OPAL-RT TECHNOLOGIES

AGENDA

RT SPOTLIGHT
GLOBAL REACH, LOCAL PRESENCE

OPAL-RT'S 1st Local Conferences
on Real-Time Simulation

SEPTEMBER 17-18, 2019
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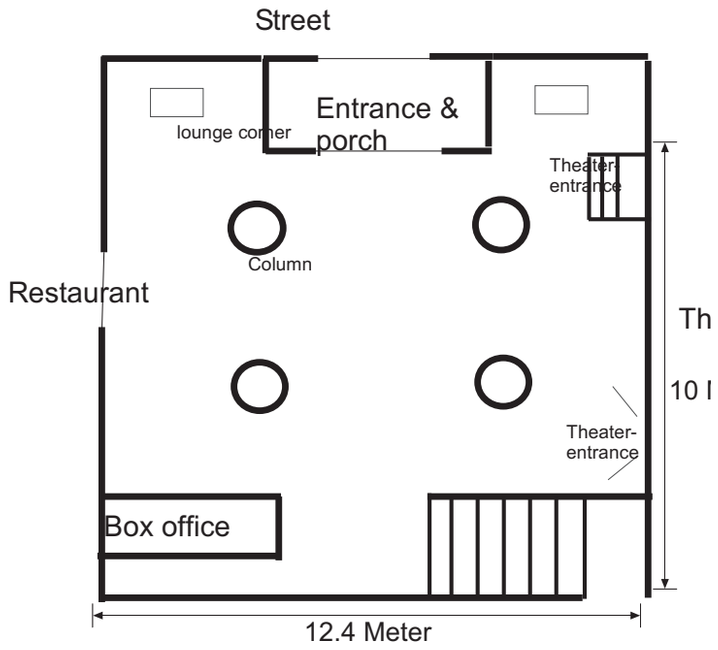
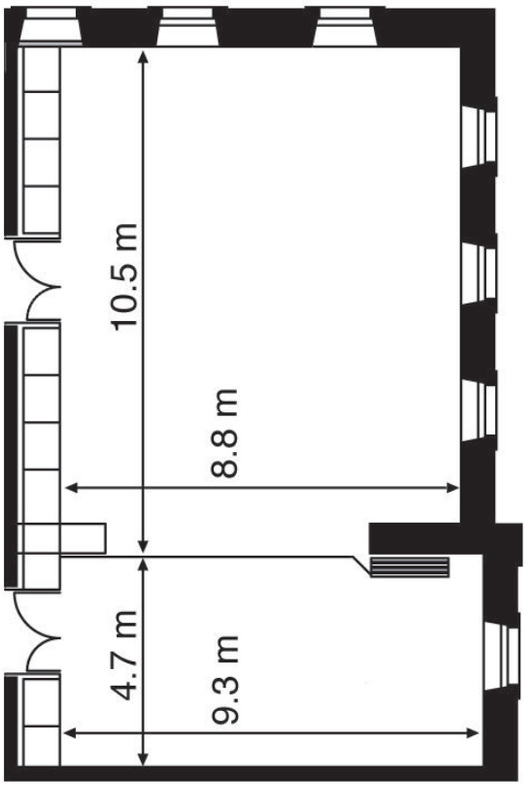
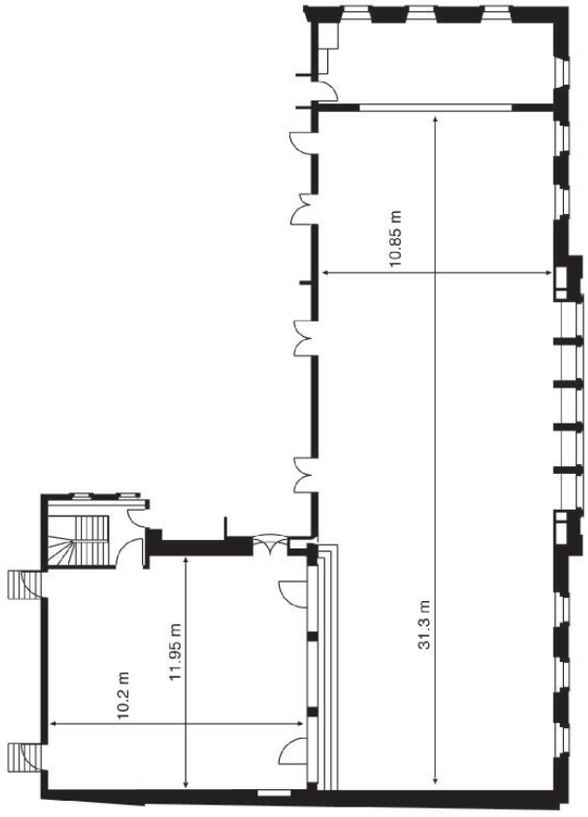
FLOOR PLANS



Floor lobby

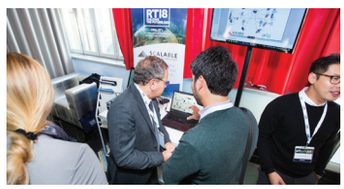




AGENDA

TUESDAY, SEPTEMBER 17th, 2019

TIME	ACTIVITY	PRESENTER(S)
8:00 AM – 9:00 AM	Registration & Breakfast	
9:00 AM – 9:45 AM	Welcome to RT Spotlight, Zürich Opening ceremony: HIL Trends, where OPAL-RT stands and where OPAL-RT is going ?	Jean Bélanger, CEO & CTO, OPAL-RT
9:45 AM – 10:15 AM	The grid of the future and the evolving role of real-time simulation in the digital transformation	Nils Siebert, SGRT Team Technical Coordinator, GE Grid Solutions
10:15 AM – 10:45 AM	HiL simulators in the drive industry : main benefits, opportunities and challenges	Mathieu Giroux, Team Leader Control Software R&D, ABB Switzerland Ltd
10:45 AM – 11:00 AM	**BREAK**	
11:00 AM – 11:30 AM	Understanding the PHIL process	Syed Qaseem Ali, Team Leader AXES, OPAL-RT TECHNOLOGIES
11:30 AM – 12:00 PM	Discover the Power of eHS' FPGA Power Electronics Toolbox: New Features & Presentation	Christophe Brayet, Director, Product Management Office, OPAL-RT TECHNOLOGIES
12:00 PM – 1:00 PM	**LUNCH**	
1:00 PM – 1:30 PM	AIT D-HIL Lab: A Cyber-Physical Framework for Emulating Large Scale Distributed Systems And Smart Grid Applications	Georg Lauss & Catalin Gavriluta, Research Engineers, AIT
1:30 PM – 2:00 PM	Improving Microgrid Resiliency using Real-Time Simulation	Jean-Nicolas Paquin, Division Manager AXES, OPAL-RT TECHNOLOGIES
2:00 PM – 2:30 PM	Real-time simulation of EV propulsion systems in RT-Lab OP4510	Edorta Ibarra, Assistant Professor and Researcher, UPV/EHU and APERT group
2:30 PM – 3:00 PM	HVDC Systems Studies with Power-Hardware-in-the-Loop Experiments	Marc René Lotz, Research Assistant, Ostfalia University of Applied Sciences
3:00 PM – 3:15 PM	**BREAK**	
3:15 PM – 3:45 PM	Validation and Development of Resilient Grid Automation using Real-time Simulation	Davood Babazadeh, R&D Manager, OFFIS
3:45 PM – 4:15 PM	Hybrids-Simulation using Different Model Basis for Converter Dominated Distribution Grid	Jiang Teng, Doctoral Student, TU Ilmenau
4:15 PM – 5:00 PM	An open source model of an inertia-reduced IEEE 39 bus benchmark grid & Development of a new software PMU into the RTLab environment	Yihui Zuo, Phd Student & Dr Guglielmo Frigo, PostDoc, Swiss Federal Institute of Technology of Lausanne (EPFL)
5:00 PM – 6:30 PM	Exhibition	Sponsors
6:30 PM – 9:30 PM	**WELCOME RECEPTION**	



AGENDA

WEDNESDAY, SEPTEMBER 18th, 2019

TIME		ACTIVITY	PRESENTER(S)
8:00 AM – 9:00 AM	—	Registration & Breakfast	
9:00 AM – 915: AM	—	Opening	Dr. Ravinder Venugopal, Managing Director, OPAL-RT Germany
9:15 AM – 9:45 AM	—	The use of real time simulation to de-risk and manage HVDC and FACTS schemes	Dr. Hani Saad, HVDC Technical Expert, RTE
9:45 AM – 10:15 AM	—	PHIL for the Investigation and Demonstration of Multi-Terminal HVDC Network Controls	Philipp Ruffing, Head of Team DC Control and Protection, RWTH Aachen University
10:15 AM – 10:30 AM	—	**BREAK**	
10:30 AM – 11:00 AM	—	Real-Time Transient Stability Simulation of ENTSO-E Initial Dynamic Model of Continental Europe	Artjoms Obusevs, Research Associate, Zurich University of Applied Science ZHAW
11:00 AM – 11:30 AM	—	Power Hardware-in-the-Loop – Emulation of Distribution Grid Challenges at KIT-IEH	Sebastian Hubsschneider, Research Associate, Karlsruhe Institute of Technology
11:30 AM – 11:45 AM	—	Closing	François Deudon, Managing Director, OPAL-RT Europe & Africa
11:45 AM – 1:00 PM	—	Exhibition	Sponsors
1:00 PM – 2:00 PM	—	**LUNCH**	
2:00 PM – 2:45 PM	—	ZHAW Lab Visit - **Group 1 (limit of 20)**	
2:00 PM – 2:45 PM	—	eHS User Group Workshop – Q&A session for users and deep dive into application experience of eHS	Christophe Brayet, Product Office Manager, OPAL-RT TECHNOLOGIES
2:45 PM – 3:30 PM	—	ZHAW Lab Visit - **Group 2 (limit of 20)**	
2:45 PM – 3:30 PM	—	Hypersim User Group Workshop – Q&A session for users and deep dive into application experience of Hypersim	Francois Tempez, Sales Engineer, OPAL-RT Germany
3:30 PM – 4:15 PM	—	ZHAW Lab Visit - **Group 3 (limit of 20**)	
	—	**END OF RT SPOTLIGHT, ZÜRICH**	

THANK YOU FOR VISITING US AT RT SPOTLIGHT!

PRESENTATIONS DAY 1 – SEPT. 17TH, 2019

9:00 AM – 9:45 AM

Welcome to RT Spotlight, Zürich Opening ceremony: HIL Trends, where OPAL-RT stands and where OPAL-RT is going?

JEAN BÉLANGER
CEO & CTO
COMPANY: OPAL-RT TECHNOLOGIES

BIO: Jean Bélanger is the co-founder, CEO and CTO of OPAL-RT TECHNOLOGIES. He received his Electrical Engineering degree in 1971 in Laval University, in Quebec City, and his Master degree from the École Polytechnique de Montreal. Also, Jean Bélanger is a fellow of the Canadian Academy of Engineering.

Jean Bélanger founded OPAL-RT TECHNOLOGIES in 1997, OPAL-RT develops and commercializes digital real-time simulators for the design of systems and the testing of electronic controllers.

Under his direction and technological leadership, OPAL-RT became a well-known developer of state-of-the-art real-time simulators capable to simulate all sorts of mechanical and electrical systems, including the fastest power electronic converters used in a wide range of industries - from hybrid vehicles to entirely electrical-driven aircrafts, and from micro-grids to very large AC/DC power systems.

Jean Bélanger began his career at Hydro-Quebec's System Planning Division and in IREQ. His contribution allows the insulation and co-ordination of equipment and the installation of lines on the 765-kV James Bay transmission system, as well as the installation of static var compensators and series capacitor. He also contributed to the design and construction of Hydro-Quebec real-time simulators.

Today, Jean Bélanger foresee that high-end real-time simulators will soon be available to all engineers, scientists and students by taking full advantage of off-the-self PCs. This is the driving challenge that we have taken as primary goal.

9:45 AM – 10:15 AM

Keynote Presentation

NILS SIEBERT
SGRT Team Technical Coordinator
COMPANY: GE Grid Solutions

BIO: Nils Siebert is R&D leader for Advanced Automation Applications, GE Grid Solutions. Nils joined the GE's Automation Business in 2016 and has been involved developing and delivering power systems applications for transmission and distribution substations and for microgrids. Nils joined Alstom/GE in 2012 as part of Software Solutions where he was technical lead in smart grid innovation projects dealing with DER integration in the distribution grid (demand response management, DERMS, optimization, forecasting, software/solution architecture). Prior to joining Alstom/GE, Nils worked as Technical Leader and research engineer for Armines in the field of short-term RES forecasting and renewable integration. In this role he conducted academic research in the frame of several EU/National funded projects. Nils holds a Master's degree in Applied Mathematics and Computer Science from Université Catholique de l'Ouest (2003) and a PhD in Energy Studies from MINES ParisTech (2008).

ABSTRACT: This talk will address major trends driving the evolution of the grid and discuss the evolving role of real-time simulation in the development and deployment of advanced grid management solutions.

PRESENTATIONS DAY 1 – SEPT. 17TH, 2019

10:15 AM – 10:45 AM

HiL simulators in the drive industry: Main benefits, opportunities and challenges

MATHIEU GIROUX
Team Leader Control Software R&D
COMPANY: ABB Switzerland Ltd – Motion, Product Group System Drives

BIO: Mathieu Giroux is working for ABB in Turgi, Switzerland, since 2013. He is currently leading a team that develops control software for power converters driving the largest offshore wind turbines in the world. Mathieu started his career at Opal-RT Technologies in 2007. He moved to the industry in 2010 and has since then continued to use HiL simulators to support his daily work. He holds a master's degree in electrical engineering from the Montreal Ecole Polytechnique.

ABSTRACT: ABB System Drives uses HiL simulators for more than 10 years. The presentation highlights the benefits of real-time simulators in a business R&D environment where large medium voltage drives are delivered to customers with complex and critical applications. It also addresses few technical and organizational challenges faced by the team towards RT-simulators. Finally, it presents the future opportunities for HiL simulation and projects foreseen in the next years in the business.

11:00 AM – 11:30 AM

Understanding the PHIL process

SYED QASEEM ALI
Team Leader, AXES Division
COMPANY: OPAL-RT TECHNOLOGIES

BIO: Syed Qaseem Ali got his B. Engg. Degree from NED University of Technology, Karachi and his MS in Electrical Engineering Power and Control from Illinois Institute of Technology, Chicago in 2010. He obtained his PhD in Electrical Engineering from McGill University in the area of integrated battery charger design for electric vehicles in 2018. He joined OPAL RT Technologies in the January 2017 and currently is a lead simulation expert for the Transmission & Distribution and DER team in the Application eXpertise and Electrical Simulation (AXES) division.

Before joining McGill he worked as a Research Engineer at King Saud University, Riyadh. His current research interests include microgrid controls, DER integration, and power electronic converters for renewable energy applications.

ABSTRACT: Power hardware-in-the-loop (PHIL) simulations have been increasingly looked upon for design-testing and validation of equipment in various stages of the engineering design and deployment projects. It allows the users to test devices with higher flexibility than a full-scale deployed testbed. However, the process of setting up a PHIL simulation is not straight forward as the PHIL interface, if not designed correctly, may de-stabilize and otherwise stable system. Therefore, the process of setting up a PHIL simulation requires careful consideration of various elements to ensure a stable interface. These considerations along with the use of PHIL in different application areas will be presented. The speaker will also introduce solutions offered by OPAL-RT Technologies in the PHIL application area.

PRESENTATIONS DAY 1 – SEPT. 17TH, 2019

11:30 AM – 12:00 PM

Discover the Power of eHS' FPGA Power Electronics Toolbox: New Features & Presentation

CHRISTOPHE BRAYET
Director, Product Management Office
COMPANY: OPAL-RT TECHNOLOGIES

BIO: With the support of his team, Christophe leads the company's product vision and strategy, and strengthens the company's leadership position in the real-time simulation industry. He is responsible for the product road maps, as well as for capitalizing on new market opportunities.

ABSTRACT: eHS is OPAL-RT's nanosecond power electronics solver for real-time simulation on FPGA. This presentation focuses on features, applications and enhanced workflows in the new version, featuring new components (transformers, line models, switching functions, and switches) as well as improved accuracy and precision. The improved usability of eHS' workflows comes from the powerful and intuitive Schematic Editor, which enables construction, editing and integration of circuits, and is integrated within eHS. This new generation of solver has use cases within all types of electrical conversion testing, like renewable energy conversion (photovoltaics, wind power, battery management and microgrid), industrial drive systems, electric transportation and power electronics research.

1:00 PM – 1:30 PM

AIT D-HIL Lab: A Cyber-Physical Framework for Emulating Large Scale Distributed Systems And Smart Grid Applications

GEORG LAUSS
Research Engineer
COMPANY: AIT Austrian Institute of Technology GmbH

BIO: Georg Lauss received the Dipl.-Ing. degree from the Johannes Kepler University JKU Linz, Austria, in 2006 and jointly from the Eidgenössischen Technischen Hochschule ETHZ, Zürich, Switzerland, and the Université Pierre-et-Marie-Curie, Paris, France. He is a researcher with the AIT Austrian Institute of Technology, Vienna, Austria. His main interests include electromagnetic systems, power electronics, system and control theory, mathematical methods for optimized control systems, hardware-in-the-loop simulation systems, and real-time simulation for electromagnetic power systems.

Georg Lauss is the Chairman of the IEEE WG P2004 Recommended Practice for Hardware-in-the-Loop (HIL) Simulation Based Testing of Electric Power Apparatus and Controls and the IEEE PES Task Force on Real-Time Simulation of Power and Energy Systems.

— AND —

DR. CATALIN GAVRILUTA
Research Engineer
COMPANY: AIT Austrian Institute of Technology GmbH

BIO: Catalin Gavriluta received his Ph.D. degree from the Technical University of Catalonia, Barcelona, Spain in 2015. Afterwards, he was enrolled for two years as a post-doc researcher with the Grenoble Institute of Technology, Grenoble, France working as part of the G2ELab.

Since 2017 he joined AIT as a research engineer in the digitalization team inside the center for energy. His work and interests are oriented towards smart grid applications, with specific focus on the control and management of distributed cyber-physical systems, as well as on the testing and validation of such systems using hardware and controller in the loop approaches.

ABSTRACT: This paper proposes a cyber-physical framework for investigating distributed control systems operating in the context of smart-grid applications. At the moment, the literature focuses almost exclusively on the theoretical aspects of distributed intelligence in the smart-grid, meanwhile, approaches for testing and validating such systems are either missing or are very limited in their scope. Three aspects need to be taken into account while considering these applications: 1) the physical system, 2) the distributed computation platform, and 3) the communication system. In most of the previous works either the communication system is neglected or ersimplified, either the distributed computation aspect is disregarded, either both elements are missing. In order to cover all these aspects, we propose a framework which is built around a fleet of low-cost single board computers coupled with a real-time simulator. Additionally, using traffic control and network emulation, the flow of data between different controllers is shaped so that it replicates various quality of service (QoS) conditions. The versatility of the proposed framework is shown on a study case in which 27 controllers self-coordinate in order to solve the distributed optimal power flow (OPF) algorithm in a dc network. Keywords: cyber-physical systems, smart grid, distributed control and optimization.

PRESENTATIONS DAY 1 – SEPT. 17TH, 2019

1:30 PM – 2:00 PM

Improving Microgrid Resiliency using Real-Time Simulation

JEAN-NICOLAS PAQUIN, P.ENG., M.ENG.
Division Manager Application eXpertise and Electrical Simulation
COMPANY: OPAL-RT TECHNOLOGIES

BIO: Jean-Nicolas Paquin, P.Eng., M.Eng. is Manager of the Application eXpertise and Electrical Simulation (AXES) Division at OPAL-RT Technologies. He has been involved in EMT simulation and modeling since his undergraduate studies and has been passionate about it since then. He started his career in real-time simulation and has experience in the simulation and studies of HVDC controls and protections. He also has worked as a consultant Engineer, involving in studies and specialized testing in power generation and wind farm engineering. At OPAL-RT he initiated and manages a group of experts in fields related to real-time simulation applications and modeling of electrical systems in different domains like protection and control, power system stability, microgrids and more electric aircrafts. As a subject matter expert, he is also involved in market strategy and R&D orientation for key product development and innovation at OPAL-RT. He is a senior member of IEEE and member of the IEEE Power and Energy Society (IEEE-PES). He is a registered Professional Engineer in the province of Quebec, Canada.

ABSTRACT: Microgrids are enablers for distributed energy resources (DER) integration into the distribution systems. In order to optimize the utilization of the sources, optimize the operational costs and ensure resilience to faults on the grid, it utilizes complex control and protection systems for dispatch and transitions from and to grid-connected operation. In order to study the implementation of these systems, digital simulation technologies are used in the industry. As an extension to model-based design used upstream in the engineering workflow, the modeling and simulation approach can be extended to the use of Hardware-in-the-Loop testing using real-time simulators. This presentation will describe different modeling fidelity or approaches that can be applied to microgrid and power system integration studies as well as some simulation algorithms and tools available for that matter. The use of real-time simulators for testing the performance of controllers will be introduced with a focus on specific use-cases. Finally, real research and industrial applications using these studies and testing technologies will be presented to the audience.

2:00 PM – 2:30 PM

Real-time simulation of EV propulsion systems in RT-Lab OP4510

EDORTA IBARRA
Assistant Professor and Researcher
COMPANY: UPV/EHU, and APERT group

BIO: Edorta Ibarra received the first M.Sc. degree in electronic engineering from the University of the Basque Country, Bilbao, Spain, in 2004, the second M.Sc. degree in electronic physics from the University of Cantabria, Santander, Spain, in 2005, and the Ph.D. degree in electronics engineering from the University of the Basque Country, in 2011.

During 2006 to 2007, he was with the Technical Engineering School of Bilbao, Spain. From 2007 to 2014, he was with the Applied Electronic Research Group, University of the Basque Country, where he completed his pre-doctoral formation (2007-2011) and participated as a researcher in several research projects. From 2014 to 2016, he was with Fundación Tecnalia Research & Innovation, Industry and Transport Unit, Derio, Spain, as the technological leader of the eDrive group in the Industry and Transport area, where his main activities where focused on the research and development of electric vehicle propulsion systems and their control. Since 2016, he has been an Assistant Professor in the Department of Electronic Technology, University of the Basque Country.

He is a member of the APERT research group, formed by 13 professors from the Electronic Technology Department of the UPV/EHU, and a varying member of PhD and master students. The main two research lines of the group are Power Electronics and System-on-Chip. In the last 15 years the group has achieved a big number of research grants, contracts and publications. The group has a high rating and it is recognised as A type group by the Basque Government in the 2016 call.

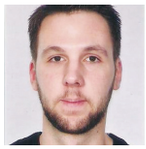
Edorta Ibarra is author of 12 articles in indexed scientific journals (10 Q1 and 2 Q2), 3 technical books, 2 patents, 11 divulgation articles and 48 conference communications. He has participated as a researcher in 26 projects (5 European projects), including relevant automotive and aerospace industrial partners in such projects. Hi has directed 1 PhD thesis in the field of electric vehicle propulsion systems field weakening and sensorless control.

ABSTRACT: Simulation is widely used for the development of modern electric drives that constitute electric vehicle (EV) propulsion systems. Using conventional offline simulation, it is possible to design and fine tune their controllers, and also to evaluate system performance under steady state and short transient conditions. However, in the EV context, it can be of great interest to analyse the performance of the power system and its control and modulation algorithms under realistic driving conditions, as this can provide valuable information regarding efficiency, autonomy and thermal cycling, among others. However, driving cycles include long transient conditions that are unfeasible to be simulated in a reasonable time frame when conventional simulation approaches are followed. Considering all these, the experience of the Applied Electronics Research Team (UPV/EHU) regarding real-time simulation of EV propulsion systems in an OP4510 platform is covered in this presentation, with special emphasys on implementation details and on the usage of the eHS solver for this purpose.

PRESENTATIONS DAY 1 – SEPT. 17TH, 2019

2:30 PM – 3:00 PM

HVDC Systems Studies with Power-Hardware-in-the-Loop Experiments



MARC RENÉ LOTZ, M.ENG.
Research Assistant
COMPANY: Ostfalia University of Applied Sciences
Institute of Electrical Systems and Automation Technology (IfEA)

BIO: Marc René Lotz received his bachelor's and master's degree in electrical engineering from the University of Applied Sciences, Wolfenbüttel, Germany. He is currently working at the Institute of Electrical Systems and Automation Technology (IfEA) at Ostfalia University. His field of research is the study of dc and hybrid ac/dc grids using Power-Hardware-in-the-Loop setups and analysing the stability of interfacing methods. He is planning on working towards his Ph.D. through collaborative work with the elenia institute at Technische Universität Braunschweig.

ABSTRACT: Topic of the presentation is the validation of HVDC systems studies with Power-Hardware-in-the-Loop (PHIL) experiments. After a short introduction to this field of research -- depicting real-time simulation as the centre spot --, a workflow of designing a PHIL setup with the institute's available equipment will be presented through an example study case, especially regarding scaling and interfacing methods. Then, the steps necessary to enhance the PHIL setup for validation of studies on meshed grids will be depicted, namely the design of Modular Multilevel Converters (MMC) for scaled PHIL experiments.

3:15 PM – 3:45 PM

Validation and Development of Resilient Grid Automation using Real-time Simulation

DAVOOD BABAZADEH
R&D Group Manager
COMPANY: OFFIS

BIO: Davood Babazadeh is an R&D manager at OFFIS Institute for information technology in Germany since 2017. He received his first master degree in energy engineering from Sharif University of Technology - Tehran in 2008. Then, he worked in industry in the field of reliability analysis in power systems for four years. He received his second master degree in electric power engineering in 2012 and afterwards his PhD from KTH Royal Institute of Technology-Sweden with the focus on distributed control of hybrid AC/DC transmission grids. In 2016, he worked as an area manager in Swedish Center for Smart Grids and Storage (SweGRIDS) in Stockholm. His areas of research are focused on Smart grid resilience, power system automation as well as multi-domain co-simulation testbeds.

ABSTRACT: Provision of services over the current structure of power grids with a large number of actors, e.g. distributed energy resources (DER) and active consumers, relies heavily on Information and Communication Technologies (referred to as grid automation system) for metering, processing, communicating and decision making. Moving towards digitalized complex power systems with their unpredictable and susceptible nature, the risk of disruptive events with large magnitude and consequence becomes higher. The grid automation system as a significant integrated component of the power system has to be designed to deal with these disruptive events as well, regardless the origin of the event (e.g. from physical or cyber side). This talk focuses on the significance of real-time simulation infrastructure in validating and development of intelligent grid automation solutions.

PRESENTATIONS DAY 1 – SEPT. 17TH, 2019

3:45 PM – 4:15 PM

Hybrids-Simulation using Different Model Basis for Converter Dominated Distribution Grid

JIANG TENG
Doctoral student
COMPANY: TU Ilmenau

BIO: M.Sc. B.B.A Teng Jiang, received the bachelor's degree from North China University of Technology in Business admiration in 2002, bachelor's degree in mechanical engineering and M. Eng. degree from Technische Universität Ilmenau in Electrical Power Control Engineer in 2012. he is currently doctoral student at the Power System Group. His special focus lies on Power system modeling and simu-lation as well as distribution grid operation.

ABSTRACT: The objective of this presentation is to demonstrate a practical real-time approach for simulation of a converter dominated distri-bution grid. To find an equilibrium between calculation efficiency and simulation accuracy, this approach suggested, use ePHASORSIM to simulate the large-scale over-layer grid in phasor-domain, and eMEGASIM for selected buses of 20kv grid in EMT-based detailed equivalent model. The improvement on real time capability and system-usage by using this hybrid ap-proach are demonstrated with real -time simulation results on OPAL RT.

4:15 PM – 5:00 PM

An open source model of an inertia-reduced IEEE 39 bus benchmark grid & Development of a new software PMU into the RTLab environment

MS YIHUI ZUO
Phd Student
COMPANY: Distributed Electrical Systems Laboratory, Swiss Federal Institute of Technology of Lausanne (EPFL), Lausanne Switzerland

BIO: Yihui Zuo was born in Sichuan, China, in 1992. She received the B.Sc. and M.Sc. degrees in electrical engineering from North China Electric Power University, Beijing, China, in 2013 and 2016, respectively. She is currently pursuing the Ph.D. degree with the Distributed Electrical System Labo- ratory, Swiss Federal Institute of Technology of Lau sanne, Lausanne, Switzerland. Her current research interests include the impact of battery energy storage on the dynamics of power system with increasing resources interfaced with power electronics.

ABSTRACT: We present an open-source model of an inertia-reduced IEEE 39-bus power system, where we introduced some renewable distributed generation in order to better represent modern power system scenario.In this context, we investigate the impact of synchrophasor estimation algorithms in Under-Frequency Load-Shedding (UFLS) and Load-Restoration (LR) schemes, relying on frequency and Rate-of-Change-of-Frequency (ROCOF) measurements produced by Phasor Measurement Units (PMUs).

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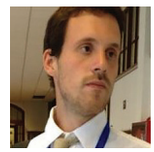


DR GUGLIELMO FRIGO
PostDoc
COMPANY: Distributed Electrical Systems Laboratory, Swiss Federal Institute of Technology of Lausanne (EPFL), Lausanne Switzerland

BIO: Guglielmo Frigo was born in Padua, Italy, in 1986. He received the B.Sc. and M.Sc. degrees in biomedical engineering from the University of Padova, Padua, in 2008 and 2011, respectively, and the Ph.D. degree from the School of Information Engineering, University of Padova, in 2015, with a dissertation about compressive sensing theory applications to instrumentation and measurement scenario. Since 2018, he has been with the Distributed Electrical Laboratory, Swiss Federal Institute of Technology of Lausanne, Lausanne, Switzerland, and he is member of IEEE TC-39 working group for measurements in power systems. His current research interests include the development of enhanced measurement devices for active distribution networks.

ABSTRACT: We present the design and implementation of two new PMU models within the Opal-RT eMEGAsim RTS. The synchrophasor estimation algorithm relies on a Compressive Sensing Taylor-Fourier Model (CS-TFM) approach, and enables us to extract the dynamic phasor associated to the signal fundamental component. The estimation accuracy of the proposed models is characterized with respect to the compliance tests of the IEEE Std. C37.118.1.

PRESENTATIONS DAY 2 – SEPT. 18TH, 2019

9:00 AM – 9:15 AM

Opening

DR. RAVINDER VENUGOPAL
Managing Director, OPAL-RT Germany
COMPANY: OPAL-RT Germany

9:00 AM – 9:15 AM

The use of real time simulation to de-risk and manage HVDC and FACTS schemes

DR. HANI SAAD
HVDC Technical Expert
COMPANY: RTE - Réseau de Transport d'Électricité

BIO: Hani Saad (S'07) received his B.Sc. and Ph.D. degrees in electrical engineering from the Polytechnique of Montréal in 2007 and 2015, respectively. From 2008 to 2010 he worked at Techimp Spa. and in the Laboratory of Materials Engineering and High Voltages (LIMAT) of the University of Bologna on R&D activities. In 2013, he joined the French TSO RTE (Réseau de Transport d'Electricité), where he is currently involved in HVDC projects as a technical expert and in EMT studies.

ABSTRACT: Several projects involving power electronic based equipment such as HVDC links, static VAR compensators and wind power plants have been decided and build by RTE. In the long term, the share of power electronics connections into existing ac systems will significantly increase due to the massive penetration of wind power plants and HVDC links. For several years, the French TSO (Transmission System Operator) RTE, has been involved in research and development activities to model and study power electronic devices. To support these activities, numerical tools are needed that offer detailed modeling HV components and controls while maintaining a good compromise between robustness, accuracy, and flexibility.

This presentation illustrate how replicas are used at RTE to improve system operation since 2011. This solution will be presented with real events that occurred on the French grid with HVDC devices. Special incidents are presented, that is: DC cable fault event and AC emulation behavior due to inter-area oscillation. Also, the paper explains how real-time simulation with physical controls supports maintenance, training and R&D activities by providing robust and reliable tool.

PRESENTATIONS DAY 2 – SEPT. 18TH, 2019

9:45 AM – 10:15 AM

PHIL for the Investigation and Demonstration of Multi-Terminal HVDC Network Controls

PHILIPP RUFFING, M. SC.
Head of Team DC Control and Protection,
Department Grid Integration and Stability
COMPANY: RWTH Aachen University

BIO: Philipp Ruffing was born in Saarbrücken, Germany, in 1990. He received his B.Sc. and M.Sc. degree in electrical engineering from RWTH Aachen University, in 2013 and 2015, respectively. He is currently working as research associate at the Institute for High Voltage Technology of the RWTH Aachen University pursuing the doctoral degree. Since June 2019 he is leading the team "DC Control and Protection". His research interests include control and protection of VSC HVDC systems as well as their investigation using hardware-in-the-loop systems. Since 2016 he is leading the work package "MMC Test Bench Demonstrator" in the EU Horizon 2020 project PROMOTioN. He is a member of CIGRÉ.

ABSTRACT: The future integration of multi-terminal HVDC networks into the European power grids presents novel challenges to transmission grid operators, grid planners and manufacturers. A major obstacle to building HVDC networks is the limited experience available regarding their control and operation as well as their interaction with AC transmission systems and offshore wind power plants. To address these issues a laboratory-scale multi-terminal HVDC demonstrator – the MMC Test Bench – has been built at RWTH Aachen University within the framework of the EU-Horizon2020 Project PROMOTioN. At the heart of this PHiL demonstrator are eight laboratory-scaled Modular Multilevel Converters (MMCs) which are embedded in a real-time simulation of the surrounding AC systems by employing four-quadrant linear power amplifiers.

Within this presentation the setup of the PHiL demonstrator, the corresponding research objectives and first results regarding the controllability of HVDC networks in combination with offshore wind power plants are presented.

10:30 AM – 11:00 AM

Real-Time Transient Stability Simulation of ENTSO-E Initial Dynamic Model of Continental Europe

DR. ARTJOMS OBUSEVS
Research Associate
COMPANY: Electric Power Systems and Smart Grids group at the Institute of Energy Systems and Fluid Engineering (IEFE) of the Zurich University of Applied Science ZHAW

BIO: Dr. Artjoms Obushevs received the BSc, MSc, Ph.D. degree in electrical engineering from the Riga Technical University, in 2008, 2010 and 2014 respectively. He is currently a Research Associate in Electric Power Systems and Smart Grids group at the Institute of Energy Systems and Fluid Engineering (IEFE) of the Zurich University of Applied Science ZHAW. His main research is focused on methods of mathematical modelling of electrical networks and systems elements; development of power systems planning; dynamic optimization methods and decision systems.

ABSTRACT: In this presentation, an overview and implementation of the dynamic model of Continental Europe from ENTSO-E in Real-Time simulator, where the main characteristics are summarized and discussed, are introduced. The ENTSO-E initial dynamic model is a comprehensive representation of interconnected Continental Europe. The complexity and precision of the system are evident, as indicated by the large volume of components involved. There are more than 1800 transmission lines spanned along with extended distances from up to 300km in Turkey to short connections of 0.1km in the Netherlands and connecting more than 23'000 nodes, 7'000 loads and 6'000 generators. The real-time simulation of such a massive power gird exploits four CPU cores of OP5600 on which the computations are dispatched in parallel. The experimental results verify the performance and scalability of the ENTSO-E system and the ePHASORSIM engine.

PRESENTATIONS DAY 2 – SEPT. 18TH, 2019

11:00 AM – 11:30 AM

Power Hardware-in-the-Loop – Emulation of Distribution Grid Challenges at KIT-IEH

SEBASTIAN HUBSCHNEIDER, M.SC.
Research Associate
COMPANY: Karlsruhe Institute of Technology

BIO: Sebastian Hubschneider finished his studies of electrical engineering and information technology at the Karlsruhe Institute of Technology (KIT) in June 2015 with the academic degree Master of Science. During his time at the University, he specialized on power engineering with a focus on energy grids and the energy sector in general, including markets and economy.
Since July 2015, Sebastian works as a research associate at the Institute of Electric Energy Systems and High-Voltage Technology (IEH), KIT. His research focuses on Power Hardware-in-the-Loop systems in conjunction with energy grids and electrical equipment.

ABSTRACT: The power hardware-in-the-loop environment at the Institute of Electric Energy Systems and High-Voltage Technology (IEH), KIT, consists of an OP5607 driving two 30 kVA linear 4-quadrant-amplifier. Besides other electrical equipment and different devices under test (DUT) it includes the KIT Energy Smart Home Lab, a smart, automated residential building comprising building automation, measurement devices, and different prosumers, allowing for the provision of ancillary grid services. The research focuses on detailed simulation of four wire distribution systems and emulation of challenging situations in those. This implies the analysis of requirements regarding different time scales and system setups as well as a stable and precise loop-feedback with minimal lag. The presentation will present latest results regarding grid simulation and requirements as well as an overview of the system setup at KIT-IEH.

11:30 AM – 11:45 AM

Closing

FRANÇOIS DEUDON
Managing Director, OPAL-RT Europe & Africa
COMPANY: OPAL-RT Europe

PRESENTATIONS DAY 2 – SEPT. 18TH, 2019

2:00 PM – 2:45 PM

eHS User Group Workshop – Q&A session for users and deep dive into application experience of eHS

CHRISTOPHE BRAYET
Director, Product Management Office
COMPANY: OPAL-RT TECHNOLOGIES

BIO: With the support of his team, Christophe leads the company's product vision and strategy, and strengthens the company's leadership position in the real-time simulation industry. He is responsible for the product road maps, as well as for capitalizing on new market opportunities.

2:45 PM – 3:30 PM

Hypersim User Group Workshop – Q&A session for users and deep dive into application experience of Hypersim

FRANÇOIS TEMPEZ
Sales Engineer
COMPANY: OPAL-RT Germany

BIO: François received his Master's in Electrical Engineering from the Ecole Centrale de Lille. As a power system technical manager, he used to manage most of the power system projects in Europe; for pre-sales activities, custom on-site trainings and advanced technical support. From October 2018, François is Sales Engineer responsible for the German market. His main areas of expertise are the analysis of complex electrical systems as well as the knowledge of simulation software and computer equipment.

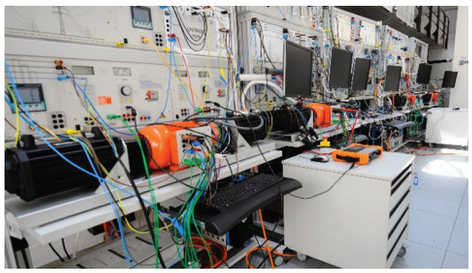
PRESENTATIONS DAY 2 – SEPT. 18TH, 2019

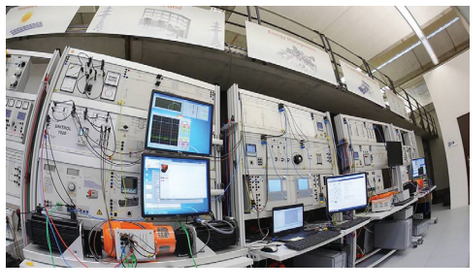
2:00 PM – 2:45 PM
ZHAW Visit - Group 1
(limit of 20)

2:45 PM – 3:30 PM
ZHAW Visit - Group 2
(limit of 20)

3:30 PM – 4:15 PM
ZHAW Visit - Group 3
(limit of 20)

Laboratory Tour – Demonstration of ZHAW Realizations on Transmission and Distribution Grid





PRESENTERS:
Dr. Artjoms Obusevs
Dr. Jean Dobrowolski
Daniel Baltensperger

BIO: The Electric Power Systems and Smart Grid team of ZHAW propose to show you some of their real implementations during a Laboratory tour of approximately 45 minutes. Realizations on the wide topics of transmission and distributions grids will be presented with the well-known Kundur 4 generators transmission grid or an Energy Management System for a connected microgrid, for example. The visit will end with the presentation of realizations using OPAL-RT instrumentation.

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COMPANY DECSRIPTION:
With nearly 105,000 km of lines, RTE's grid is the biggest in Europe. 46.2% of extra-high voltage lines (400,000 and 225,000 volts) transmit electricity over long distances and to 60 cross-border connections with the neighbouring countries. The lines at 150,000, 90,000 and 63,000 volts are designed for regional sub-transmission. RTE also provides services to third party with its subsidiary RTE International.

PRODUCT DESCRIPTION:
A dedicated team to support your HVDC projects: RTE and the Real-time laboratory provide services in power systems with a focus on HVDC and FACTS.

We offer comprehensive services to meet the needs of the ever-changing power industry. With its team of experts coming from multiple backgrounds and specialized in Power Electronics, RTE tackles a wide variety of challenges in Power Systems.

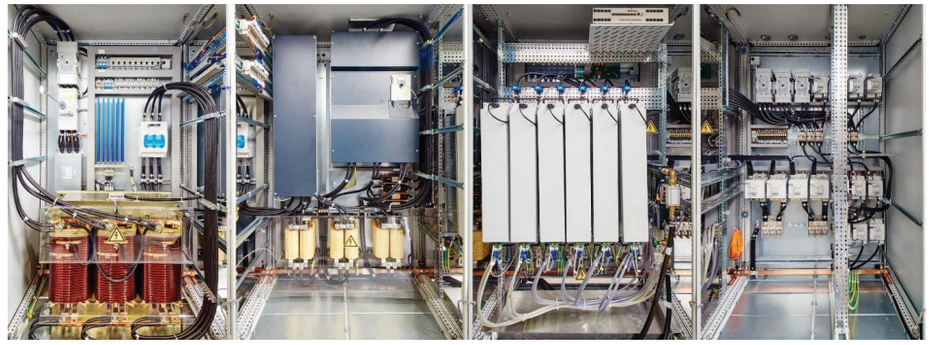
www.hvdcsquare.com

SILVER SPONSORS

EGSTON POWER

COMPANY & PRODUCT DESCRIPTION:
Austrian-based EGSTON Power Electronics offers a revolutionary power electronic test bench based on P-HIL technology (Power – Hardware in the Loop). Our unique COMPISO system offers a high voltage bandwidth of 5 kHz at 440 VRMS which can generate harmonics of up to 15 kHz with a power range of 100kW up to 1,2MW. Based on a modular design, the COMPISO P-HIL System offers full flexibility and can be used as an AC source/sink, DC source/sink, smart grid, aerospace grid, PV-panel, battery or electrical machine emulator.

www.egstonpower.com



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PUISSANCE PLUS

COMPANY DECSRIPTION:
Puissance Plus provides competences & technological bricks in Power Electronics, Analogical signal, Digital signal, Measurement, Low layer programming, in Linear & Switching technologies for:

- Catalog Products: power amplifiers, current generators, power supplies, loads, emulators
- Projects and Solutions
- OEM Solutions
- Customer & Services

With more than 25 years of experience, Puissance Plus becomes a leader in Emulation & Simulation.

MAIN MARKETS:
- Electrical safety: Test and Qualification/Homologation/Production of Breakers/Differential Relays/Current sensors
- Railway: Relay test, Auxiliary static converters test system, Breaker test
- Energy & University: Grid Protection, Power amplifiers for Smart grid (PHIL)
- Aeronautics: Flight test, V&V Power testing, Manufacturing test bench
- Automotive: E-Motors & Battery Emulation

Quality at the heart of our business: RoHS II - ISO 9001 certification Version 2015

PRODUCT DESCRIPTION:
Our 4 Quadrant Power Amplifiers, AC, DC, AC-DC, one-phase or three-phases, operate in two modes: voltage regulation with current limitation, or current regulation with voltage limitation. They behave either as generators or as absorbers.

The analog input receives a "pilot" signal coming from the internal synthetizer or from an external synthetizer or emulator. The power amplifier output is insulated from the analog input and from mains.

Two analog outputs insulated from power output return images of voltage and current.

The linear technology used for these amplifiers allows:
- A very low distortion (< 0.3%) on a wide frequency range (DC to 10 kHz) and a large bandwidth (35 kHz)
- A high accuracy (<0.2%)
- A high stability (<0.1%)
- Fast transients (<8µs)
- To provide power peaks up to 4 times its nominal power
- An easy integration for "Real-Time" or "Power Hardware In the Loop" applications with simulators

www.puissanceplus.com

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COMPANY DECSRIPTION:
Imperix is a Swiss company developing high-end control equipment and prototyping hardware for power electronics, drives, smart grids and related topics. Its products are designed to enable cutting-edge innovation in corporate and academic environments. They are especially valued for their ability to accelerate the implementation of laboratory-scale power converters and facilitate the derivation of high-quality experimental results.

The company also offers various levels of integration services, intended to assist its customers in their prototyping activities. As such, its offering ranges from the delivery of plug-and-play hardware and software, to that of fully customized systems involving specialized control software algorithms.

COMPANY DECSRIPTION:
Imperix offers a complete family of control solutions, supporting the whole life cycle of power conversion systems, from R&D to commercial products.

Real time controllers
The B-Box RCP is a controller dedicated to rapid control prototyping (RCP) applications. It distinguishes by its specialized analog front end with hardware protections and offers best-in-class control and modulation performance, making it the perfect platform for the validation of advanced control techniques.

The B-Board PRO is a product-embeddable module that guarantees a seamless portability of developments made on B-Box RCP.

Power modules
With the help of power modules and their associated chassis, power converters of practically any topology can be built up within minutes. Topologies can of course always be altered and modules reused in multiple scenarios.

Four types of power modules are available, with different ratings and internal structures. All modules possess integrated current and voltage sensors, as well as internal protections.

www.imperix.ch

Open **rack 3U**

Closed **rack 4U**

B-**Box RCP**

B-**Board PRO**

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COMPANY DECSRIPTION:
Doble Engineering Company strives to ensure all people have reliable, safe and secure power. We do this by providing advanced diagnostics and engineering expertise to the energy industry worldwide. Our companies and product lines include Manta Test Systems, Morgan Schaffer, Vanguard Instruments and Xtensible Solutions. Whether the goal is condition monitoring or asset management, Doble has solutions for any need. Doble is part of the Utility Solutions Group of ESCO Technologies Inc. (NYSE: ESE).

PRODUCT DESCRIPTION:
F6350e / F6300e External Amplifiers

These amplifiers are useful in high power protection testing applications when you need additional current and/or voltage sources, for critical high burden relay testing, as well as system modeling.

When used in combination with Doble's Protection Suite software, you will have the ultimate flexibility to test complex schemes. These amplifiers also offer the industry's most current sources in one piece of equipment.

www.doble.com

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REGATRON
programmable power supplies

COMPANY DECSRIPTION:
REGATRON is a specialized Swiss engineering company with solid and comprehensive expertise in developing, manufacturing and sales of programmable power supplies. Since 50+ years, REGATRON's continuous focus on power electronics has led to a well-established and field-proven portfolio of programmable DC and AC power sources. All over the world, REGATRON power supplies are used in laboratories, test fields and production lines for simulation, testing, development and research purposes or in various process technologies as voltage / current sources.

PRODUCT DESCRIPTION:
TC.ACS is a series of full digital, full 4 quadrant, full regenerative 3-phase AC power sources. The multi-level inverter technology combined with a remarkable high switching frequency opens up a wide base frequency range from DC up to 1000Hz and a high modulation bandwidth of 5 kHz. Due to the modular structure based on 30kVA and 50kVA units, a flexible adaptation to power requirements subject to changes is possible. By simply connecting basic units in a parallel mode, systems of up to 1MVA can be set up. TC.ACS offers exceptional programming features and can be used as a versatile synthesized grid simulator, as a fast 3-phase full 4-quadrant voltage or current amplifier and as a programmable RLC electronic load.

www.regatron.com

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COMPANY DECSRIPTION:
We are one of the worldwide leading manufacturers for analogue linear transistor amplifiers, AC/DC current and voltage power supplies for industrial measurement and testing systems. Our services extend from single amplifiers for AC and DC mains simulation to complex completely computer controlled testing and measurement systems. Based on our 4-quadrant linear power amplifiers we are able to simulate all supply voltages from DC to several hundred kHz with power up to the megawatt range.

HIGHLIGHTED PRODUCT:
The APS 4-quadrant power amplifier is a universal source for both voltage and current applications with a power capability between 1kVA and 60kVA per phase.

— The adjustable and desired output current is automatically regulated and stabilized according to the user's preferences, the only limitation is the amplifier's performance characteristic.

— The main APS benefits are a very high peak load ability, adjustable low internal resistance, fast slew rate as well as low harmonic distortion.

— It's bandwidth is from DC to 10kHz (large signal) up to 50kHz (small signal), overload monitoring allows long and short term overload possibilities.

— The sink operation mode and the adjustable voltage and current limitation is the base for flexible applications. The high-speed optical interface is ideal for PHIL applications.

www.spitzenberger.de

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OMICRON

COMPANY DECSRIPTION:
OMICRON serves the electrical power industry with innovative products and services for testing, diagnostics and monitoring of assets worldwide. We help to make the generation, transmission and distribution of electricity safe and reliable.

PRODUCT DESCRIPTION:
CMS 356 – Voltage and Current Amplifier for Power System Simulations

The CMS 356 voltage and current amplifier is the link between your real-time power system simulation and the protection relay. The signals received from the power system simulator are amplified and fed into VT and CT inputs of the devices under test.

KEY FEATURES:
- Numerous output configurations, for example, 3 x 300 V + 3 x 64 A or 6 x 32 A
- Parallel connection of several CMS 356 units for even higher current amplitudes
- Easy-to-use web interface
- New digital interface to power system simulators

StationGuard - Cyber security and functional monitoring for substations:
The Intrusion Detection System StationGuard can monitor Ethernet networks in substations and detects suspicious behavior, unauthorized actions and malfunctions on the IEC 61850 station or process bus. StationGuard uses the substation's SCL file to create a complete system model of the IEC 61850 SAS and substation and then compares each individual packet in the network with the live system model. StationGuard performs a detailed verification of all data traffic. StationGuard is configured without a learning phase, using only the SCL description of the system and a few manual entries.

www.omicronenergy.com

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LUCAS-NÜLLE

COMPANY DECSRIPTION:
Lucas-Nülle GmbH develops and produces innovative training systems for vocational training worldwide. With Lucas-Nülle, trainees and employees in continuing education learn skills in more than 15 different technical fields. The training systems are practice-oriented and cover complex technical topics. The basis is a didactic concept based on experimental hands-on training. With its principles Lucas-Nülle has been successfully convincing schools, universities and training companies all over the world for over 45 years. The company has also been a pioneer in digital education for more than 20 years. All teaching devices are connected to digital learning content, which guides the user in experimental learning and controls his success. In the field of electrical engineering, Lucas-Nülle offers completelab from power generation to consumtion.

Since 2017, the company has also been offering its own e-learning platform, VOCANTO. Lucas-Nülle expanded its offering with the cloud-based tool and now offers content from the commercial and scientific fields in addition to the technical professions. Lucas-Nülle GmbH cooperates with three subsidiaries in the USA, the United Arab Emirates and China as well as with trading partners in more than 130 countries. The companies with a total of approx. 160 employees generated an annual turnover of approx. 40 million euros in 2018.

PRODUCT DESCRIPTION:
The perfect combination of virtual reality and state-of-the-art training system Thanks to a successful cooperation with OPAL-RT, now complex simulations are possible with Lucas-Nülle's Power Engineering Training systems.

The new system integrates modern hardware-in-the-loop simulation tools from OPAL-RT with the practical training systems from Lucas-Nülle. On the one hand, this increases the range of applications for the Lucas-Nülle power engineering systems, especially in higher education. On the other hand, the cooperation offers OPAL-RT users the opportunity to test their own simulations on authentic hardware Modular Reconfigurable Microgrid PHIL Laboratory:

- Simulate, observe and control the power flow of the interactive real-time MicrogridSimulation System running a high-accuracy real-time simulation of a complete grid/ microgrid network and DERs. Design your own microgrid network topology or modify an existing one
- Interact with real DER modules provided by Lucas-Nülle training system (photovoltaics, wind turbine, batteries, loads) by using the innovative OPAL-RT 4-Quadrant PHIL Amplifier

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