AAM ecosystem, ensuring that these technologies can operate cohesively and effectively in real-world scenarios.

The Team Behind the Innovation

The NTX cohort comprises 15 organisations, including startups, established companies, and universities. Each member brings unique expertise to the table, contributing to the creation of a comprehensive AAM ecosystem. Dr Kamesh Namuduri from the University of North Texas (UNT) and Keven Gambold from Unmanned Experts provided overall leadership, coordinating closely with NASA. This collaborative effort is marked by significant contributions from various entities, each playing a crucial role in the project's success.

Professor Namuduri and Mr Gambold led a team that included Avianco, which provided urban air mobility (UAM) services and was responsible for integrating air traffic management systems to ensure smooth operations within urban airspaces. Hermes Autonomous Air Mobility Solutions acted as the data exchange hub provider, facilitating real-time data sharing across the AAM ecosystem, ensuring that all stakeholders had access to critical information. Delmont Systems offered advanced weather forecasting and monitoring services to ensure safe and efficient flight operations, while Metron managed airspace capacity and ensured that flight operations were balanced and efficient.

ResilienX contributed an in-time aviation safety management system (IASMS), ensuring that the AAM ecosystem could respond effectively to safety and operational challenges. Bell Textron supplied advanced air vehicles designed for urban air mobility, and Frequentis ensured seamless coordination between air and ground traffic systems. The academic partners, Texas A&M University at Corpus Christi and the University of Massachusetts Amherst, provided mission planning and weather event prediction capabilities, contributing valuable research and expertise to the project.

Project X4+: Objectives and Execution

Project X4+ was designed to address the need for additional simulations before conducting real-world flight tests. This project ran from July to December 2022 and included a series of simulation exercises, referred to as sprints, followed by a live flight demonstration. Each organisation deployed its respective subsystem, forming an interconnected ecosystem. The primary objective was to ensure that all components could work together seamlessly, addressing potential issues before live testing.

The sprints focused on different aspects of air mobility operations. The first sprint tested the integration of weather-related constraints into the AAM ecosystem. Weather conditions play a crucial role in air mobility operations, and this sprint aimed to ensure that the system could effectively manage weather-related challenges.

The sprint involved creating weather capacity constraints (CCs) that were shared with NASA's systems and all partners in real time. This ensured that all stakeholders had access to accurate and up-to-date weather information, allowing for safe and efficient flight operations. The sprint followed a detailed playbook to ensure systematic testing of weather constraints, including steps such as sending operational intents, relaying responses, activating operational intents, and simulating telemetry. The sprint also included rerouting flights in response to weather constraints, demonstrating the system's ability to adapt to changing conditions.

The second sprint focused on demand capacity balancing (DCB), which is critical for maintaining smooth and efficient operations within the AAM ecosystem. This sprint tested the ability of the system to balance demand for airspace resources, ensuring that flights could be conducted without overloading the system. Similar to the first sprint, this sprint followed a structured playbook to test various scenarios. It included querying vertiport capacity, estimating demand, and modifying operational intents in response to DCB constraints. The sprint also introduced dynamic capacity estimation, taking into account time and weather-dependent factors to ensure accurate capacity management.

The third sprint demonstrated the resilience of the AAM ecosystem during unexpected events. This sprint was crucial for testing the system's ability to handle anomalies and adverse conditions, ensuring that it could maintain safe and efficient operations even under challenging circumstances. The first scenario in this sprint tested the system's ability to detect and respond to anomalies in telemetry data. The IASMS monitored telemetry data for quality issues, generated capacity constraints around the last known quality location, and alerted nearby operations. This demonstrated the system's capability to maintain safety and operational integrity even when data anomalies occurred. The second scenario focused on the impact of losing connectivity with a critical service. The IASMS detected the loss of liveliness, adjusted vertiport capacity accordingly, and communicated the changes to the AAM ecosystem. This scenario highlighted the system's ability to adapt to service disruptions and maintain operational stability.

The fourth sprint was a live flight test showcasing the autonomous operations developed during the project. The live demonstration was the culmination of Project X4+, providing a real-world test of the integrated AAM ecosystem. The flight involved a Bell 407 helicopter flying predetermined routes, with real-time telemetry and operational data shared over cellular and mesh networks. The live demonstration followed a detailed playbook, similar to the previous sprints. The onboard operator submitted operational intents, which were relayed to various subsystems for checks and activation. The demonstration included real-time telemetry sharing, rerouting requests, and communication support through both cellular and mesh networks. The successful completion of the live demonstration validated the integration and functionality of the AAM ecosystem.

Key Outcomes and Observations

The project yielded several significant outcomes. The project successfully tested the AAM architecture, including the PSU, SDSPs, and all interfaces. This validated the system's ability to integrate various subsystems and operate cohesively. The project demonstrated the viability of V2I communication networks, although some challenges were encountered with cellular service reliability.

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The collaborative efforts led by Professor Kamesh Namuduri and Keven Gambold, along with their partners, have demonstrated the feasibility and potential of advanced air mobility solutions.

The mesh network provided a more stable alternative, highlighting the importance of robust communication infrastructure for AAM operations. The project established a baseline NC test track, providing a foundation for future testing and development of AAM technologies. The successful completion of the first AAM flight test under NASA's NC-1 program marked a significant milestone for the project and the broader AAM initiative.

A Vision for the Future

The Advanced Air Mobility National Campaign and Project X4+ represent a significant step forward in the field of urban air transportation. The collaborative efforts led by Dr Kamesh Namuduri and Keven Gambold, along with their partners, have demonstrated the feasibility and potential of advanced air mobility solutions. As the team moves forward with new projects and continued research, the future of urban air transportation looks promising, with the potential to transform the way we move within our cities and beyond. By addressing the challenges associated with urban air mobility and leveraging cutting-edge technologies, the AAM National Campaign is poised to create a safer, more efficient, and sustainable transportation system for the future.

MEET THE RESEARCHERS

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Kamesh Namuduri is a Distinguished Research Professor of Electrical Engineering and the director of the Autonomous Systems Laboratory at the University of North Texas. He earned his PhD in Computer Science and Engineering from the University of South Florida. With over fourteen years of research experience in aerial networking and communications, Dr Namuduri serves as the chair for two IEEE Standard Working Groups focused on aerial communications and vehicle-to-vehicle communications for unmanned aircraft systems. He is also a distinguished lecturer for the IEEE Vehicular Technology Society (2021 to present).

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KEY COLLABORATORS

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Keven Gambold
Unmanned Experts Inc., USA

Keven Gambold completed 21 years of active duty service with the Royal Air Force as a front-line combat pilot, logging 1,500 hours in Tornado GR4 fast jets and another 1,500 hours of unmanned combat missions, including two deployments to Iraq. He has published peer-reviewed papers on unmanned aircraft systems (UAS) operations in the civil sector and is an active member of RTCA SC-203 and SC-228. Keven has chaired several global UAS conferences and workshops, authored numerous books, and taught international UAS training courses. He holds an MSc in Aeronautical Operations and a commercial pilot license and is the co-founder and CEO of Unmanned Experts Inc.

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FURTHER READING AND RESOURCES

Digital Twin Approach for Integrated Airspace Management With Applications to Advanced Air Mobility: https://ieeexplore.ieee.org/document/10239467

North Texas team tests emerging Advanced Air Mobility technology: https://news.unt.edu/news-releases/north-texas-team-tests-emerging-advanced-air-mobility-technology

NASA Goes Live with Surrogate eVTOL Flight Tests in Texas: https://www.nasa.gov/centers-and-facilities/armstrong/nasa-goes-live-with-surrogate-evtol-flight-tests-in-texas/

Challenges to Solve Before We Can Commute by Air Taxi: https://spectrum.ieee.org/evtol-2661135407

Creating North Texas' First Air Corridor for Air Taxis and Air Ambulances: https://www.youtube.com/watch?v=0qINeL5cJx4