DIGITAL TWIN FOR SUSTAINABLE ENERGY

IMPROVING LIFETIME VALUE OF A FUSION POWERPLANT USING A PHYSICS-BASED DIGITAL TWIN

About the Customer

Assystem is an international engineering and digital services group focused on low-carbon projects that accelerate the transition to clean energy. Assystem is committed to the development of decarbonised electricity (fusion energy, renewables and electricity grids) and clean hydrogen. The Group is also helping drive the use of decarbonised electricity in industrial sectors such as transportation.

Assystem is contracted by United Kingdom Atomic Energy Authority (UKAEA) to work on fusion energy-related programs, and especially to develop physics-based digital twins for their in-operation powerplants.

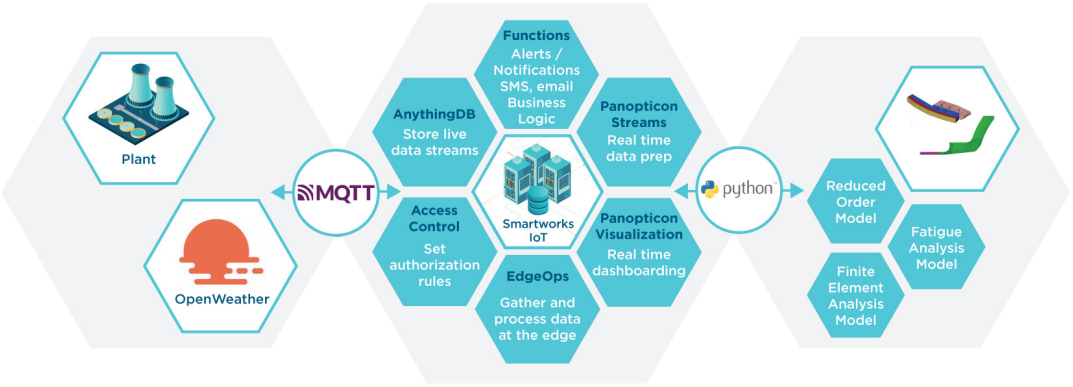
> We could set up the interfaces to connect structural integrity models with Altair® IoT Studio™, right out of the box. This empowers operators to leverage the powerful models originally used to design their plant, feeding into them the live operational data from the plant throughout its life to gather critical insights and make decisions.
>
> Dr. Adam Towse, Head of Discipline (Simulation and Assessments), Assystem

These programs include the development of the Spherical Tokamak for Energy Production (STEP), the U.K.'s prototype fusion powerplant that will demonstrate fusion energy's commercial viability.

Their Challenge

Fusion powerplants require complex digital simulation models during the design assessment phase. Their inspection and maintenance intervals and total life are defined based on the expected loading on the as-designed model, factoring in significant risks. Meanwhile, the actual loads the plant is subjected to may differ. This gap provides a scope for programs directed at either improving the plant's lifetime value or quantifying the effects of higher-than-expected usage.

The Assystem team wanted to leverage the expensive design models to create a digital twin by inputting the sensor data that was livestreamed from the plant, which helps engineers understand the plant's structural integrity and further optimize inspection and maintenance schedules. The simulation models can be the original full fidelity models, or they can be converted via Reduced Order Models (ROM) and Functional Mock-up Units (FMU). The finished system had to accommodate virtual sensors for variables which can't be physically measured on real systems, and also had to interface seamlessly with UKAEA's existing communication systems.



Altair IoT Studio leverages a web-of-things concept to connect plant operational data to physics-models and provides a visualization layer to get all the insights from the digital twin in real-time

Our Solution

The hosted (cloud agnostic) version of Altair IoT Studio formed the solution's backbone and analytic front end. It allows automation through serverless backend functions, data storage, edge connectivity to the operational systems, and advanced dashboarding capabilities that give users immediate insight.

The pilot phase used synthetic data to simulate the real-time data stream from operating plants into the IoT platform. Defined Python scripts trigger related physics models, which then process the data and return the results back to the IoT platform. A configured front end provides visual analytics highlighting event repercussions for better decision-making. Finite element analysis (FEA) models from multiple vendors, a commercial-grade fatigue analysis solver, and real-time weather data from OpenWeather were all connected to the IoT platform, and the Simulation Process Data Management (SPDM) system at UKAEA was linked to store the data models. Email (calendar requests for maintenance) and SMS (alerts) were also integrated to alert the operators to exceptional events (like seismic events).

Results

Altair IoT Studio helped Assystem create a seamless data flow between the plant and the physics-based models to create a true digital twin. Incorporating virtual sensors allowed engineers to make better decisions regarding support on fatigue damage and also helped calculate the remaining useful life (RUL). Insight into the impact of real loading conditions improved efficiency and maintenance schedules, further extending the plant's useful life. Lastly, using the original design models in the digital twin solution resulted in a higher return on Assystem's development investments.

To learn more, please visit **assystem.com/en/digital/digital-twin/** and **altair.com/digital-twin**.

The digital twin uses a cloud native IoT platform and visualization leveraging existing FEA models to drive critical decisions that improve plant operation and maintenance.