OPAL-RT TECHNOLOGIES

SUBSTATION AUTOMATED TRAINING SIMULATOR (SATS)

Dominion Energy®

Application

- Substation Automation

Related Products

- HYPERSIM

Type of Simulation

- Hardware-in-the-Loop (HIL)

SUCCESS STORY

INTRODUCTION

Partnering & Development Well Into the 21st Century

Since 1997, OPAL-RT has committed itself to cultivating a diverse clientele within the electric utility sector, spanning energy production, distribution, forecasting, and management. This focus is vital for both OPAL-RT and its partners, addressing the rapidly evolving electric utility landscape that compels today's companies to function in areas of interest and operational concentrations far exceeding the scope of those from just 50 years ago.

An example of innovation in this landscape is Dominion Energy, which showcases leadership in power system training through the successful implementation of Simulator HYPERSIM for their **Substation Automation Training Simulator (SATS)**.

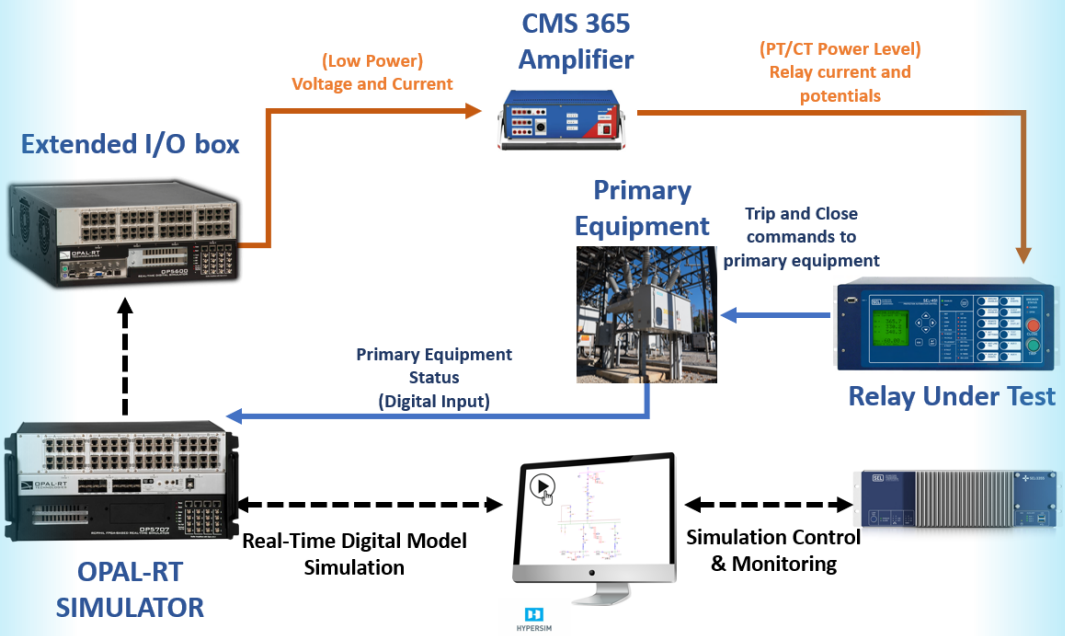
The cutting-edge technology featured in SATS demonstrates industry excellence and highlights the effectiveness and reliability of HYPERSIM in real-world applications. OPAL-RT takes pride in contributing to Dominion Energy's pioneering initiatives.

Dominion Energy in Brief

Dominion Energy Virginia owns and operates significant transmission, generation, and distribution assets, employing over 17,000 people and serving approximately 7 million customers across 15 states.

As of December 31, 2022, Dominion Energy's portfolio of assets includes approximately 31.0 GW of electric generating capacity, 10,600 miles of electric transmission lines, 78,500 miles of electric distribution lines and 93,500 miles of gas distribution mains and related service facilities, which are supported by 4,000 miles of gas transmission, gathering and storage pipeline.

Currently, Dominion Energy is actively involved in planning, building, and maintaining some large clean-energy projects, including the 2.6-GW Coastal Virginia Offshore Wind project, set for completion in 2026.



The Substation Automated Training Simulator (SATS)

In 2021, Dominion Energy installed a new training simulator, the Substation Automated Training Simulator (SATS). **SATS is state-of-the art training environment**. It is flexible enough to **store and recall hundreds of transmission or distribution simulations**. SATS is also very flexible and can provide **realistic training based on specific classes**.

SATS incorporates an OP5700 simulator, 4 OP5600 expansion boxes, with 24 Omicron Power Amplifiers that are mounted on 5 equipment panels. Adjacent to the protective relay panels is a dedicated simulator room which houses patching panels for easy system reconfiguration. The system is directly connected to the protective relay equipment panels and primary equipment.

The closed loop system is versatile enough to train engineers on abnormal, yet realistic, power system situations. It seamlessly replicates the power system response while switching primary substation equipment. This provides a method to validate entire protection schemes, including equipment wiring, individual protective relay settings, and overall device coordination.

A Sit-Down Talk with Ms. Genesis Alvarez of Dominion Energy

During our annual conference, OPAL-RT spoke in-depth with **Ms. Genesis Alvarez**. The discussion covered Dominion Energy's emphasis on sustainable resources, its advanced protection and control schemes, the advantages of real-time simulation training, the introduction of the OPAL-RT platform, and Dominion Energy's vision for a promising and collaborative future.

Ms. Alvarez holds both bachelor's and master's degrees in electrical engineering from Florida Atlantic University and Virginia Tech, respectively. She is an Engineer III at Dominion Energy, and actively involved in the development and deployment of power systems models in hardware-in-the-loop systems for training environments.

OPAL-RT TECHNOLOGIES

OBSTACLES & TRAINING BENEFITS

Risk Factors Implementing Protection/Control Systems & Mitigation

OPAL-RT: *Since Dominion Energy has embarked on the transition to more renewable energy sources and more complex protection and control schemes, can you highlight some of the key risk factors that might impact operations and uninterrupted service to clients? And how these factors might be mitigated?*

Genesis Alvarez (GA): One of the challenges is that some of our photo-voltaic (PV) sites are located in a low system strength area, which can cause voltage issues. To mitigate that, Dominion has installed FACTS (Flexible AC Transmission Systems) devices on both the distribution and transmission sides. FACTS are power electronics devices that can increase power transfer capacity, conduct voltage control, and mitigate licker. Overall, FACTS devices provide grid stability and improve power quality.

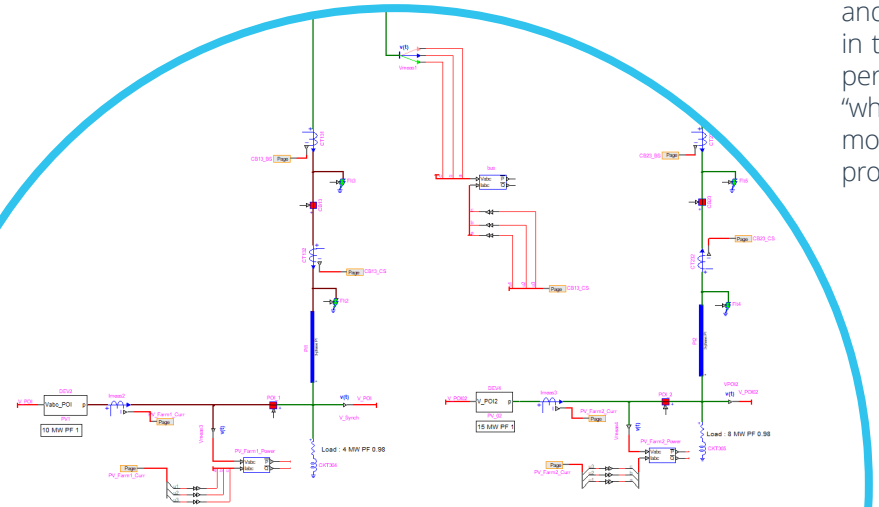
Another issue is that as more Inverter-Based Resources (IBRs) come online, inertia and system strength are lowered. This can impact frequency and voltage stability. Fault current contribution from the IBRs is minimal compared to the contribution from conventional synchronous machines.

Having distributed energy resources on the grid can also cause a considerable change in the fault current magnitude, which, on the distribution side, challenges conventional protection and automation practices. Having a training program that addresses these evolving changes becomes crucial. We're modeling some of our PV sites within our grid and incorporating the models in our training program. This will provide our system protection technicians with the chance to observe relay response and coordination during a fault event.

The Importance of Training with Real-Time Simulators and Their Benefits

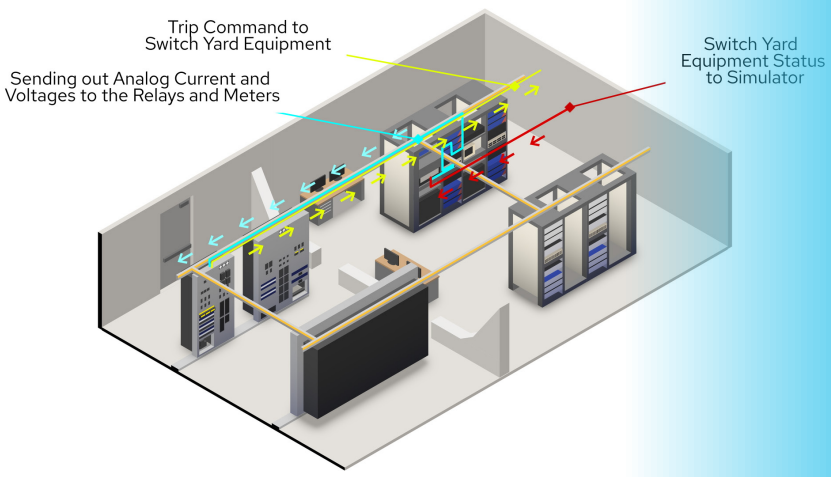
OPAL-RT: *Why is training with real-time simulators so important and what can they bring that, say, a theoretical or non-simulated training environment cannot?*

GA: We incorporated the Substation Automated Training Simulator in our training programs to provide students with a realistic training experience without the hazard of transmission and distribution primary-level voltage. We use SATS primarily as a training tool to replicate a transmission substation with its protection equipment and to evaluate the relays' actual performance. This closed-loop system enables a simulation to seamlessly replicate the power system response while trainees are switching primary substation equipment.



Beyond that, SATS provides a method to validate an entire protection scheme, including equipment wiring, individual protective relay settings, and overall device coordination. In the control house, trainees can switch in a circuit switcher, or they can use a Motor-Operated Air-Break (MOAB) switch to demonstrate a realistic switching order. SATS allows for the development, storage, and execution of countless simulations that can demonstrate normal substation conditions, a variety of fault conditions (phase-ground, phase-phase, 3-phase, etc.), and common error conditions, such as incorrect CT connections, phasing, or ratios.

Our old simulator did not have this flexibility. A real-time simulator enhances the trainees' learning experience and prepares them for practical issues that may occur in the field. Having this experience will reduce human performance errors. We can introduce many and varied "what if?" scenarios. We are also implementing distribution models in addition to our transmission simulations. This project has been great for all the instructors and students.



"Our training was excellent in terms of preparation... Various departments rolled up their sleeves and helped ***company-wide."***

TRAINING APPROACH

Introduction of Platform & New Training Approaches

OPAL-RT: *What was your experience of introducing this platform, especially considering this is an innovative approach to training for your organization?*

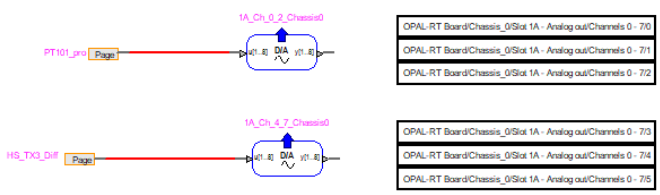
GA: It was challenging at first. We had no knowledge of the HYPERSIM software or the OPAL-RT hardware platform. In 2020, we went as a team to train at OPAL-RT, and we built our system from the ground up.

Initially, we had some minor pushback because we had no firm idea of what our exact training implementation would be. But I'm happy to say that it ended up as a **fully collaborative effort**. Various departments throughout Dominion Energy supported this initiative: the instructors at the Training Center helped with an applied curriculum; we had our IT and Tech Support folks help us remote-login to the Training Center. Our System Protection team did the relay settings, and I created the HYPERSIM models for the system.

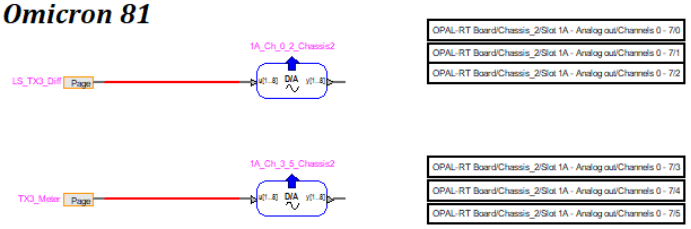
Now everybody clearly sees **the SATS capability and the flexibility it has given us to develop diverse case scenarios**. The project has been recognized by our industry peers with the Chairman's Excellence Award in the training category at the Southeastern Electric Exchange Conference.

The SATS project has expanded beyond training field operators. We also now have interns working on model development, and they are writing and publishing conference papers. It is an exciting time for us.

Omicron 41



Omicron 81



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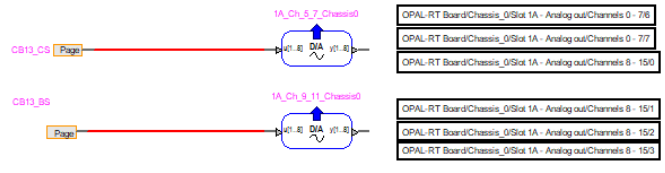

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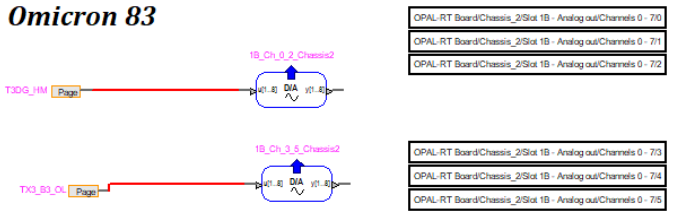

CONCLUSION

Upcoming Plans for HYPERSIM & the Platform Within Dominion

OPAL-RT: *Thanks for this detailed reporting back, and for speaking with us, Ms. Alvarez! Can you expand a little on what is planned for the future?*

GA: We are looking forward to installing a new control house with training for IEC 61850. We are expanding the reach of our new expertise beyond protection technicians to other groups in the company. Our system protection group, who is responsible for creating our relay settings, and our fault analysis team, will all benefit from this training.

As the complexity of today's power system intensifies, it is essential to have a system protection training program that can **adapt to evolving changes** and **accurately replicate a realistic environment**. Dominion Energy stands at the forefront of this initiative, developing real-time models to conduct closed-loop tests. Dominion Energy's collaboration with OPAL-RT will revolutionize the way they inform and educate their stakeholders.

"Our old simulator did not have real-time simulation capabilities, and so we simply did not have the flexibility that we do now to introduce many and various 'what if' case scenarios. We can now model our distribution portion as well as our transmission—it has been great for us in the system protection technical training program, both for all the instructors and the students."

Ms. Genesis Alvarez, Engineer III at Dominion Energy