Industry Challenge-Led Accelerator Challenge Brief: Vertical Aerospace

UK Digital Twin Centre
Delivered by Digital Catapult

Real-time predictive digital shadows for eVTOLs

Background

Flight testing is a crucial part of developing aircraft such as eVTOLs (electric vertical take-off and landing aircraft). Identifying where issues may arise, and ensuring the aircraft will be safe to use in real world scenarios involves factors across the overall aircraft such as component and system behaviours, along with environmental factors, many of which are monitored in real-time.

When problems are identified during a flight test, the test may need to be aborted. This is to prevent physical damage or risk to personal safety. There are cases where this is unavoidable, and the testing should be aborted. However, there can be anomalous detections of limits, where upon later review, it can be determined that the test flight did not need to stop. Furthermore, if situations with potential for approaching limits can be predicted in real-time with sufficient advance warning, an alternative course of action could be identified, and avoid the need to stop a test.

Identifying these scenarios would help maximise flight testing and minimise the associated costs of curtailed tests that will need to be repeated, while also improving insights gained through these tests. Using predictions on real-time data to inform corrective decision-making can be seen in industries such as food manufacturing and automotive racing, and transferable learning for eVTOLs is welcomed.

Challenge

Vertical Aerospace, in collaboration with the UK Digital Twin Centre, is looking for solutions to improve the efficiency of testing its aircraft. These solutions should leverage modelling and simulation data to generate real-time predictions for the test flight, creating a digital shadow running in parallel to identify potential limit conditions and suggested pre-emptive decision-making support for telemetry and test engineers, and pilots. Aspects of the aircraft systems that this could encompass include thermal, loads and vibration, flight control, or electrical system properties, among others, which can be predicted in models but currently not in real time.

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Key issues to address

- **Capture of real flight test**: Run in parallel to flight test to create the digital shadow of the aircraft
- **Latency:** Low latency is required to be able to inform real-time decision-making
- **Data quality**: Capture relevant data sufficiently cleanly (low noise), quickly, and input into simulation.
- **Anomaly detection and prediction**: Identify upcoming limits and alert operators, using real-time data from the flight testing
- **Suggested actions**: Identify corrective actions where relevant that would enable continuation of test flight or other insights

Expected outcomes

The solution should demonstrate measurable technical and operational benefits for flight testing by delivering:

- Predictive analysis in real time following training on existing models and simulations, identifying approaching limits and other insights
- Suggestion of alternative actions that enable the test to continue where safe to do so eg change of manoeuvre, configuration, or system settings
- Human-in-the-loop testing, augmenting flight test telemetry subject matter experts with improved information
- Identified technical architecture, and infrastructure and data streaming needs to inform future system builds
- Outputs to improve future modelling of test flights

To note

- eVTOLs are human-occupied aircraft
- Features such as conversational AI to interact with the operator are considered out of scope for this challenge
- Operational decisions and changes to flight testing will remain in the control of the operator
- Simulation and predictive analysis must be rooted in real data, minimising use of LLMs due to risks from hallucination

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- The parameters in scope will largely focus on the aircraft rather than environmental factors
- Existing flight and simulation test data is mostly time series data
- Systems used previously include IADS telemetry systems, Influx databases and MATLAB Simulink
- NDAs may be required between Vertical Aerospace and successful applicants, at Vertical Aerospace's discretion

SME requirements and preferences

- Applicants with experience in aerospace systems and processes are preferred

About Vertical Aerospace

Vertical Aerospace is a global aerospace and technology company pioneering electric aviation. Vertical is creating a safer, cleaner, and quieter way to travel. Valo is a piloted, four-passenger, Electric Vertical Take-Off and Landing (eVTOL) aircraft, with zero operating emissions. Vertical is also developing a hybrid-electric variant, offering increased range and mission flexibility to meet the evolving needs of the advanced air mobility market. Vertical combines partnerships with leading aerospace companies, including Honeywell, Syensqo and Sonaca, with its own proprietary battery and propeller technology to develop the world's most advanced and safest eVTOL. Vertical has c.1,500 pre-orders of Valo, with customers across four continents, including American Airlines, Avolon, Bristow, GOL and Japan Airlines. Certain customer obligations are expected to be fulfilled via third-party agreements. Headquartered in Bristol, UK, Vertical's experienced leadership team comes from top-tier aerospace and automotive companies such as Rolls-Royce, Airbus, GM, and Leonardo. Together, they have previously certified and supported over 30 different civil and military aircraft and propulsion systems.

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