



OPAL-RT
TECHNOLOGIES

Success Story



OPAL-RT Assists CEPRI in Building Next- Generation Simulation Platform

1. Context

The rapid development of electric power grids in China has increased concerns about operational safety. More and more large-scale power grids are turning to real-time simulation technology to prevent outages and to increase security.

China Electric Power Research Institute's (CEPRI) simulation center is responsible for building a new-generation simulation platform. OPAL-RT's OP5607 was used to interface the HYPERSIM real-time simulator and the control and protection (C&P) replica of the new-generation high voltage transmission networks, including LCC-HVDC, LCC-UHVDC and MMC.

The OP5607 is an I/O expansion unit based on the Xilinx Virtex-7 FPGA, and can provide up to 256 additional I/Os and the high-speed SFP communication links often used to connect HYPERSIM to the real C&P device in a variety of configurations.

HYPERSIM is a large-scale digital real-time simulation system that can simulate thousands of nodes and components. This system can use an SGI high-performance computer to calculate power system transient models in real time, and run the hardware-in-the-loop (HIL) tests on the actual C&P devices with the OP5607. It can also acquire online data from an automation dispatching or SCADA system, and perform closed-loop simulation tests of protection relays, system security devices, FACTS or HVDC transmission C&P systems.

2. Challenge

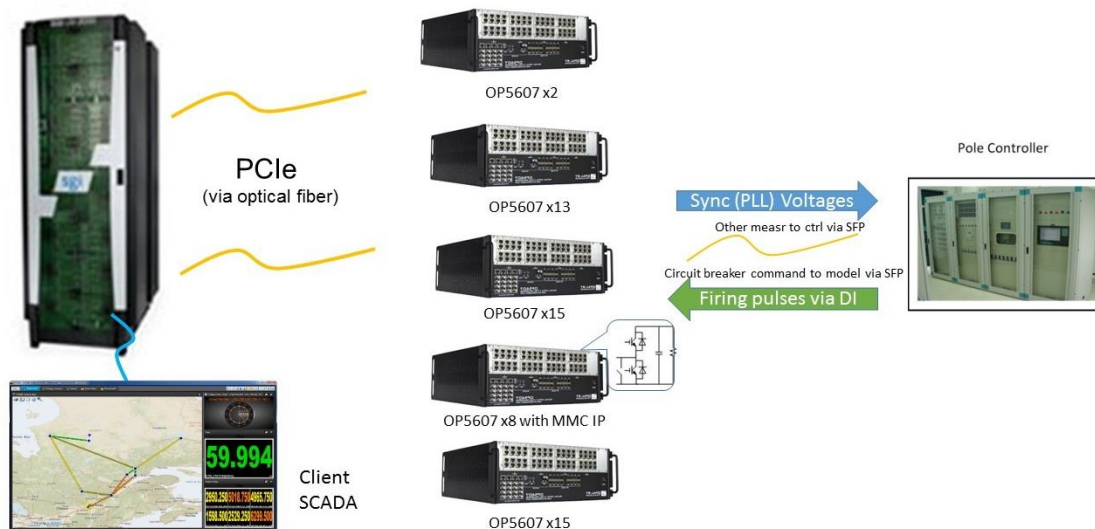
With the construction of the ultra-high-voltage DC interconnected national power system and the commissioning of long distance transmission with increasing capacity, the operating characteristics of large scale grid becomes more and more complex. However, since HVDC control and protection devices have too many panels with scattered I/O signals, traditional digital and analog I/O interfaces will result in very high costs and a large amount of wiring work. This could cause issues when simulating various power grid characteristics by connecting more than ten HVDC C&P systems at the same time.

3. Solution

The China Electric Power Research Institute (CEPRI) simulation center is establishing a large hybrid real-time simulation platform for AC-DC grid, which provides technical support for the planning, construction and safe operation of national grids, and improves the simulation capacity of large scale AC-DC power systems from multiple perspectives.

Real-time simulation of complex electrical networks on parallel CPU cores.

System Overview



The HIL simulator for this new simulation platform was developed by the CEPRI simulation center, which has already built several test rigs, such as a fully digital simulation platform, a physical analog test bench, hybrid digital analog simulation, and an operation and security monitoring platform. The lab also possesses a complete physical test bench and a fully digital simulation system that could cover four $\pm 500\text{KV}$ bipolar long-distance HVDC transmission systems, two $\pm 800\text{KV}$ bipolar long-distance HVDC transmission systems, one MMC-HVDC transmission system, as well as a variety of AC systems including UHVAC system. The OP5607 provided by OPAL-RT has a large amount of SFP connectors, which can transmit the measurements acquired from the simulated grid in real-time to the physical HVDC control and protection system with a speed of up to 5Gbps, and receive the control commands from the control and protection system. These unique SFP connectors can connect almost all the signals in the real-time model (except for thyristor firing pulse and synchronous voltage phasor acquisition) to the real C&P devices, which not only reduces connection work, but ensures the fast and accurate communication between all C&P systems under test and the real-time simulator, thus providing a powerful solution to HIL test of more than 10 UHVDC C&P systems simultaneously.

4. Results

This HIL simulation lab will allow accurate simulation of the backbone of the State grid structure and all existing HVDC links before 2018, and accomplish tasks such as calculations and evaluations for different operating modes and incident analysis. The lab will also improve the knowledge and the ability to control and manage the power system, thus providing more powerful support to the construction of Chinese UHV AC/DC grid and even to global energy interconnection networks.