

Industry Challenge-Led Accelerator

Challenge Brief: BAE Systems

Digital Twin Development for In-Service Aircraft Systems

Background

Modern non-civilian aircraft are being developed more quickly and are in service for less time. While speedier development cycles are beneficial, the shorter lifespan means there is less historical data and experience to draw from when maintaining these aircraft. Older aircraft have been in service for as long as twenty years, with a rich history for support teams to draw from. However, managing even these aircraft is reactive and based on historical knowledge. Better tools are needed to understand how aircraft are being used, predict failures and how best to maintain them to keep high levels of availability for the end customer.

Digital twins as an enabling technology has been explored across a number of different sectors and use cases, with varying returns on investment. Given the scale of operation and cost in aerospace, a successful digital twin could unlock significant value, not only by enabling predictive rather than reactive fleet management, but also by feeding back into the design of future aircraft. Realising this potential starts with demonstrating that a robust, reliable digital twin can be built and validated against a real aircraft system.

Challenge

BAE Systems, in collaboration with the UK Digital Twin Centre, are looking for solutions to develop a digital twin of an in-service aircraft system, as a foundational step towards improved fleet management, monitoring and predictive maintenance. In this challenge, successful applicants will focus on either the actuation or fuel system to demonstrate their solution, building and validating a digital twin that accurately reflects its behaviour and condition in service. This demonstrator will establish the technical foundation needed to later support predictive maintenance and improved availability, as well as informing the design of future aircraft.

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Key issues to address

- **Aircraft system health monitoring:** Improve understanding of the health and status of aircraft systems, focusing on actuation systems or fuel systems
- **Integration of physical and digital systems:** Demonstrate how data from physical components can be connected to and represented within a digital twin to build a more accurate understanding of system behaviour
- **Modular and scalable modelling approach:** Establish a reproducible methodology for developing individual system-level digital twins that can be combined and expanded to ultimately represent an entire aircraft
- **Path to predictive capability:** Reduce reliance on reactive maintenance by identifying potential system degradation and failure earlier
- **Early lifecycle application:** Enable digital twin approaches to be incorporated earlier in the design and engineering of next-generation aircraft

Expected outcomes

The solution should demonstrate a practical approach to digital twin-enabled aircraft fleet and health management by delivering:

- A standalone, representative digital twin of BAE Systems' aircraft actuation system or fuel system, demonstrating relevant system behaviour
- Clear visualisation and demonstration of the digital twin and its outputs, allowing BAE Systems' engineering and platform teams to understand potential value and future applications
- A standards-based approach to modelling and interoperability, demonstrating how the methodology can be applied using appropriate industry standards
- A modular and reproducible methodology for developing digital twins that can be scaled from individual systems towards an integrated aircraft-level digital twin
- Clear roadmap for future development and deployment, outlining how the digital twin could evolve from the initial system demonstrator towards platform level health management
- Credible route towards prediction, showing how AI or other appropriate techniques could enable predictive health management and prognostics, using simulated data

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To note

- All work and discussion will be at an Unclassified level of security
- Integration with the existing system is not expected during this programme – the system can be standalone
- Demonstrating predictive capabilities is not expected during this programme but a credible route to stochastic/probabilistic forecasting of maintenance events/conditions is required
- Data is not being streamed in real-time, and will be downloaded after a flight
- Sensor data is also captured from aircraft, and successful applicants will need to incorporate this into their digital twin, as well as simulating the eg actuator position sensor attached to the actuator
- The design of future solutions is not constrained by use of existing tools and software for simulation and design
- Outputs should be industry standard and interoperable rather than bespoke tools and software
- An ontological approach adhering to standards is welcomed if it can be created at pace to keep in line with short engineering cycles
- A single actuation or fuel system will contain several elements to be modelled. These can include the hydraulic power source, control electronics, position sensors, mounting hardware, and feedback and monitoring equipment, among others
- NDAs may be required between BAE Systems and successful applicants, at BAE Systems' discretion

SME requirements and preferences

- Applicant companies must operate in the UK/Europe only, in addition to accelerator activities taking place in the UK only
- Applicants must demonstrate deep digital twin expertise, particularly in the domain of modelling components and systems, decentralised and centralised data distribution, and the ability to bring this data together
- Applicants must demonstrate the use of existing or emerging industry standards associated with modelling and simulation, and more general information sharing across digital twin structures

About BAE Systems

At BAE Systems, we serve, supply and protect those who serve and protect us. For decades, our government customers have trusted us to develop the next generation of defence and security capabilities. We are a workforce of around 110,000 highly-skilled people in more than 40 countries, providing some of the world's most advanced,

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technology-led defence, aerospace and security solutions. Working with our customers and local partners, we develop, engineer, manufacture and support products and systems to deliver military capability, protect national security and keep critical information and infrastructure secure. We support our customers so that they can stay ahead of evolving threats across land, sea, air, cyber and space. Keeping aircraft operational and available is critical to our customers. BAE Systems is constantly investing in state of the art technology to keep aircraft availability as high as possible.