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CACI

Defence Fuels Digital Twin: A proof of concept for Defence Fuels Enterprise (DFE)

Background

While improving your operations is essential to moving your organisation forward, associated risks can make it hard to take the leap. The ability to model changes and predict the impact of any decisions provides substantial advantages.

CACI's Digital Twin capability offers these advantages, with realistic and reliable data that guides the way towards a successful future. Serving as the real-time digital counterpart of any system, it produces a virtual representation of simulated situations. This helps decision-makers action improvements in cost and availability, resilience and performance, and compliance and safety.

The Digital Twin draws on our MooD software, a large-scale data visualisation platform that integrates systems to create a single working model for management and planning. Combined with the Digital Twin, it enables modelling of potential solutions and ensures all stakeholders work towards the same strategic and operational goals.

Challenge

The Defence Fuels Enterprise (DFE) needed to understand the past and predict near and distant future events regarding fuel movement within an air station. Therefore, CACI developed a proof of concept (PoC) to test out the application of a Digital Twin design in collaboration with the MOD's Defence Fuels Transformation. This PoC identified three use cases of increasing sophistication that would broadly cover the Digital Twin concept and help the DFE overcome their visibility challenges, including:

1. **Understanding what has been happening:**
   Showing fuel efficiency, holdings and asset utilisation issues.

2. **Predicting the near future:**
   Supplying an 'early warning' of upcoming situations that could lead to issues.

3. **Testing further reaching change:**
   Enabling changes to an air station to be made and tested as though they were actually happening.

Solution

To develop our PoC for DFE, we followed best practice principles including selecting use cases and benefits and engineering based on CACI's DevSecOps methods, using readily available technology and services. Our PoC was carried out over three months using Agile sprints, with five roles delivered and several supportive methods carried out to solve DFE's challenges, including:

1. **A front end that allows operators to interact with, track or control what it does.** Our PoC included a user interface allowing direct interaction with a visualisation of the structural model, including a representation of the decision processes.

2. **Structural models that act as the central definition for everything else the twin does.** For instance, a 'Bill of Materials' of the system to be twinned could be created, laying out all components and connections.

3. **A data pipeline that takes data from sensors or business systems.** Ideally, every manual procedure would be monitored through an app, and every automated procedure would be managed with the aid of real-time sensors. We wanted our PoC to show what could be achieved by simply using declassified data from the Bulk Fuels Information System (BFIS) regarding fuel movements and from Future Fuels Management Tool (FFMT) regarding stock holdings.

4. **Predictive models that can learn from actual behaviour to predict what might happen next.** These models are trained on historical data to identify patterns and trends. This allows them to predict future events with a high degree of accuracy.

5. **Machine learning models for prediction.** We used a small sample of historical data concerning requirements for refuelling vehicles given a certain demand, allowing an 'early warning system' to be created.

6. **Simulation models for testing the effect of change.** We adapted and integrated an existing Defence Fuels Enterprise simulation model, Fuel Supply Analysis Model (FSAM), to test how a unit would operate given changes to the configuration of refuelling vehicles.

Our PoC ultimately defined an appropriate architecture, implemented a Digital Twin solution, proved it could be built using available cloud tech and skills and demonstrated a low-cost front end. It proved its ability to generate hundreds of thousands of pounds of savings (per month, per air base) and significant productivity benefits, offering faster, more objective information.

Results

All three use cases from our PoC showed improvements that would support a human decision-maker. The project's many achievements included:

- Defining the architecture of a 'Digital Twin of the enterprise' suitable for the Defence Fuels enterprise.
- Implementing a Digital Twin solution to define a 'simplest possible' example for each use case.
- Showing that such a solution could be built using cloud technologies and skills readily available to MOD, based on models, data pipelines, machine learning and simulation.
- Demonstrating a low-cost front end that provides decision-making support and encourages the enhanced automation of decision processes.

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