ATC
RTDS APPLICATIONS & TECHNOLOGY CONFERENCE

2025 NORTH AMERICA

RTDS® TECHNOLOGIES APPLICATIONS & TECHNOLOGY CONFERENCE

May 6 - 8, 2025 • Navy Pier • Chicago, Illinois, United States

RTDS Technologies / AMETEK®

WELCOME TO Chicago

CONTENT

Dear Delegates,

We welcome you to the RTDS Technologies North American ATC 2025 in Chicago, Illinois! We are excited to host you at this anticipated conference, which brings together our valued customers and partners all over North America, and other parts of the world.

In attending this event, you'll hear from fellow RTDS Simulator users who are pushing the boundaries of innovation. Your expertise and leadership have helped shape our technology over the years, and we are excited to continue advancing alongside you as we look toward the future of the power industry.

Thank you for joining us for this meeting, and we hope you enjoy both the conference and the vibrant city of Chicago. Don't forget to explore ComEd Maywood Technology Center Laboratory during your visit.

Cheers,
The RTDS Technologies Team

RTDS Technologies
AMETEK

EVENT INFO

VENUE

Navy Pier
600 E Grand Ave,
Chicago, IL 60611 United States

ENTRANCE 2, ROOM 207

REGISTRATION & LIGHT BREAKFAST

8:00 - 9:00 A.M.

MEALS

Morning and afternoon refreshments, as well as lunch will be provided for delegates each day.

ComEd LAB TOUR

Wednesday, May 7
2:00 P.M. - 5:00 P.M.
Transportation is provided.

Enjoy a tour of ComEd Maywood Technology Center Laboratory to experience their state-of-the-art facilities and cutting edge innovations shaping the future of energy. This is for pre-registered delegates only.

NETWORKING EVENT

Join us at The Chicago Sports Museum & Harry Caray's 7th Inning Stretch! Enjoy engaging conversations, delicious food, and the vibrant atmosphere of Chicago's iconic sports history.

ADDRESS & DATE:
The Chicago Sports Museum
Water Tower Place, 835 N. Michigan Avenue
Tuesday, May 6 , 6:00 P.M. - 9:00 P.M.

RTDS TEAM

KATI SIDWALL

Kati Sidwall holds a B.Eng in Sustainable and Renewable Energy Engineering from Carleton University, Canada. She founded the annual Carleton University Green Energy Symposium in 2010. In 2012, she received the Canadian Solar Industries Association's Emerging Leader Award. She currently serves as the Technical Marketing Manager at RTDS Technologies Inc.

Cyprian Peters received his B.Sc. Degree in Electrical Engineering from the University of Manitoba, Canada in 2010. Following graduation, he joined RTDS Technologies where he currently holds the title of Technical Sales Manager. Cyprian has full sales & customer relations responsibility for multiple geographic regions and has travelled to over 45 countries to market, sell, and commission real time simulators.

CYPRIAN PETERS

CHRISTIAN JEGUES

Christian Jegues joined RTDS Technologies Inc. in 2014 after receiving his Bachelor of Science degree in Electrical Engineering from the University of Manitoba, Canada. Since joining, Christian has been involved in a wide range of tasks such as customer support, on-site commissioning and training courses, and model development. Christian is the applications leader for the Renewable Energy, Microgrids, Distribution Systems and Power Hardware-In-the-Loop (PHIL) applications.

Gregory Jackson holds a M.Sc.EE degree from the University of Manitoba with a focus on Power System Engineering. He joined RTDS Technologies in 2008 and currently serves as a Principle Simulation Engineer with the company. Greg has a lot of experience developing simulation cases for the RTDS Simulator and has recently taken on the role of project lead for the redevelopment of the RSCAD FX software suite.

GREGORY JACSON

HEATHER MEIKLEJOHN

Heather Meiklejohn received her B.Sc. degree in Electrical Engineering from the University of Manitoba in 1996. After graduation she joined RTDS Technologies. She has been involved in many different areas of RTDS over the years and currently holds the title of 'Manager Customer Support & Development. Heather is a registered professional engineer in the province of Manitoba, Canada.

KEYNOTE SPEAKER

Dr. Mohammad Shahidehpour
Illiniois Institute of Technology

Tuesday, May 6

AGENDA

MORNING

8:00 - 8:45	**REGISTRATION & LIGHT BREAKFAST**
8:45 - 9:00	Welcome Message - Kati Sidwall & Kelly McNeill, RTDS Technologies
9:00 - 9:30	Keynote speech - Mohammad Shahidehpour, Illiniois Institute of Technology
9:30 - 10:00	**USER PRESENTATION 1:** Emerging RTDS HIL Use cases in Microgrids, BESS, and Data Centers **Presented by:** Mohsen Hosseinzadehtaher & Ahmad Momeni, Quanta Technology
10:00 - 10:30	**NETWORKING BREAK**
10:30 - 11:00	**USER PRESENTATION 2:** Application of RTDS Simulator for Real-Time Large-Scale Power System Hybrid Electromagnetic-Transient and Phasor-Domain Simulation **Presented by:** Ning Lin, Powertech Labs
11:00 - 11:30	**USER PRESENTATION 3:** PHIL testing at CAPS over the last 5 years **Presented by:** Harsha Ravindra, Florida State University
11:30 - 12:00	**RTDS PRESENTATION 1:** New Python Scripting Feature in RSCAD FX **Presented by:** Gregory Jackson, RTDS Technologies

AFTERNOON

12:00 - 1:00	**LUNCH**
1:00 - 2:00	**USER PRESENTATION 4:** Overview of SCE's Bulk Power RTDS Model and HIL Integration with SVC Replica Controller **Presented by:** Venkat Lakshminarayanan, Nayak Corporation & Joshua Park, Southern California Edison
2:00 - 2:30	**USER PRESENTATION 5:** Validation and system integration of the GTSOC model for IBR controller **Presented by:** Lung-An Lee, Dominion Energy
2:30 - 3:00	**USER PRESENTATION 6:** Developing Dynamic Models for Nuclear-based Small Modular Reactors for load-following operation and electrical-side transient/dynamic analysis of the SMR power plants **Presented by:** Ramakrishna Gokaraju, University of Saskatchewan
3:00 - 3:30	**NETWORKING BREAK**
3:30 - 4:00	**USER PRESENTATION 7:** Testing of busbar protection in a IEC 61850 based digital secondary system **Presented by:** Md Aamir Rahmani, Schweitzer Engineering Laboratories

6:00 PM - 9:00 PM NETWORKING EVENT

Wednesday, May 7

AGENDA

MORNING

8:30 - 9:00	**REGISTRATION & LIGHT BREAKFAST**
9:00 - 9:30	**USER PRESENTATION 8:** Virtual Reality-Augmented RTDS-Based Digital Twin for Grid Operator Training **Presented by:** Ali Mehrizi-Sani, Virginia Tech
9:30 - 10:00	**USER PRESENTATION 9:** Development of large-area AC network model for HIL testing of a Wide-area Protection Scheme **Presented by:** Hiranya Suriyaarachchi & Akbo Rupasinghe, TransGrid Solutions
10:00 - 10:30	**NETWORKING BREAK**
10:30 - 11:00	**USER PRESENTATION 10:** Enhancing Inverter Performance through CHIL Testing and Ensuring Grid Compliance **Presented by:** Jigarkumar Gorasiya, Enerzingx
11:00 - 11:30	**USER PRESENTATION 11:** DER Inverter Control Fault Ride Through Model in Accordance with IEEE 1547-2018 Std **Presented by:** Mark Booge - Western Michigan University
11:30 - 12:00	**USER PRESENTATION 12:** Use of power hardware-in-the-loop and controller hardware-in-the-loop to de-risk the use of grid-forming fuel cell inverter in microgrids **Presented by:** Kumaraguru Prabakar, National Renewable Energy Laboratory

AFTERNOON

12:00 - 1:00	**LUNCH**
1:00 - 1:45	**RTDS PRESENTATION 2:** Recent Developments for the RTDS Simulator **Presented by:** Cyprian Peters, RTDS Technologies
2:00	Leave for ComEd Maywood Technology Laboratory Tour
5:00	Return to Navy Pier

Thursday, May 8

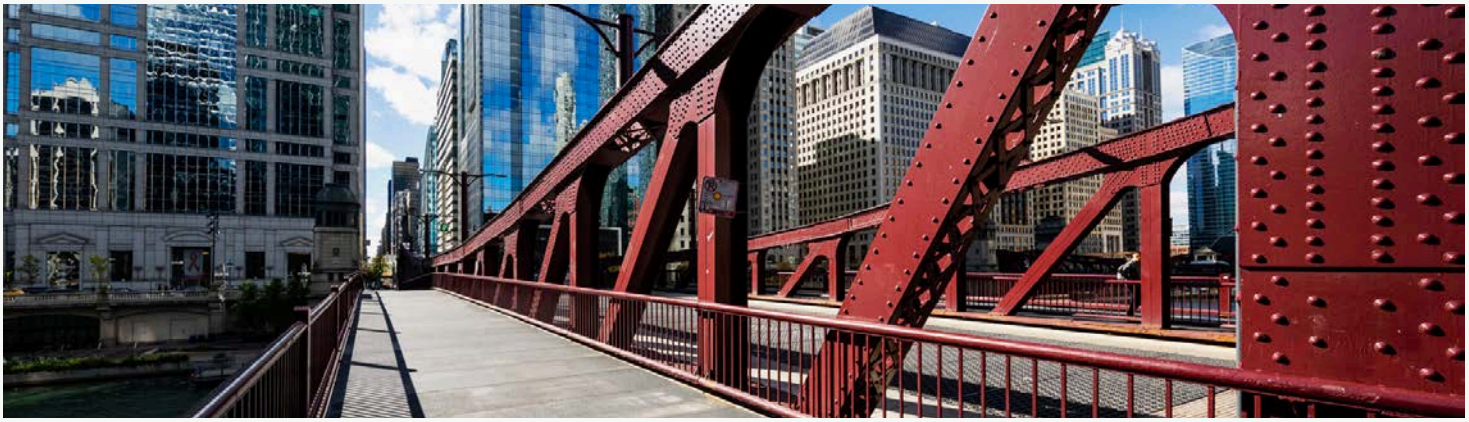
AGENDA

MORNING

08:30 - 09:00	**LIGHT BREAKFAST**
09:00 - 09:30	**USER PRESENTATION 13:** A Comparison of IEC 61850-Based Digital-HIL and Analog-HIL Using RTDS **Presented by:** Omar Alamr, Mutah University
09:30 - 10:00	**USER PRESENTATION 14:** Mitigating the Impact of Geomagnetically-Induced Currents on Transformer Protection **Presented by:** Leila Chebbo, Dominion Energy
10:00 - 10:30	**NETWORKING BREAK**
10:30 - 11:00	**USER PRESENTATION 15:** Use of RTDS in executing HVDC and FACTS projects by Siemens Energy **Presented by:** Davendra Kumar, Siemens Energy
11:00 - 11:30	**USER PRESENTATION 16:** A Real-Time Cyber-Physical System Testbed for Studying the Impact of Cyberattacks on a Synthetic Power Distribution System **Presented by:** Karen Butler-Purry, Texas A&M University
11:30 -12:00	**USER PRESENTATION 17:** Power-Hardware-In-the-Loop Validation of Synchronous Wind: An Inverterless Grid-Forming Wind Power Plant **Presented by:** Weihang Yan, National Renewable Energy Laboratory

AFTERNOON

12:00 - 1:00	**LUNCH**
1:00 - 2:00	**RTDS PRESENTATION 3:** New Frequency Scan Tool in RSCAD FX **Presented by:** Heather Meiklejohn, RTDS Technologies
2:00 - 2:30	**USER PRESENTATION 18:** Partial Virtual DIM and application **Presented by:** Harsha Ravindra, Florida State University



PRESENTATIONS

Tuesday

01 Emerging RTDS HIL Use cases in Microgrids, BESS, and Data Centers

09:30 AM - 10:00 AM

Mohsen Hosseinzadehtaher & Ahmad Momeni, Quanta Technology

This presentation will share practical experiences with emerging use cases of Real-Time Digital Simulator (RTDS) Hardware-in-the-Loop (HIL) testing in Microgrids, Battery Energy Storage Systems (BESS), and Data Centers. It aims to demonstrate the critical role of HIL testing in de-risking and accelerating the deployment of advanced grid technologies, emphasizing its advantages from utilities, Tech companies, and renewable energy developers' perspectives. We will present field-validated use cases where RTDS-HIL platforms were deployed to test and verify protection and automation schemes, conduct fault studies in both grid-connected and islanded modes, and assess black start and load restoration capabilities. Use cases involving microgrid controller validation in accordance with IEEE P2030.8 operating modes, including grid-connected operation, islanding, reconnection, and black start, will also be covered. Additional applications include HIL-based testing of Power Plant Controllers (PPCs) and Energy Management Systems (EMSs) for inverter-based resources, DERMS integration, communication performance evaluation, smart inverter functionality, and studies on the coordination of multiple inverter-based resources.

02 Application of RTDS Simulator for Real-Time Large-Scale Power System Hybrid Electromagnetic-Transient and Phasor-Domain Simulation

10:30 AM - 11:00 AM

Ning Lin, Powertech Labs

Massive integration of power electronic devices including inverter-based resources (IBRs) into power systems has significantly prompted electromagnetic transient (EMT) simulation for great insight. An RTDS simulator offers a tremendous simulation advantage over its offline EMT counterparts by incorporating external equipment for real-time hardware-in-the-loop testing. This presentation demonstrates that RTDS simulators can run real-time simulations concurrently with phasor-domain transient stability analysis tools. As a result, hardware-in-the-loop simulation can be carried out in the context of large-scale power system planning, scheduling, and operation. The IEEE 39-Bus System and a real case with over 5000 buses are used as two benchmarks to illustrate procedures to perform real-time power system study using both RTDS and the transient stability analysis tool TSAT. Results show that with the RTDS simulator being able to simulate in conjunction with another tool, more comprehensive evaluations can be made based on both system- and device-level details that are subsequently revealed in different domains. In particular, due to the ability of RTDS simulators to deploy detailed models including but not limited to HVDC, FACTS, and IBRs, the hybrid simulation has wide applicability to satisfy various purposes in the power sector.

03 PHIL testing at CAPS over the last 5 years

11:30 AM - 12:00 PM

Harsha Ravindra, Florida State University

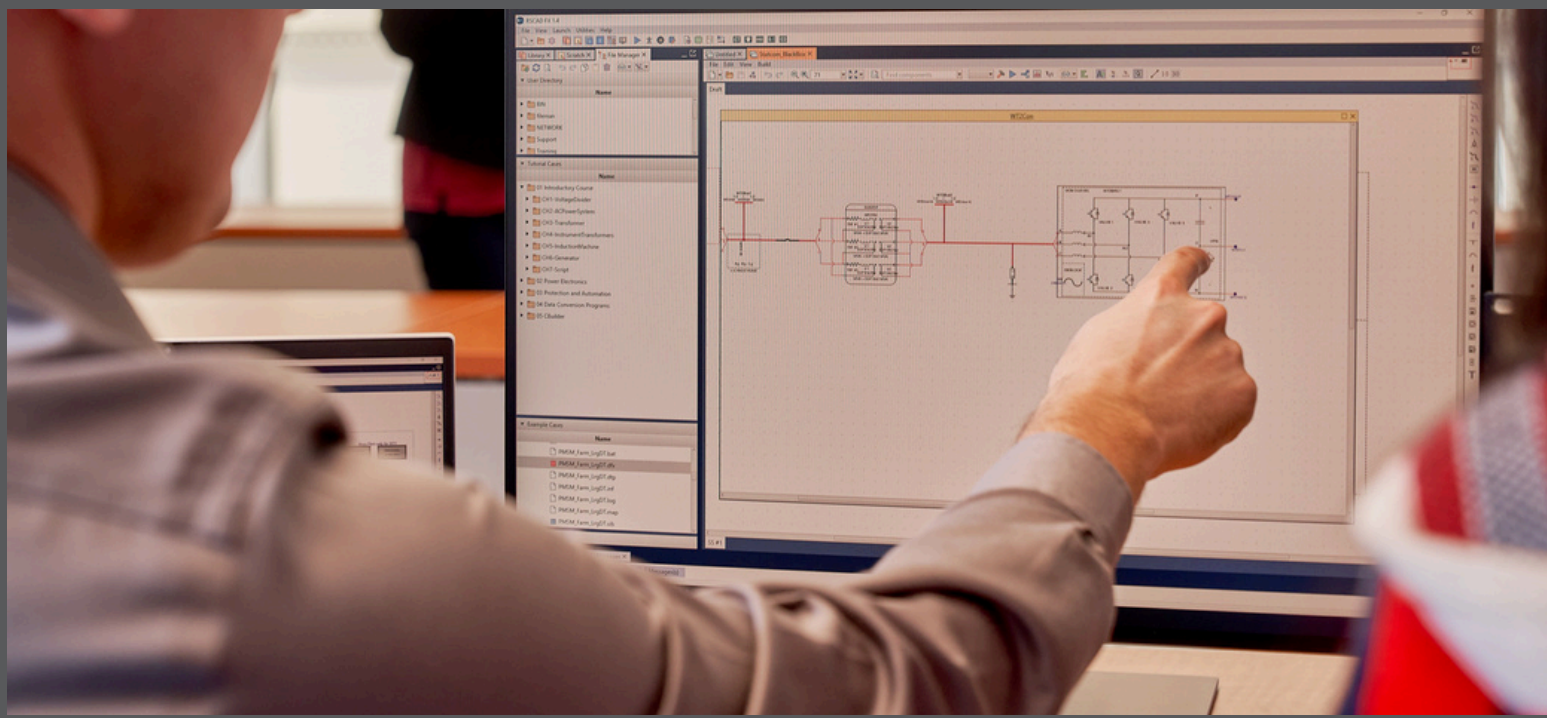
This talks covers power hardware-in-the-loop (PHIL) testing at CAPS over the last 5 years that includes testing of a 3 MW diesel generator (DG) in PHIL where in the DG was connected to a power amplifier emulating different loading conditions , testing of multiple energy magazines (EM) and islanded microgrid PHIL.

RTDS Presentation 1: New Python Scripting Feature in RSCAD FX

1:00 PM - 2:00 PM

Gregory Jackson, RTDS Technologies

This presentation will give an overview of the new Python scripting API that was recently added to RSCAD FX. The Python scripting implementation is a replacement for our legacy C-based scripting. In its simplest form, scripting allows users to automate the running of simulation cases and the collection of simulation results. More complicated applications include analysis of simulation results, adaptive testing and report generation. The addition of the Python API opens up new opportunities for users to leverage the abilities of third-party Python packages and incorporate them into their simulation work. Packages like Matplotlib, NumPy, SciPy and TensorFlow offer interesting possibilities for displaying and analysing simulation data. The presentation is targeted at novice users and aims to give all the information needed to get started with recording and modifying Python scripts in RSCAD. Some new capabilities of Python scripting relative to legacy scripting will be highlighted and a few examples will be shown.



04 Overview of SCE's Bulk Power RTDS Model and HIL Integration with SVC Replica Controller

2:00 PM - 2:30 PM

Venkat Lakshminarayanan, Nayak Corporation & Joshua Park, Southern California Edison

Southern California Edison (SCE) initiated the development of a Real-Time Digital Simulator (RTDS) model of its bulk power transmission network to support transmission-level studies, including Hardware-in-the-Loop (HIL) testing. The original model was developed using earlier versions of RSCAD for PB5 rack-based RTDS systems and was distributed across 14 subsystems (racks), interconnected through transmission lines. It captured the complete 230 kV and 525 kV systems, along with selected 345 kV, 115 kV, and lower voltage buses. Since the model's initial development, the SCE transmission system has undergone significant changes. With renewed interest from various departments in leveraging the model for advanced studies, the original model was updated to reflect the latest network configuration and migrated to the NovaCor platform. The updated model has been validated for both power flow and short-circuit strength, providing a solid foundation for further analysis. This model was used for HIL testing of a Static Var Compensator (SVC) replica controller as part of the SVC upgrade project at one of the SCE Substations. The findings of these tests helped update the SVC control, and it was successfully commissioned in the field. This presentation will outline the key steps, challenges, and strategies involved in developing and updating SCE's bulk power RTDS model, as well as the integration of the SVC replica controller for HIL testing.

05 Validation and system integration of the GTSOC model for IBR controller

2:30 PM - 3:00 PM

Lung-An Lee, Dominion Energy

To ensure the reliable operation of inverter-based resource (IBR) systems, Dominion Electric Transmission Energy Center for Grid Transformation (DETECT) lab, which houses the Real-Time Digital Simulator, has adopted the Giga-Transceiver System-on-a-Chip (GTSOC) platform. The GTSOC enables vendors to convert their IBR models into a black-box format that interfaces with RTDS simulations. Dominion Energy utilizes vendors' GTSOC models for electromagnetic transient (EMT) simulations of IBR systems. The inverter control capability and performance of the GTSOC model were verified through Dominion Energy's Facility Interconnection Requirements (FIR). Additionally, the GTSOC model has been integrated with a generic Power Plant Controller (PPC) and connected to a transmission system to demonstrate control coordination between IBRs and PPC. The GTSOC model was also connected to Dominion Energy's system equivalent to simulate and analyze field switching events In this presentation, we will present the results of RTDS simulations using the GTSOC platform. Various PCC control modes will be demonstrated, including PQ control, power factor, and voltage control. Additionally, field events analyses and system stability will be discussed.

06 Developing Dynamic Models for Nuclear-based Small Modular Reactors for load-following operation and electrical-side transient/dynamic analysis of the SMR power plants

3:30 PM - 4:00 PM

Dr. Ramakrishna Gokaraju, University of Saskatchewan

Small Modular Reactors (SMRs) present a promising solution, not only for power generation but also for enhancing grid stability by complementing variable renewable energy sources. The increasing penetration of intermittent generation, such as wind and solar, shifts the load curve and introduces challenges that require nuclear power plants to dynamically adjust their output. However, frequent control rod adjustments to enable flexible operation can lead to issues such as thermal fatigue, accelerated component aging, erosion and corrosion of hydraulic systems, core power redistribution, and fission product poisoning. This presentation will describe a dynamic model of an integral pressurized water reactor (iPWR)-type SMR and studies assessing the contribution of the reactor to the electrical side dynamics utilizing the PSS/E software and the RTDS platform. It will also discuss alternative methods to enhance operational flexibility in SMRs, including the integration of bypass systems to manage minor fluctuations and the utilization of variable thermal and electrical loads to balance excess steam generation. One approach involves directing surplus thermal energy toward district heating, ensuring efficient heat utilization while maintaining reactor performance. Another strategy leverages surplus energy for hydrogen production via electrolysis, promoting sector coupling and expanding nuclear energy's role beyond electricity generation. By adopting these approaches, SMRs can play a crucial role in creating a resilient, adaptive and sustainable energy future.

07 Testing of busbar protection in a IEC 61850 based digital secondary system

4:00 PM - 4:30 PM

Md Aamir Rahmani, Schweitzer Engineering Laboratories

With the increasing demand for electrical power, power utilities are investing in massive substations with a complex busbar arrangement to reliably facilitate the dispatch of electric power. The advent of digital secondary systems (DSS) technology, such as IEC 61850 GOOSE and Sampled Values, has optimized the installation, operation maintenance, and expansion cost for the relay protection and control system within the substation. Given the high importance of these systems, utilities and manufacturers have a strong interest in testing busbar arrangements before deploying solutions in the field. This presentation will cover a hardware-in-the-loop (HIL) test strategy using RTDS technology to test and verify busbar protection solutions utilizing DSS technology. SEL has a complete solution to support various protective relay schemes using digital secondary systems, including distributed bus bar protection for complex and large busbar arrangements. Recently SEL has extended support for o□ering busbar protection up to 21 bays with a digital secondary system. O□ering such a solution requires regress testing in a complete substation environment, including exchange of information for successful operation of the protective relay. So, this requirement is where RTDS HIL simulators have helped SEL to develop, build and mimic the complete substation environment for benchmarking the protective relay schemes. This presentation will cover briefly digital secondary substations, IEC 61850 Sampled Value based technology, busbar di□erential protection, building the test network and HIL test setup. The focus of the presentation would be to demonstrate how the hardware and software from RTDS were used for building the HIL simulation environment for testing busbar protection in a substation with digital secondary system.

08 Virtual Reality-Augmented RTDS-Based Digital Twin for Grid Operator Training

09:00 AM - 09:30 AM

Ali Mehrizi-Sani, Virginia Tech

The primary objective of the power grid is to provide continuous and reliable electricity supply to the end consumers. Maintaining power grid operations, whether routine or unplanned, requires qualified operators. Power system operator training covers a broad range of topics, from fundamental circuit theory to real-time grid operation. A key aspect of any grid operator training program is understanding and operating the grid-level supervisory control and data acquisition (SCADA) system. However, most traditional training curricula only rely on studying equipment and software tool documentations and basic simulation exercises that do not fully reflect the full range of scenarios that could happen in the actual power grid. In this work, we aim to create an enhanced system operator training program by offering virtual reality-based "hands-on" experience with station-level and bay-level human machine interface (HMI) panels. The setup consists of a photorealistic virtual reality environment built in Unreal Engine 5.2.1, modeled after one of the Virginia Tech Electric Service (VTES) substations. This 3D environment features an RTDS-based digital twin of the VTES grid and a user datagram protocol (UDP)-based communication channel to enable real-time interaction. A screen recording of a player interacting with the environment is shown as a proof of concept.

09 Development of large-area AC network model for HIL testing of a Wide-area Protection Scheme

09:30 AM - 10:00 AM

Hiranya Suriyaarachchi & Akbo Rupasinghe, TransGrid Solutions

South Australian power system is heavily dominated by inverter-based resources. Maintaining the stability of such a power system is always challenging. This system is interconnected with the Victoria AC system with a 275 kV AC interconnector. At present, another interconnector is being planned to connect the South Australia system with the New South Walse system. Studies have revealed that a trip of these interconnectors can create stability risks to the South Australian network. To mitigate these risks, EneltraNet is developing a wide area protection scheme. This presentation will discuss the development of a wide-area network model in RTDS to perform the HIL testing of this wide-area protection scheme. The presentation will include the following:

- A description of the need for this protection scheme
- Model development methodology
- Challenges encountered during the model development
- The test plan requirements incorporated

10 Enhancing Inverter Performance through CHIL Testing and Ensuring Grid Compliance

10:30 AM - 11:00 AM

Jigarkumar Gorasiya, Enerzingx

With the growing integration of renewable energy sources, the performance and reliability of grid-connected inverters are increasingly vital to maintaining power system stability. Controller Hardware-in-the-Loop (CHIL) testing has emerged as a powerful technique for validating and enhancing inverter control systems in real-time, effectively bridging the gap between software simulation and field deployment. This presentation examines how CHIL testing can be leveraged to optimize inverter performance, refine control strategies, and ensure compliance with evolving grid codes and interconnection standards. Through real-world case studies and detailed test methodologies, we demonstrate the benefits of CHIL-based validation in identifying control challenges, fine-tuning parameters, and verifying dynamic behavior under diverse grid conditions. The findings underscore CHIL as an essential tool for inverter manufacturers and project developers striving to meet stringent utility requirements while minimizing development timelines and deployment risks.

11 DER Inverter Control Fault Ride Through Model in Accordance with IEEE 1547-2018 Std

11:00 AM - 11:30 AM

Mark Booge, Western Michigan University

Distributed Energy Resources (DER) with smart inverters are becoming more prevalent as the need for renewable energy and grid stability increases. An important challenge arises when considering that inverter-based generation methods contribute less current during faults, rendering traditional overcurrent protection unsatisfactory. DERs have fault ride-through requirements when operating in high or low voltage, outlined by IEEE Std. 1547-2018. Faults cause the voltage to reach abnormal steady state magnitudes, depending on the fault resistance and fault type. There are several high voltage and low voltage ride-through zones defined by IEEE Std. 1547-2018. Each zone's ride through duration decreases as the applicable voltage measurement, i.e., the phase RMS voltage, deviates from its nominal value.

This presentation demonstrates the implementation of IEEE Std. 1547-2018 high and low voltage ride-through grid support functions using a preexisting RSCAD model, discussing the challenges presented during this process. The implemented controls monitor the filtered phase voltages to have a more accurate reading of the applicable voltages. The controls sense the duration that the applicable voltage remains in a specific zone. The breaker trips and ceases energization to the grid when the duration is exceeded. The standard allows the operator to adjust the ride-through times and voltage zones from the default settings. These ranges are implemented into the runtime, which acts as the operator's SCADA. The results show the accuracy of the voltage measurements, which remain within the IEEE Std. 1547-2018 for all cases.

12 Use of power hardware-in-the-loop and controller hardware-in-the-loop to de-risk the use of grid-forming fuel cell inverter in microgrids

11:30 AM - 12:00 PM

Kumaraguru Prabakar, National Renewable Energy Laboratory

Use of power hardware-in-the-loop and controller hardware-in-the-loop to de-risk the use of grid-forming fuel cell inverter in microgrids
Microgrids continue to proliferate, particularly those that rely on inverter-based resources as the microgrid's voltage and frequency leader. Hardware-in-the-loop simulations can de-risk microgrid deployments, and therefore we need power-hardware-in-the-loop (PHIL) interfaces for grid-forming (GFM) inverters to enable simulations of seamless transitions between islanded and grid-connected operation. Such interfaces are particularly challenging when the inverters need to switch modes, i.e., between grid-following (GFL) and GFM as the microgrid transitions between grid-connected and islanded operation. This presentation shows the use of PHIL interfaces for such microgrids and the preliminary experimental results.

RTDS Presentation 2: Recent Developments for the RTDS Simulator

1:00 PM - 1:45 PM

Cyprian Peters, RTDS Technologies

RTDS Technologies has been hard at work on new features to support the industry's growing real-time simulation needs. This presentation will outline new hardware and software developments that RTDS Technologies has released and is working on.

13 A Comparison of IEC 61850-Based Digital-HIL and Analog-HIL Using RTDS

09:00 AM - 09:30 AM

Omar Alamr, Mutah University

This research investigates the integration of Real-Time Digital Simulator (RTDS) technology with Intelligent Electronic Devices (IEDs) using IEC 61850 communication to implement and evaluate protection systems within digital substations. A fully digital Hardware-in-the-Loop (HIL) testing setup was established by connecting an RTDS equipped with a GTNETx2 card to the ABB REX640 IED. The IED received real-time voltage, current, and breaker status data from the RTDS and sent trip signals in return. In parallel, a performance comparison was conducted between traditional Analog-based protection and IEC 61850-based digital protection schemes using identical fault scenarios and system parameters. Results demonstrated a reliable and stable IEC 61850 communication link, with fault detection and isolation times of less than 6 milliseconds. Additionally, the digital scheme achieved a response of up to 65.6% faster than the analog setup. These findings highlight the effectiveness of IEC 61850-based digital substations in enhancing protection system speed and reliability, emphasizing their importance for academic research and smart grid applications.

14 Mitigating the Impact of Geomagnetically Induced Currents on Transformer Protection

09:30 AM - 10:00 AM

Leila Chebbo, Dominion Energy

Faults within the power transformer protection zone must be instantly cleared by a differential relay to avoid instability, environmental hazards, or loss of equipment. However, the differential relay can misoperate in the presence of harmonics induced by geomagnetically induced currents (GIC) in transformers. This paper investigates the performance of waveshape-based unblocking to improve the sensitivity and dependability of transformer differential protection during GIC conditions. The evaluation was conducted in a hardware-in-the-loop (HIL) environment using a commercial relay and a validated 500/230 kV transformer model connected to the reduced network equivalent of a U.S.-based electric utility. Results from 2,322 simulations demonstrate that waveshape-based unblocking significantly enhances the sensitivity of the differential relay, making it a recommended approach for transformers expected to experience significant GIC.

15 Use of RTDS in executing HVDC and FACTS projects by Siemens Energy

10:30 AM - 11:00 AM

Davendra Kumar, Siemens Energy

16 A Real-Time Cyber-Physical System Testbed for Studying the Impact of Cyberattacks on a Synthetic Power Distribution System

11:00 AM - 11:30 AM

Dr. Karen Butler-Purry, Texas A&M University

This work presents a real-time cyber-physical testbed developed to study the impact of cyberattacks on active distribution systems. The testbed integrates a Real-Time Digital Simulator (RTDS) for distribution system simulation and a Common Open Research Emulator (CORE) for communication network emulation, enabling synchronized simulation of both physical and cyber subsystems in real time. A realistic distribution feeder was modeled using the SMART-DS dataset, which includes residential and commercial loads, photovoltaic systems, electric vehicle chargers, and advanced metering infrastructure. The RTDS simulation was implemented using RSCAD software and executed on a NovaCor chassis with GTNETx2 interface cards for high-fidelity real-time communication. Communication between physical and cyber layers is conducted via TCP/IP sockets using the GTNETx2 module, supporting flexible configuration of bidirectional data exchange across DERs, aggregators, and utility. The cyber layer, emulated in CORE using containerized nodes, models a realistic AMI network based on RF mesh architecture and includes smart meters, routers, data collectors, and SCADA/DSO entities. The emulation supports real-time data flow through TAP interfaces and Ethernet bridging, enabling direct interaction with RTDS components.
The testbed allows comprehensive experimentation with real-time scenarios and communication protocols, offering a robust foundation for future studies on grid-edge intelligence, distributed optimization, and cybersecurity.

17 Power-Hardware-In-the-Loop Validation of Synchronous Wind: An Inverterless Grid-Forming Wind Power Plant

11:30 AM - 12:00 PM

Weihang Yan, National Renewable Energy Laboratory

Grid-forming (GFM) control of Type-3 and Type-4 wind turbine generators (WTGs) has attracted substantial attention in power systems research; however, the limited overcurrent capability of power electronics converters continues to deteriorate the grid strength of the evolving power systems. Synchronous wind, also known as a Type-5 WTG, offers a unique GFM solution to address grid integration and grid strength issues by keeping the grid largely synchronous at very high integration levels of renewable generation. A Type-5 WTG interfaces with the electric grid via a synchronous generator driven by a variable-speed hydraulic torque converter; hence, the wind rotor operates in variable-speed mode for maximum power generation, and the generator shaft remains synchronous to the grid. This presentation gives the modeling and demonstration effort of a high-fidelity model of a Type-5 WTG in a power-hardware-in-the-loop (PHIL) testing environment using NREL ARIES. The PHIL demonstration shows that a Type-5 WTG inherently behaves as a GFM unit and can obtain similar performance in terms of power responses, wind rotor dynamics, and efficiency compared to a Type-3 WTG in high-wind conditions. Various oscillation damping mechanisms have be demonstrated with the synchronous machine based wind turbine. The testing result provides further insight into how Type-5 WTGs can benefit the smooth transition to power systems with high reliability and resiliency.

RTDS Presentation: New Frequency Scan Tool in RSCAD FX

1:00 PM - 2:00 PM

Heather Meiklejohn, RTDS Technologies

The Frequency Scan and Stability Analysis tool (FSAT) is a new feature available in RSCADFX. With increasing introduction of power electronic based systems to the grid, frequency scanning is being used to investigate the potential adverse interactions. Based on the frequency scan results, the tool can be used for stability analysis. An overview of the tool and its applications will be discussed and examples provided.

18 Partial Virtual DIM and application

2:00 PM - 2:30 PM

Harsha Ravindra, Florida State University

Power hardware-in-the-loop (PHIL) simulation is a technique whereby actual power hardware is interfaced to a virtual surrounding system, simulated in real-time, through PHIL interfaces making use of power amplifiers and/or actuators. A number of interface approaches (IA) have been proposed in the literature for achieving the virtual coupling between the simulated and physical portions of the system, with the damping impedance method (DIM) often cited and employed due to its high stability and accuracy in cases in which the damping impedance can be closely matched to the impedance of the hardware of interest (HOI). However, in many cases, including many applications with power electronic converters, the impedance of the HOI is not easily represented by a passive network, as the converter controls may arbitrarily shape the impedance characteristic within the controllable bandwidth of the power converter. In this paper, a variation of the DIM IA is proposed in which the damping impedance is represented virtually as a voltage drop with the stimulus source, allowing arbitrary transfer function characteristics to be represented for the damping impedance. A variant is also proposed in which part of the damping impedance is represented virtually, and part of the damping impedance is represented explicitly with a passive network. An analysis of these approaches is provided to show the potential benefits and limitations of these approaches, illustrating these through practical examples.

NOTES

RTDS Technologies

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