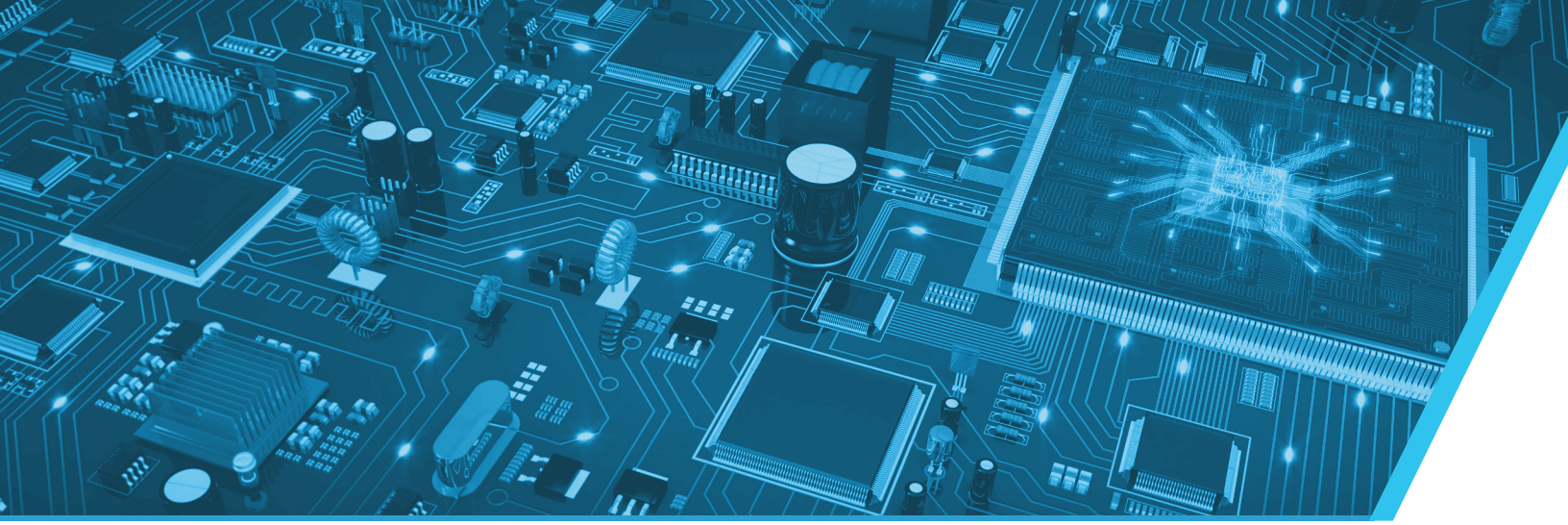


OPAL-RT TECHNOLOGIES

University of Alcalá: External primary control in power electronics applications

Universidad de Alcalá

GEISER

velox POWER SUPPLIES

Application

- Energy conversion

Related Products

- RT-LAB
- eHS | FPGA-based Power Electronics Toolbox
- OP5707XG

Type of Simulation

- Hardware-in-the-Loop

SUCCESS STORY

INTRODUCTION

The University of Alcalá *(Universidad de Alcalá)* is a Spanish public university located in Alcalá de Henares. The GEISER group belongs to the University of Alcalá and it is located 25kM from the capital of Spain and is one of the most relevant power electronics laboratories in Europe. It has developed more than a dozen power converter systems in the last years, showing great experience in the energy area.

This project results from years of collaboration between the GEISER group of the University of Alcala and OPAL-RT to **improve the capabilities of Hardware-in-the-Loop (HIL) systems.** In addition, the Velox-PS company is sponsoring the project proving the great interest of this concept in the private energy sector.

Velox-PS is a young company in the energy sector. It unites more than 15 years of experience in designing converters and control systems. It provides adaptable power electronics solutions, offers power design projects, and builds customised testing laboratories, high power supplies, power quality stations, and traction solutions.

University of Alcalá/GEISER and Velox-PS members in the GEISER's power electronics laboratory

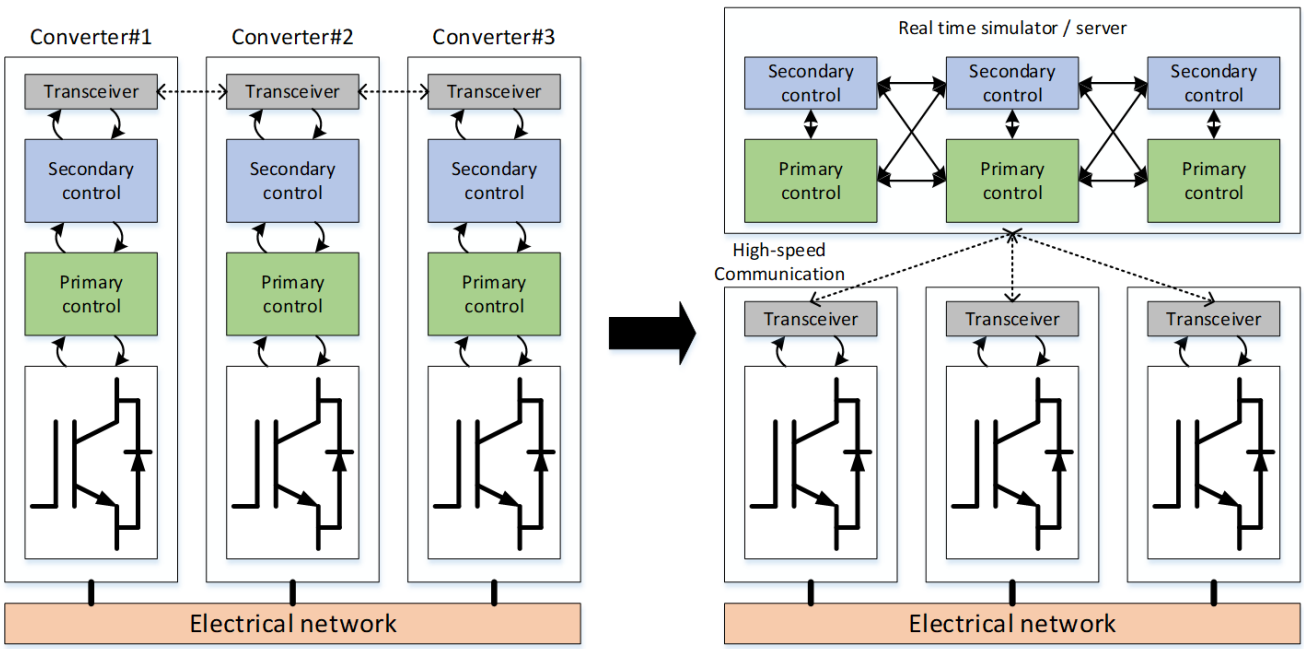
OBJECTIVE

Typically, the control of energy equipment is divided into two types: primary control and secondary control. The main difference between them is the speed at which they act. The primary control is usually integrated locally, as it is the control that should act the fastest. It is focused on ensuring that the equipment works according to control references or setpoints. Secondary control is slower and higher-level control. Its task is to change the primary control references to reduce deviations or errors on a permanent regime. As the secondary control is slower than the primary control, usually it is implemented in external equipment.

The main goal of our work is to run the primary control outside the converter. That is, to run it on an external real-time simulator or an external server. This proposal represents a paradigm shift in power equipment management as it centralises the primary control of multiple devices on a single server and reuses the control system's resources.

Since primary control can now be externalised, now it is possible to use real-time simulation system to verify any novel control algorithm. It is no longer necessary to re-program the power equipment when the control algorithm is changed. It is now possible to use OPAL-RT's advanced automatic code generation techniques for this purpose.

This requires the creation of a fast and reliable communication interface between the power systems. Thanks to advances in the telecommunications industry, mature platforms are now available that allow high-speed communication channels. These high-speed communications achieve rates from 1 Gbits up to 100 Gbits. One of the most widely used high-speed communication channels in the telecommunication industry is based on SFP (small form-factor pluggable) transactors with optical fibre. Optical fibre is immune to electromagnetic interference, which is essential for power equipment. These types of systems are a huge source of interference. It also maintains galvanic isolation between power equipment and allows long-distance communication.



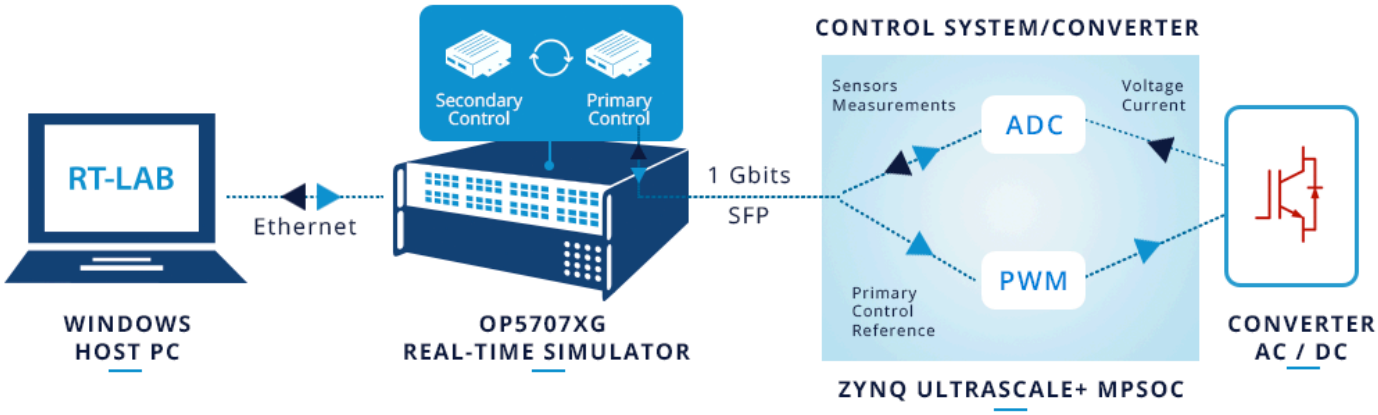
SOLUTIONS & DEVELOPMENT

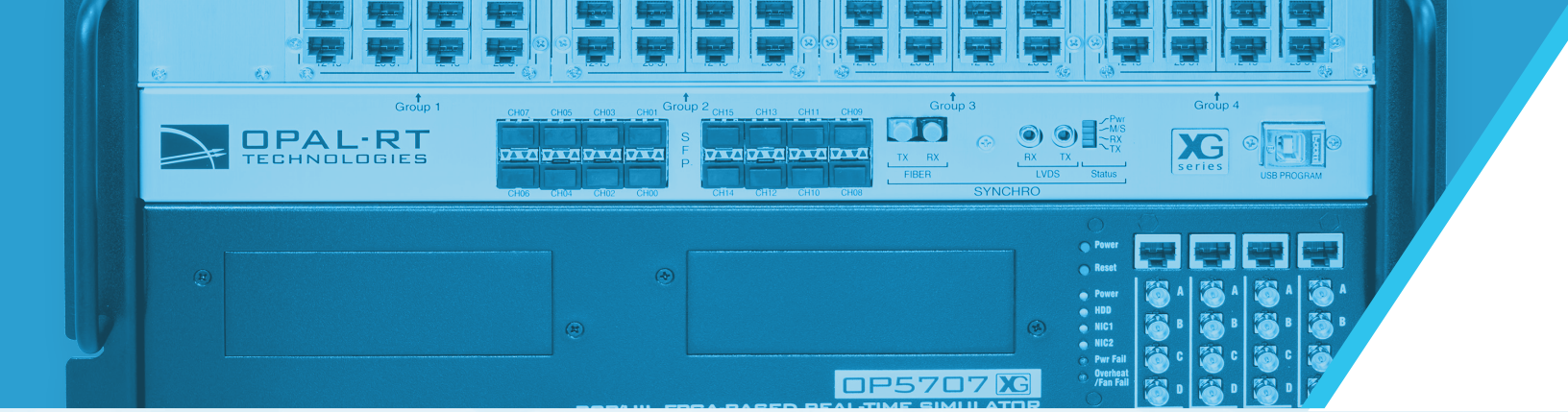
The proposed external control system consists of two platforms: the converter control system and an external real-time simulator with sufficient computing power to run the primary and secondary control algorithms with very low latency. Communication between the converter and the external real-time simulator must be high-speed.

The chosen real-time simulator is the OP5707XG from OPAL-RT. This system allows direct use of Matlab/Simulink models to implement the control algorithms in the real-time simulator. This makes it an exceptional tool for testing novel control algorithms.

The converter control system consists of three main modules. The acquisition module or ADC is responsible for obtaining the voltage and current measurements from the sensors of the converter. The SFP module is in charge of packaging the information from the sensors and sending it through the SFP communication channel to the real-time simulator. Finally, the PWM module takes the control references from the real-time simulator and applies them. As a result, the PWM signals that control the IGBTs of the converter are obtained.

The speed of the whole system is critical. Efforts are made to minimise the latency of the SFP channels and to ensure that the primary and secondary control is executed within the time constraints. Currently, it is working with control periods of around 100 us.





RESULTS

The results demonstrate that it is possible to externalise the primary control of control systems in power electronics applications. It also provides an excellent fast prototyping system for research purposes.

This project has been made possible thanks to OPAL-RT's OP5707XG simulator architecture, which allows the use of up to 5Gbit communication channels via 16 SFP channels.

"We believe that OPAL is currently the most mature real-time simulator distributor on the market. We have been working with their equipment for years and they have allowed us to carry out multiple studies and doctoral theses.

OPAL-RT allows us to emulate both the control plant and our control system and insert it into a real system. This is vital to verify that the whole real plant with our control system is working correctly."

Edel Diaz Llerena, associate professor and Research Manager

Watch the webinar "Real-Time Simulation of Complex Converters Models and Fast Converter Start-Up" and learn more about this project. **Watch now >**