OPAL-RT TECHNOLOGIES

Success Story

Greener, smarter, better connected grids: Innovation at the SESA-Lab

The SESA-Lab (Smart Energy Simulation and Automation Laboratory) in Oldenburg is presenting an innovative approach to testing electrical systems of the future and is offering reliable solutions to help integrate green energy into our grids. In the context of increasingly complex grids, where numerous heterogeneous components must exist and communicate, OFFIS and the University of Oldenburg have developed an advanced and indispensable tool to test those components in “near” real conditions, thus decreasing their time-to-market. This technological gem, including the integration framework mosaik, is a ground-breaking real-time co-simulation platform.

1. Challenge

Better connected, more efficient grids...

The goal of every electrical grid is to deliver power to the consumer in the best, quickest, safest way with as little loss as possible. But, when renewable energy sources, which are by nature intermittent and unpredictable, are part of the grid everything gets complicated. Therefore, all grid elements must be able to communicate to ensure that controllable power sources can compensate for renewable energy sources’ unpredictable behavior as well as for varying user’s consumption.

… thanks to Information & Communications Technologies (ICT)

SESA-Labs’ principal mandate, and that of the OFFIS research institute on which it depends, is to analyze the complex interaction between the various grid components and also between the consumer and the power grid. These interactions correspond to messages intended to control one or more elements, to activate a protection system or to

optimize the grid's overall operation. Implementing these ICTs in this framework requires a great deal of feasibility testing and extreme precision, which is difficult to do in real conditions, for a number of reasons (risk of damaging the actual grid, lack of flexibility, costs, etc.).

2. Solution

A ground-breaking co-simulation platform

The idea was born in 2009 to develop a tool capable of virtually reproducing the entire grid and all its external environment by integrating existing hardware and software simulators and models. So the simulation of electrical grids was linked to real converters and market trends thanks to the newly developed tool, which allows for modelling scenarios representing a realistic electrical environment, complete with various characteristics and dynamics based on simulation orchestration.

The SESA laboratory called on OPAL-RT for the electrical aspect of the project. The OPAL-RT real-time simulator (eMEGAsim) performs the execution of highly detailed, dynamic power grid models on powerful processors. It allows the simulation of transient phenomena of the electric AC system, with accuracy up to 10 µs (100 KHz). This allows hardware in-the-loop (HIL) operation of real devices.

Using existing simulation models and hardware

Mosaik, as a flexible co-simulation framework, allows the reuse and combination of existing simulation models and simulators to create large-scale SmartGrid scenarios (thousands of simulated entities distributed over multiple processes). Mosaik is written in Python programming language and is now completely open-source.

The elements that are part of the complex co-simulated SmartGrid include real-time platforms, which can execute component models on MATLAB/Simulink® and standard industry components able to implement controllers (control and protection systems).

Standard Processes and Protocols
Ethernet and EhterCAT communication links are used to combine various systems, along with analogue and digital interfaces based on copper wires. This allows a flexible connection of the dynamic models without significant changeovers. Moreover, the mosaik interfaces allow the connection with infrastructures from external research partners. Last but not least, the SESA-Lab relies on integrated standard processes and protocols, such as IEC61850, OPC UA, CIM.

3. Conclusion

The SESA-Lab opened its doors in 2014, offering a ground-breaking open simulation platform to all European researchers and industrialists. The platform allows them to remotely test – using only an internet connection - their electrical components in a virtual grid that identically reproduces all the characteristics of a real electrical grid. The feat is that the simulation does not only reproduce power grid characteristics thanks to the OPAL-RT's power grid simulator, but also its environment: market fluctuations, legislation and even weather conditions.

For more information on mosaik, visit http://mosaik.offis.de/