OMICRON

4TH Annual Canada Protection Symposium

The Westin Harbour Castle, Toronto
December 3 – 5, 2019

WELCOME

4TH ANNUAL CANADA PROTECTION SYMPOSIUM

OMICRON

Dear Participant,

On behalf of the entire OMICRON team, welcome to the **4th Annual Canada Protection Symposium (CPS)**. We encourage you to be an active participant by asking questions, and sharing your experiences.

We have assembled an exciting agenda covering various topics impacting our industry. This is a thrilling time to be part of the electric power industry with so many emerging technologies such as microgrids, system based testing, big data, DERs, IEC 61850 implementation, etc.

Plans are already underway for next year's CPS. It will be held December 1-3, 2020. Please mark your calendars and save the date.

OMICRON has a dedicated team located in Toronto. Our office in Toronto provides **application and technical support, customer service, training, and sales management**. Keep an eye out for additional seminars and training classes being offered in Canada in 2020. And, don't hesitate to call on us whenever we can be of assistance.

Thank you to all of our presenters for giving their valuable time and for sharing their expertise and knowledge. A special thank you to G&W Electric for once again hosting the welcome reception, and dinner.

Welcome again to the 4th Annual Canada Protection Symposium.

Sincerely,
Wayne Bishop Jr. & Kevin Donaldson

For OMICRON events visit omicronenergy.com/events
or for trainings, visit omicronenergy.com/training

Agenda

Tuesday | December 3, 2019

7:30 Check-in & Continental Breakfast

8:00 Welcome, Agenda Overview, and Speaker Introduction
Wayne Bishop, OMICRON
Eugenio Carvalheira, OMICRON

8:10 IEC 61850 Tutorial by OMICRON
This optional half-day session gives an introduction to the IEC 61850 standard for participants with little or no experience. It enables participants to get familiar with the standard and technologies.

12:00 Networking Lunch

1:00 Distribution Automation Tutorial by G&W Electric
This optional half-day session will go over ABB, GE, and SEL relays and their uses with underground switchgear. Topics that will be covered are automation, capabilities, communications, protection and what needs to be considered when designing controls using each relay. There will be case studies for each relay covered such as fault location, isolation, service restoration and loss of voltage when using ABB relays and SF6 switchgear. The tutorial is graciously hosted by G&W Electric.

6:00 Welcome Reception
Firkin on Harbour - 10 Yonge St, Toronto, M5E 1R4
Drinks and dinner graciously hosted by G&W Electric

Wednesday | December 4, 2019

7:15 Check-in & Breakfast Buffet

8:00 Welcome, Agenda Overview, and Speaker Introduction
Wayne Bishop, OMICRON

8:15 Opening Keynote Address
Dr. Edmund O. Schweitzer, III, founder of Schweitzer Engineering Laboratories

9:00 The Evolution of Transformer Protection Schemes and How to Test Them
Christopher Pritchard, OMICRON

9:30 ComEd's Experiences Designing and Implementing IEC 61850
John Bettler, ComEd

10:00 Coffee Break
Tech Talk & Visit Equipment Displays

10:30 NERC PRC-024-02 and PRC-025-02 Case Study
Jean-François Veilleux, CIMA+

11:00 Attacking an IEC 61850 Substation
Fred Steinhauser, OMICRON

11:30 Asset Performance Management (APM) – Data, Analytics and Flexible Dashboards
John McDonald, GE

12:00 Networking Lunch

1:30 Advances in Generator Protection
Dale Finney, SEL

2:00 Managing the New Grid
Damir Novosel, Quanta Technology
Farid Katiraei, Quanta Technology

2:30 Validation of Power Network Simulations with RelaySimTest and Commercial Simulation Software
Stephan Brettschneider, Stantec

3:00 Coffee Break
Tech Talk & Visit Equipment Displays

3:30 History of IEC 61850: Past, Present, Future
Alex Apostolov, PAC World

4:00 Centralized Protection and Modern Communication within a Distribution Network
Valeri Oganezov, ABB

4:30 Panel Discussion: Creating a Culture of Trust
Jackie Peer, OMICRON
Lorraine Gray, Hydro One
John Kumm, POWER Engineers
Jeff Mitchell, ReliabilityFirst

5:30 Reception
Drinks and dinner hosted by OMICRON

Thursday | December 5, 2019

7:15 Breakfast Buffet

8:00 Welcome, Agenda Overview, and Speaker Introduction
Wayne Bishop, OMICRON

Agenda

8:15 Keynote Speaker
Andrew Spencer, VP Transmission and Stations, Hydro One

9:00 Best of Both Worlds – Analog Protection Principles in a Digital Relay
Bogdan Kasztenny, SEL

9:30 Transmission Protection Modeling and NERC Compliance Automation
Muna Anazodo, Hydro One
Ryan Parappilly, Hydro One
Ishwarjot Anand, Quanta Technology

10:00 Coffee Break
Tech Talk & Visit Equipment Displays

10:30 Bulk Power System Transformation
Mark Lauby, NERC

11:00 Engineering a Cyber-Resilient Smart Grid
Eman Hammad, PwC

11:30 FLISR, LOV, and Improved Reliability
Katherine Cummings, G&W Electric
Robert Westphal, G&W Electric

12:00 Networking Lunch

1:30 Automated Distribution Coordination Setting Evaluation
Mehrdad Chapariha, Quanta Technology

2:00 Substation Automation Systems – From Engineering to Automated Testing
Eugenio Carvalheira, OMICRON

2:30 Coffee Break
Tech Talk & Visit Equipment Displays

3:00 Distribution System Automation Using IEC 61850 Protocol for Automatic Restoration
Himanshu Tiwari, S&C Electric
Rupali Jain, S&C Electric

3:30 Hybrid Renewable Energy Standalone Systems
Ambrish Chandra, ETSMTL

4:00 System-Based Testing
Kevin Donaldson, OMICRON

4:30 Final Words and Conclusion of CPS
Derek Brown, OMICRON

Opening Keynote Address

Dr. Edmund O. Schweitzer, III, Ph.D.
President, Chairman of the Board, and Chief Technology Officer, SEL

Dr. Edmund O. Schweitzer, III, is recognized as a pioneer in digital protection and holds the grade of Fellow in the IEEE, a title bestowed on less than one percent of IEEE members. In 2002, he was elected as a member of the National Academy of Engineering.

Dr. Schweitzer received the 2012 Medal in Power Engineering, the highest award given by IEEE, for his leadership in revolutionizing the performance of electrical power systems with computer-based protection and control equipment.

In 2019, Dr. Schweitzer will be inducted into the National Inventors Hall of Fame for his invention of the first digital protective relay.

Dr. Schweitzer is the recipient of the Regents' Distinguished Alumnus Award and Graduate Alumni Achievement Award from Washington State University and the Purdue University Outstanding Electrical and Computer Engineer Award. He has also been awarded honorary doctorates from both the Universidad Autónoma de Nuevo León, in Monterrey, Mexico, and the Universidad Autónoma de San Luis Potosí, in San Luis Potosí, Mexico, for his contributions to the development of electric power systems worldwide. He has written dozens of technical papers in the areas of digital relay design and reliability and holds more than 200 patents worldwide pertaining to electric power system protection, metering, monitoring and control.

Dr. Schweitzer received his bachelor's and master's degrees in electrical engineering from Purdue University, and his doctorate from Washington State University. He served on the electrical engineering faculties of Ohio University and Washington State University, and in 1982, he founded Schweitzer Engineering Laboratories, Inc. (SEL), to develop and manufacture digital protective relays and related products and services.

SEL is a 100 percent employee-owned company that serves the power industry worldwide through the design,manufacture, supply, and support of products and services for power system protection, monitoring, control, automation, and metering. SEL offers unmatched local technical support; a worldwide, ten-year product warranty; and a commitment to making electric power safer, more reliable, and more economical.

Keynote Speaker

Andrew Spencer
VP Transmission and Stations, Hydro One

Andrew Spencer has been with Hydro One Networks since 2002 and has held a variety of technical and leadership positions within the organization. As Hydro One's Vice President, Transmission & Stations, Andrew now leads a team of approximately 3,000, accountable for the safe, reliable and cost effective delivery of an annual work program of $1.5 billion per year build and maintain Ontario's electricity grid.

Following a degree in Electrical Engineering from Queen's University, Andrew's career began in field-service engineering roles focused on troubleshooting and support to maintenance and operations staff. In 2006 he transitioned into the manager of this team, and has taken on a number of management roles of increasing scope and complexity since where he has led teams accountable for Maintenance, Asset Management, Engineering. In August 2017, Andrew accepted the opportunity to lead the Transmission & Stations business unit with accountability for project delivery framework, Construction & Maintenance Operations for Hydro One's 29,000km of Transmission and 1,300 substations at transmission and distribution voltages. Andrew has been at the heart of many of the strategic and transformational initiatives at Hydro One.

He is the co-chair of Hydro One's Charity Campaign and is a champion of diversity and inclusion. He challenges the status quo and strives for gender parity and inclusion in the workplace. He is the executive sponsor of Men Advocating for Real Change, a network of male leaders at Hydro One who identify and enable the role of men in creating a diverse, equitable, and inclusive culture.

Speakers

Alex Apostolov
PAC World

Alex received MS degree in Electrical Engineering, MS in Applied Mathematics and Ph.D. from the Technical University in Sofia, Bulgaria. He has 40+ years' experience in power systems protection, automation, control and communications.

He is presently Principal Engineer for OMICRON electronics in Los Angeles, CA. He is IEEE Fellow and Member of the Power Systems Relaying and Control Committee. He is past Chairman of the Relay Communications Subcommittee, serves on many IEEE PES Working Groups and is Chairman of Working Groups C2 "Role of Protective Relaying in Smart Grid".

He is a member of IEC TC57 working groups 10, 17, 18 and 19 and Convenor of CIGRE WG B5.53 "Test Strategy for Protection, Automation and Control (PAC) functions in a full digital substation based on IEC 61850 applications" and member of several other CIGRE B5 working groups. He is a Distinguished Member of CIGRE.

Ambrish Chandra
ETSMTL

Ambrish is a professor of Electrical Engineering at École de technologie supérieure (ÉTS), Montréal since 1999. He received B.E. degree from the University of Roorkee (presently IITR), India, M. Tech. from IIT Delhi, and Ph.D. from University of Calgary, in 1977, 1980, and 1987, respectively. Before joining as an Associate Professor at ÉTS in 1994, he worked as a faculty at IITR. From 2012-15, he was the director of multidisciplinary graduate program on Renewable Energy and Energy Efficiency at ÉTS. Presently, he is the director of the master program in Electrical Engineering at ÉTS. The primary focus of his work is related to the advancement of new theory and control algorithms for power electronic converters for power quality improvement in distribution systems and integration of renewable energy sources. The key differentiator of his work is in its simplicity and practicality of new solutions and has had significant impact. His research work is referred by the engineers as well as researchers around the world. His total Google citations are more than 13600, h-Index 48, i10-Index 156.

Speakers

Bogdan Kasztenny
SEL

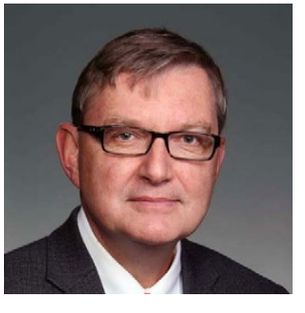
Bogdan has been working in power system protection and control since 1989. In his decade-long academic career, Dr. Kasztenny taught power system and signal processing courses at several universities and conducted applied research for several relay manufacturers. Since 1999, Bogdan has been designing, applying, and supporting protection, control, and fault-locating products with their global installed base counted in thousands of installations. Since 2009, Bogdan has been with Schweitzer Engineering Laboratories, Inc. Bogdan is an IEEE Fellow, Senior Fulbright Fellow, Canadian representative of the CIGRE Study Committee B5, and registered professional engineer in the province of Ontario. Bogdan has been serving since 2011 on the Western Protective Relay Conference Program Committee and since 2015, on the Developments in Power System Protection Conference Program Committee. Bogdan has authored over 200 technical papers and holds over 40 patents.

Christopher Pritchard
OMICRON

Christopher was born in Dortmund, Germany. He started his career in power as an electrical energy technician. Christopher received a diploma in Electrical Engineering at the University of Applied Science in Dortmund in 2006. He joined OMICRON electronics in 2006 where he worked in application software development and as the responsible Product Manager for system-based testing solutions, before he was appointed to his current position as head of product management in the field of testing solutions for protection and measurement systems.

Dale Finney
SEL

Dale Finney received his bachelor of engineering degree from Lakehead University and his master of engineering degree from the University of Toronto. He began his career with Ontario Hydro, where he worked as a protection and control engineer. Mr. Finney is currently employed as a principal engineer with Schweitzer Engineering Laboratories, Inc. Mr. Finney holds over a dozen patents and has authored more than 30 papers in the area of power system protection. He is a member of the main committee and chair of the rotating machinery subcommittee of the IEEE PSRC committee. He is a senior member of the IEEE and a registered professional engineer in the province of Nova Scotia.



Damir Novosel
Quanta Technology

Damir Novosel is president and founder of Quanta Technology, a subsidiary of Quanta Services, a Fortune 500 company. Previously, he was vice president of ABB Automation Products and president of KEMA T&D US. Damir has led development and implementation of pioneering concepts, methods, and products in the areas of automation and power system protection that improved reliability and efficiency of power grids.

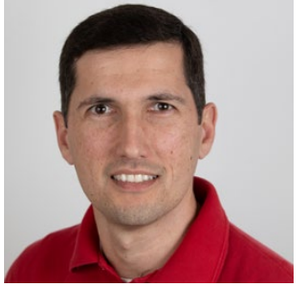
Dr. Novosel is member of US National Academy of Engineers and served as IEEE PES President and Vice President of Technical Activities. He is also a member of the CIGRE US National Committee and received the CIGRE Attwood Associate award. He is presently chairing Industry Technical Support Leadership Committee responsible for IEEE cooperation with global regulatory agencies and corporate engagement.

Damir holds 17 US and international patents, published over 140 articles, and contributed to 5 books.

Speakers

Eman Hammad
PwC

Dr. Eman Hammad combines practical experience and theoretical research to shape her vision for resilient-by-design solutions in the connected world. Eman's work focuses on how a deeper understanding of interactions between critical infrastructure systems and enabling technologies can help design new classes of operational solutions that are more resilient to cyber-physical disruptions. In her current role, she leads as an operational technologies resilience specialist with the Cybersecurity & Privacy practice at PwC with a special focus on critical infrastructures. Eman obtained her Ph.D. in cyber-physical security and resilience of smart grid systems from the University of Toronto in 2018. Eman has published 48 peer reviewed articles in highly ranked journals and conferences. Her research has been recognized with merit awards (best paper award and best poster award) and has been featured on the Smart Cybersecurity Network. Eman has been an active volunteer with IEEE and is currently serving as the chair for IEEE Toronto Communication Society. Her service has been recognized by IEEE chapter achievement and exemplary service awards. Eman has been involved in multiple organizing roles of top conferences and workshops.



Eugenio Carvalheira
OMICRON

Eugenio Carvalheira received his BSc in Electrical Engineering from the UFPE University in Brazil and his MSc in Computational Engineering from the University of Erlangen-Nuremberg in Germany. He has 16+ years' experience in Power Systems Protection, Automation and Control (PAC). He spent part of his career as a Project Engineer responsible for the design, implementation and commissioning of PAC systems at Electrical Substations and Power Plants.

He joined OMICRON in 2008 as a Training and Application Engineer developing test automation solutions for protection relays, providing technical product application support and responsible for the IEC 61850 training courses at OMICRON. He is currently Secondary Engineering Manager for North America based in Houston, TX. He is an active member of IEEE PES serving many PSRC working groups.

Fred Steinhauser
OMICRON

Fred Steinhauser studied Electrical Engineering at the Vienna University of Technology, where he obtained his diploma in 1986 and received a Dr. of Technical Sciences in 1991.

He joined OMICRON In 1998, he worked on several aspects of testing power system protection. Since 2000 he worked as a product manager with a focus on power utility communication. Since 2014 he is active within the Power Utility Communication business of OMICRON, focusing on Digital Substations and serving as an IEC 61850 expert.

Fred Steinhauser is a member of WG10 in the TC57 of the IEC and contributes the standard IEC 61850. He is one of the main authors of the UCA Implementation Guideline for Sampled Values (9-2LE). Within TC95 of IEC, he also contributes to IEC 61850 related topics. As a member of CIGRÉ he is active within the scope of SC D2 and SC B5. He also contributed to the synchrophasor standards IEEE C37.118.1 and IEEE C37.118.2

Rupali Jain
S&C Electric

Rupali Jain is an Electrical Engineer, P.Eng., working as a Project Engineer for Power System Solutions group of S&C Electric Company in Toronto,Canada. She holds a master's degree in Electrical and Computer Engineering from University of Waterloo. She is involved with projects including, power system protection and control, distribution automation, power system analysis with short circuit and coordination studies, and on site testing and commissioning activities.

Speakers

Himanshu Tiwari
S&C Electric

Himanshu Tiwari is a Senior Manager – Custom Engineering in MES-IPT department of S&C Electric Canada Ltd. He has worked on mega projects in Canada, Australia and the Middle East. His work involves electrical distribution system design, system studies, protection and coordination studies and distribution automation. He holds a Bachelor's degree in Electrical Engineering.

Ishwarjot Anand
Quanta Technology

Ishwarjot Anand, is an Advisor in the Protection & Control team at Quanta Technology. He has expertise in computer-aided modeling and analysis of protection systems for both transmission and distribution networks. He has led several protection engineering automation and data management projects, including automation for NERC PRC Standards Compliance. He has worked on large-scale wide-area protection coordination studies for AltaLink, Xcel Energy, and National Grid Saudi Arabia. He has also worked on renewable integration and automation projects.

Muna Anazodo
Hydro One

Muna Anazodo is an electrical engineer specializing in Power Systems Design, specifically Protection and Control at Hydro One. He is a Professional Engineer (P.Eng) of Ontario, and holds a Master's Degree (M.Eng) in Power Systems Engineering from the University of Waterloo, ON, Canada.

Muna has extensive senior level experience in substation design spanning Protection & Control, AC & DC Station Service, Special Protection Systems (SPS) and Remedial Action Schemes (RAS).

Mr. Anazodo has a keen interest for power system protection design and developing computer-aided system models for compliance, feasibility and fault analysis.

Ryan Parappilly
Hydro One

Ryan Parappilly is currently a Senior Protection & Control Engineer in the Standards & New Technology Department at Hydro One, and has been with the company since 2009. He is a registered professional engineer in the province of Ontario and received his BASc in Electrical Engineering in 2009 from the University of British Columbia. Ryan has extensive experience in Hydro One's P&C Design and Standards departments, and more recently has focused on P&C compliance initiatives with NERC and NPCC regulatory standards.

Speakers

Jackie Peer
OMICRON

Jackie M. Peer earned a BS in electrical engineering from Washington State University and currently serves at OMICRON electronics as the Head of Strategic Business Development in North America.

Prior to her employment at OMICRON, Ms. Peer worked over two decades for Schweitzer Engineering Laboratories (SEL) where she held a variety of leadership positions in R&D, sales, and technical marketing, and as director of SEL's Modern Solutions Power Systems Conference and SEL University. Prior to SEL, she held positions with the U.S. Army Corps of Engineers, electrical distribution sales, and at a pulp and paper industrial plant.

Ms. Peer is a senior member of IEEE and the Society of Women Engineers, IEEE Women in Engineering (WiE) member, and board member for IEEE Women in Power (WiP) and IEEE Foundation. She has been involved at the regional and national levels with the IEEE Scholarship Plus Initiative™, whose purpose is increasing the supply of well-qualified, entry-level engineers to the power and energy industry.

Jeff Mitchell
ReliabilityFirst

Jeff has worked for ReliabilityFirst since its inception in January 2006. He oversees the regional resource and transmission reliability assessments and facilitation of the stakeholder technical groups. He has served as the past chair of the NERC Planning Committee and the Eastern Interconnection Reliability Assessment Group (ERAG) Management Committee. Jeff has been involved with the NERC human performance efforts since its inception, and champions the ReliabilityFirst activities on human performance improvement.

Previously, Jeff worked with ECAR as Manager of Transmission Services and Senior Engineer supporting the planning, protection, and equipment activities within the region. Prior to joining ECAR, Jeff worked for FirstEnergy in various positions, mostly in transmission planning and distribution protection.

Jeff is a registered Professional Engineer in Ohio and Pennsylvania and received his BSET degree from the University of Akron.

John Bettler
ComEd

John Bettler, PE. John has a BSEE from Iowa State and a MSEE from Illinois Institute of Technology. John has worked at the Chicago area power company ComEd for 29 years. He has experience as a field engineer and protection engineer. Currently he is the Principal Engineer for ComEd's relay section and his team's purview includes 4kV & 12kV feeders up to 765kV transmission lines and all T&D equipment in between (TR / Buses / Cap / Inductors). John's team also reviews interconnections, IPP and Distribution Generation projects. John is also adjunct faculty at IIT and UW Madison teaching power & protection classes. He is a PE in the State of IL.

John Kumm
POWER Engineers

John Kumm is with POWER Engineers, serving as Vice President, Field Services and Director for Testing and Energization. John has been with POWER in their Clarkston, WA office since 2007.

John graduated from the University of Idaho in 1989 with a BS in Electrical Engineering and earned an Executive MBA degree from Boise State University in 2011. His career in the power industry includes experience as an applications and product engineer at Schweitzer Engineering Laboratories in Pullman, WA and eight years leading his own consulting firm. He and his team served electric utilities and wind plant owners across the US and in Canada. Since joining POWER, John has served in several project management and engineering leadership roles.

John is a regular author and presenter of technical papers and presentations in the fields of protective relaying, human performance improvement, and microgrids and is co-author of the books, "Protective Relaying Quick Reference" and "Human Performance Improvement Pocket Guide."

Speakers

John McDonald
GE

John D. McDonald, P.E., is Smart Grid Business Development Leader for GE's Grid Solutions business. John has 45 years of experience in the electric utility transmission and distribution industry. John received his B.S.E.E. and M.S.E.E. (Power Engineering) degrees from Purdue University, and an M.B.A. (Finance) degree from the University of California-Berkeley. John is a Life Fellow of IEEE, and was awarded the IEEE Millennium Medal, the IEEE Power & Energy Society (PES) Excellence in Power Distribution Engineering Award, the IEEE PES Substations Committee Distinguished Service Award, and the IEEE PES Meritorious Service Award. John is Past President of the IEEE PES, the VP for Technical Activities for the US National Committee (USNC) of CIGRE, the Past Chair of the IEEE PES Substations Committee, and the IEEE Division VII Past Director. John received the 2009 Outstanding Electrical and Computer Engineer Award from Purdue University. John has published over one hundred papers and articles, has co-authored five books and has one US patent.

Katherine Cummings
G&W Electric

Employed by G&W Electric since 2008.

Currently serves as the Manager for Power Grid Automation and previously, a Supervisor for the production electronics engineering group which supports sales orders from quote stage to aftermarket. She is also a G&W internal ISO auditor. Kate held earlier roles with Ohmite Manufacturing as an Application Engineer/Technical Support and Maplechase as a Design Engineer.

She is actively involved in a number of professional organizations including IEEE (10 years), IEEE PES (6 years) and NEMA (3 years). Kate spoke at the Omicron Recloser and DA Conference in Houston, TX during 2016, 2017, and 2019, the Omicron Conference in Toronto December 2018, and at the Survalent Users Forum in Destin, FL in 2018.

Lorraine Gray
Hydro One

Lorraine Gray is an Electrical Engineer and a Stations Services Superintendent. She manages a team of 100+ trades' professionals to maintain over 250 stations for Hydro One. She has held management positions in Technical Services, Project Management, and Stations Services. She is deeply passionate about empowering others within her team and the organization at large. She is also one of the founding members of Hydro One's Women in Trades, Technology, and Engineering employee resource group.

Kevin Donaldson
OMICRON

Kevin joined OMICRON in 2014 and is currently the Area Sales Manager for Canada East. Prior to joining OMICRON in 2014, Kevin worked for various organizations and has over 20 years of experience in the Electrical Power System industry.

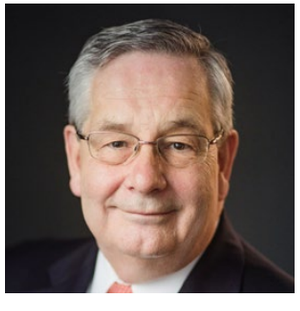
Kevin has a broad knowledge and experience in protective relaying schemes, as well as electrical power system fault analysis, automation & control design, and testing & commissioning electrical grid assets.

Kevin has presented lectures at Industry Conferences, including: Hands-On Relay School (Western Energy Institute), CEATI Conference – Protection & Control Workshop, Smart Grid Technologies Symposium and numerous utility lectures & training events.

Speakers

Mehrdad Chapariha
Quanta Technology

Dr. Mehrdad Chapariha specializes in modeling and computer simulation of power systems with focus on modeling accuracy, user experience, and process efficiency. He is actively leading the research and development activities in Quanta Technology to improve the distribution protection settings evaluation process by using software solutions. Mehrdad has been a member of IEEE since 2008, authored several technical papers, and is serving as a reviewer for the IEEE Transactions on Energy Conversion. Mehrdad obtained his Ph.D. in electrical and computer engineering from the University of British Columbia in 2013. In addition to power systems protection modeling and automated evaluation, Mehrdad worked extensively on power systems dynamics and electromagnetic transient modeling and studies.



Mark Lauby
NERC

Mark G. Lauby is senior vice president and chief engineer at the North American Electric Reliability Corporation (NERC). Mr. Lauby joined NERC in January 2007 and has held a number of positions, including vice president and director of Standards and vice president and director of Reliability Assessments and Performance Analysis.

In 2012, Mr. Lauby was elected to the North American Energy Standards Board and was appointed to the Department of Energy's Electric Advisory Committee by the Secretary of Energy in 2014. Mr. Lauby has served as chair and is a life member of the International Electricity Research Exchange, and served as chair of a number of IEEE working groups. From 1999 to 2007, Mr. Lauby was appointed as a member of the Board of Excellent Energy International Co., LTD, an energy service company based in Thailand. He has been recognized for his technical achievements in many technical associations, including the 1992 IEEE Walter Fee Young Engineer of the Year Award. He was named a Fellow by IEEE in November 2011 for "leadership in the development and application of techniques for bulk power system reliability."

Stephan Brettschneider
Stantec

Stephan received his engineering degree from the Technical University of Karlsruhe in Germany in the field of electrical energy systems and high voltage technologies. Afterwards, he obtained a Ph.D. in the field of high voltage discharges from the University of Québec in Chicoutimi. He then worked in the power industry for about 18 years. First, he held a position as a service engineer for a supplier of high voltage laboratory equipment. Starting from 2003, he has worked for a consulting company in the field of power network analysis and design, as well as in the design and testing of protection system. Since August 2019, he has been a professor at the University of Québec in Chicoutimi in the field of modern power networks.

Robert Westphal
G&W Electric

Robert Westphal is a Power Grid Automation Engineer at G&W Electric Co. in Bolingbrook, IL. Robert joined G&W in 2014 in the Production Engineering group where he focused on switchgear control design. He now specifies, develops, and commissions automation solutions for medium voltage distribution systems. He received his B.S. in Electrical Engineering from Northern Illinois University.

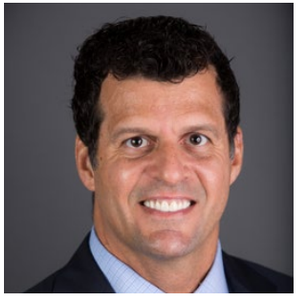
Speakers

Farid Katiraei
Quanta Technology

Farid Katiraei, Ph.D. is a senior director and head of Advanced Technology Integration business area for Quanta Technology. He has more than 17 years of professional experience in the areas of distributed and renewable energy resources, microgrids, and applications of power electronics in power systems for non-wires alternatives. In the recent years, Farid has been the technical leads for design, development and integration of several key grid modernization projects for utilities in North America involving renewable technologies, energy storage, advanced distribution automation, and community microgrids. Farid has received his PhD from University of Toronto. He is a Senior Member of IEEE, Steering committee member of the international microgrid symposium, and active participant in several technical working groups and standards development taskforces within IEEE, IEC and CIGRE.

Valeri Oganezov
ABB

Dr. Valeri L. Oganezov combines over 20 years of experience in the field of research and development, consulting, utilities and manufacturing. He joined ABB in 2008 and worked in various fields including high and medium voltage apparatus design, gas and air insulated switchgear design, distribution automation, engineering and research and development.



Wayne Bishop
OMICRON

Wayne Bishop Jr. currently works for OMICRON where he is the Head of Marketing for North America. Prior to OMICRON, Wayne was employed at Doble Engineering for more than 16 years in several senior management positions. He is a Senior Member of the IEEE Power and Energy Society, where he serves on the IEEE PES Long Range Planning Committee, the Finance Committee, and the IEEE PES Governing Board. Wayne is currently Vice President of Meetings and Conferences for IEEE PES where he is responsible for oversight of all IEEE PES Meetings and Conferences worldwide.

Wayne is a graduate of Merrimack College, Harvard University, and the Executive MBA Program at Suffolk University in Boston, graduating with honors.

He is also a recipient of the Suffolk Executive MBA Great Leaders Executive Excellence Award. He has also been inducted into Beta Gamma Sigma—the National Honor Society of Business Schools. Wayne is an Eagle Scout and lives in the greater Boston area.

Our Sponsors

OMICRON values the collaboration with industry partners. Special thanks to this year's sponsors.

Abstracts

Hybrid Renewable Energy Standalone Systems

Ambrish Chandra, ETSMTL

Several isolated areas in the world currently use only diesel generators (DGs) to serve their requirements of electrical energy. However, the use of DGs has many drawbacks: 1) high cost of electricity, 2) air and noise pollution, 3) Loss in fuel efficiency and maintenance cost. To remedy those problems it is better to generate power from a cost-effective, environmental friendly renewable energy sources (RESs) such as wind, solar, hydro, biomass, etc. RESs are clean and almost available all over the planet but are intermittent in nature, especially wind and solar power generations. This makes their integration to micro-grid with DG difficult, especially if the local grid is not connected to the main grid. Hybrid standalone system consists of many elements such as photovoltaic panels, wind turbines, DG, energy storage system, AC and DC loads, dump load etc. Most of these elements are connected to the AC or DC bus via power electronic devices. In this presentation many possible hybrid renewable energy standalone systems will be discussed. Control of some of the systems will be discussed in detail.

Best of Both Worlds – Analog Protection Principles in a Digital Relay

Bogdan Kasztenny, SEL

When semiconductor components became rugged enough for protective relay applications, relay designers introduced designs based on filtering and coincidence timing using analog circuits with semiconductors. Free of the inherent inertia of electromechanical devices, these relays operated extremely fast. As the industry continued to learn about electromagnetic interference and semiconductor failure modes, microprocessor-based relays emerged and brought unprecedented flexibility, new functionality, and unparalleled self-monitoring to address weaknesses of the early semiconductor technology. Manufacturers and users shifted toward the digital technology and the static relays became a "lost generation".

The early digital relays had very limited sampling and processing rates. Out of necessity, these relays abandoned the time-domain approaches of static relays and started a new path for implementing protection functions. This new path focused on "slowing down" the flow of information so that early microprocessors could keep up. These relays applied heavy low-pass filtering to sample just several times a cycle and "compressed samples into phasors" at the front end of the processing chain for the key benefit of processing these phasors at very low rates such as once, twice, or just a few times a cycle. Even today, many relays process protection logic just a few times a cycle.

Early digital relays did not abandon time-domain coincidence timing because of its substandard performance, but because their limited processing power did not allow them to use the analog methods. Over the first three decades of microprocessor-based relays, digital protection and phasor-based operation became synonyms. It is time to revisit this notion. Recent digital relays have enormous processing capabilities. High sampling and processing rates allow implementing principles invented for static relays. This presentation reviews the basics of coincidence timing for shaping distance element characteristics (mho, quadrilateral), explains benefits of using coincidence timing, shows digital implementations and improvements that far surpass dreams of analog relay designers, and presents test results of modern distance relay implementations using the best of both worlds – analog principles implemented in a digital relay.

Abstracts

The Evolution of Transformer Protection Schemes and How to Test Them

Christopher Pritchard, OMICRON

During the last decade, we witnessed the development from traveling-wave based, standalone fault locators to relays with integrated traveling-wave fault locators to new line protective relays that use traveling waves for tripping. Together with very fast superimposed component elements, these relays leverage the communications bandwidth available today and include sophisticated differential schemes that work on time-domain currents and voltages. As this technology is new, information on its deployment to the field is limited:

How do we test these relays in the field? Do we need different test sets? Do we need to adjust our testing methodologies to accommodate these new relays?

We will address these and other key questions by first explaining the common characteristics of traveling-wave and superimposed-component protection principles. From there, we derive the desired characteristic of the test equipment and test tools and present a suggested testing methodology.

Finally, we will discuss a real-world installation at a utility, its project goals, site selection, design, setting considerations and field commissioning.

Advances in Generator Protection

Dale Finney, SEL

Synchronous generators are complex, electrical machines. Comprehensive generator protection must consider stator and rotor winding failures as well as abnormal operating conditions that can lead to overheating of the rotor or stator or cause turbine damage. In addition, a host of other failures require protection, including breaker failure, breaker flashover, and accidental energization. The integration of these numerous functions within the first generation of digital protective relays represented a significant advancement. Most of the protection algorithms were implemented as electromechanical equivalents. However, a digital relay is capable of much more. This presentation describes several new protection enhancements that leverage the capabilities of a modern digital relay, including loss-of-field, generator unbalance, and stator faults.

Managing the New Grid

Damir Novosel, Quanta Technology
Farid Katiraei, Quanta Technology

Efficient and safe electrical power system operation is critical to our society. Key society targets include decarbonization, reliability and resilience, and affordable electrical energy prices. The electrical power and energy industry is changing rapidly to meet those society targets and address challenges. New industry trends include development and proliferation of the following technologies: renewable resources; energy storage; electrical transportation; monitoring, protection, and control systems and devices; automation; and communication infrastructure. Those technologies offer significant opportunities for realizing a sustainable energy future.

Key for de-carbonization is electrification that requires investments in a robust, hybrid electrical system. We are at a crossroads in making business and technical decisions that will allow us to optimally and cost-effectively manage the electrical system.

The presentation will address some of the challenges and opportunities facing modern electrical systems and how industry trends and innovation will shape the future. Topics included are:

> Industry trends and transformation drivers
> Opportunities and challenges with distributed energy resources, microgrids, electrification, and storage
> Monitoring, control, protection, and automation technologies for the changing nature of the grid
> Importance of testing and standards
> Key success factors to prepare for the electrical system of the future

Engineering a Cyber-Resilient Smart Grid

Eman Hammad, PwC

The smart grid is recognized as the most critical infrastructure, where the assumption of reliable and secure availability of electric power underpins the digital revolution that continues to transform our modern lives. The digital transformation of the smart grid is reshaping the interactions between smart grid systems components, between power systems and consumers, and between power systems and other interdependent critical infrastructures. Cybersecurity and resilience of smartgrids are essential enablers for continued innovation, however, existing standards and regulations follow a bottom-up technology-focused approach that may not sufficiently address the risks across the different smart grid operational layers. In this presentation, we expand the benefits of cyber-physical modeling as a useful tool to capture much of the innovation, cyber-physical threats, risks and uncertainty. We present an operational risk-based model for smart-grids that efficiently captures cyber-physical uncertainties and enables a better resilient operation. This model utilizes a cyber-physical risk metric that can be used as a parameter for operation. We also expand on the need for a data-driven definition of trust between the different smart grid system components. Finally, we outline how further studies in this direction can provide better system coordination.

Substation Automation Systems – From Engineering to Automated Testing

Eugenio Carvalheira, OMICRON

During the life cycle of a Substation Automation System (SAS), testing the communication, interlocking logic and proper operation of all signals transmitted to Supervisory Control and Data Acquisition (SCADA) systems take considerable effort and time. In a substation which makes use of IEC 61850 communication, all the engineering and configuration data can be saved in standard-format files, the so-called System Configuration Language (SCL) files. This paper presents a new test approach that increases efficiency in testing the automation and control functionality of a SAS, which is based on consuming SCL file information. This paper discusses the Intelligent Electronic Device (IED) data model and SCL file requirements that should be considered when specifying and designing a system as well as network design considerations to support testing.

Abstracts

Attacking an IEC 61850 Substation
Fred Steinhauser, OMICRON
Cyber security in substation communication networks is different from cyber secutity in normal IT networks. The attacks are very specific and there are too few of them that a system could learn from them. Cyber security measures cannot work like virus scanners that are fed by findings and experiences from many incidents world-wide. A different appproach has to be taken and for IEC 61850 system, this approach shall be based on the IEC 61850 system configuration description as well. To make the related information accessible also to substation engineers and not only to IT administrators, a user oriented interface provides a consolitaed and intuitive view.

Distribution System Automation using IEC 61850 protocol for Automatic Restoration
Himanshu Tiwari, S&C Electric
Rupali Jain, S&C Electric
This is a case study of an Ontario waste water treatment plant fed by a 3.8 kV utility feed and standby diesel generators. Given the facility's size and loads, power is distributed throughout on a 13.8 kV double-loop system. Using six Remote Supervisory Vista switchgear with protective relays for each loop, the challenge was to automate the controller logic for protection, isolation and restoration of the loop in the event of a downstream fault. The ultimate goal was to provide automatic restoration and balance or shed load as required all without any human intervention and using IEC 61850 protocol. Attend this session to learn about the considerations for design and implementation that S&C made to successfully complete this project for the customer.

Transmission Protection Modeling and NERC Compliance Automation
Muna Anazodo, Hydro One
Ryan Parappilly, Hydro One
Ishwarjot Anand, Quanta Technology
The growing complexity of modern protective devices with hundreds of functionalities and the evolving nature of power grids have posed several challenges to the transmission system operators. To determine the appropriate settings for the protective relays, and to ensure the reliability and resilience of the grid by complying to NERC PRC standards (such as PRC-026 and PRC-027), power system protection engineers need to simulate and analyze protection system behavior using modern software applications.

This presentation aims to present new automation-based approaches for modeling of complex protection functions, and simulation and analysis of the protection system performance for compliance with certain NERC PRC standards. Besides reducing time and effort, the automated approach effectively reduces errors, and therefore, increases confidence in the model and subsequent analysis. The presentation also describes the efficiency and reliability of the automated approaches based on implementation on a large power system network of over 500 transmission lines. The presentation also explores the various challenges associated with sustainability of the automated approaches, such as establishing processes for model management, tools maintenance, and training.

ComEd's Experiences Designing and Implementing IEC 61850
John Bettler, ComEd
For the past 7 years, ComEd has implemented a 61850 V1 scheme at several Intel Sub Substation. Its use was primarily messaging and in a few special cases, tripping. The was no use of special modes like Test or Block, wiring was a standard design for both DC Tripping and C/P.

But in an effort to improve reliability, enhance compliance and ultimately lower costs, ComEd has become designing five 61850 V2 stations (or major modifications to substations) and has 4 more in the planning phase. These stations will all utilize GOOSE tripping and one station will use Sampled values for several System 1 bus differential schemes. The first of these stations is under design, with construction beginning in the Fall and in service in Q3 / Q4 of 2020.

ComEd's Principal Engineer John Bettler will discuss the trial and tribulations his team has encountered while moving to implementation a 61850 V2 substation. Discussion to system design and topology, Station Bus/Process bus learnings, standardization opportunities, issues encountered and other fun facts.

Asset Performance Management (APM) – Data, Analytics and Flexible Dashboards
John McDonald, GE
This talk with discuss these topics: Key Outage Cases in Transmission & Distribution; Intelligent Asset Strategies; Extending Useful Asset Life; Power Transformer Example for Traditional Remote Monitoring & Diagnostics (RM&D); Transformer Digital Twin; Minimizing Outages through Analytics: Outage Prediction, Network Connectivity, Storm Readiness, Vegetation Management; Outage Restoration Techniques - a Range of Values => Manual: Control and Legacy Methods, Positive Step over Manual, Automation and Visualization, Digitally Enabled; and APM Integration with ERP Architecture and other IT Systems.

Abstracts

FLISR, LOV, and Improved Reliability

Katherine Cummings, G&W Electric
Robert Westphal, G&W Electric

A utility in midwestern United States realized the need to improve reliability of their distribution system. They decided to deploy a 14-recloser Fault Location, Isolation, and Service Restoration (FLISR) and Loss of Voltage (LOV). As they want it to scale easily, they chose a model-based solution using Survalent software utilizing a centralized control. To maximize reliability results, they required single phase FLISR/LOV in addition to three phase FLISR/LOV. The single phase FLISR/LOV will allow live phases on a node to stay live keeping more meters online.

Validation of Network Simulations with System-Based Testing Software and with Power System Analysis Software

Stephan Brettschneider, Stantec

The availability of detailed data is an ongoing challenge for power system modeling and protection system design. In the case of older existing systems, the owner may no longer have detailed documentation and the nameplates may be rusty and unreadable. For new installations, for example lines and cables, detailed data may not yet be available at the time of system design. Therefore, simplifications must be made in order to create the model of the electrical system. Some effects may be overlooked (e. g. transformer core losses or shunt admittances of lines) and typical values may be taken from reference tables or textbooks. Such simplifications are also interesting in order to facilitate and accelerate the modeling process.

This presentation analyses the impact of certain simplifications on the results obtained during numerical modeling of power networks for steady state simulations of short circuit and power flow. Some case studies are modeled with and without simplifications and the deviations in the obtained results are analysed. Simulations are run using three different software packages to compare whether different programs produce similar results. Two commercial software products for *electrical power system analysis* are compared with a *protection system-based testing software*. The objective is to come up with conclusions on the types of simplifications that would be acceptable and how the modeling process could be shortened without significantly affecting the results.

Bulk Power System Transformation

Mark Lauby, NERC

This is a transformational time for the electric power industry. Unprecedented shifts in the resource mix are occurring very rapidly. During these changes, the transitional and resulting resource mix must support the reliable operation of the Bulk-Power System. The two major emerging issues that should be monitored during the transition are: 1) fuel security and 2) new generation or equipment technologies being integrated into the system.

1) The changing resource mix generally will see the integration of a large magnitude of renewable variable energy resources, distributed energy resources, distribution-centric resources, micro- and smart-grids, demand response technologies as well as an increasing reliance on just-in-time delivery of natural gas to fuel new generating capacity. The pace at which the industry is adopting these changes is extraordinary.

2) New types of generation and technologies are being rapidly added to the system. Integration of more distributed energy resources is another critical consideration for bulk power system reliability. As more renewable and distribution-centric resources are added to the system, sufficient essential reliability services must be maintained to assure a steady system.

The metamorphosis of the bulk power system requires industry to amplify expertise and build collaborative bridges. By identifying and quantifying emerging issues, risk-informed recommendations can be provided and key partners engaged. Collaborative activities throughout industry are needed to support a learning environment towards improved reliability performance.

Automated Distribution Protection Coordination and Settings Evaluation

JMehrdad Chapariha, Quanta Technology

The typical electric power distribution utility may be required to perform hundreds of feeder protection settings and coordination studies each year. The volume of these studies, as well as the quicker turnaround times necessitated by the rapid expansion of renewable resources and evolving regulatory requirements, can place considerable burden on protection engineers. Software-based automation solutions represent one approach to alleviating the burden of these coordination and settings studies.

This presentation discusses the process of a typical study, including challenges with respect to data access, data availability and integrity, and the limitations of existing software tools. A comprehensive automation-based solution is presented to address these concerns and accelerate the execution of distribution coordination studies. An implementation of this solution is demonstrated for a practical distribution system involving interaction with existing industry-standard software sources for network and protection data. In addition to assisting the typical coordination studies done today, this automated solution has potential to form one of the major building blocks for implementation of adaptive protection schemes in the future.

The Evolution of Transformer Protection Schemes and How to Test Them

Kevin Donaldson, OMICRON

Due to modern transformer core materials and increasing relay processing power, time-domain waveshape-based algorithms are becoming attractive alternatives to traditional harmonic-based methods for discriminating between fault and transformer inrush conditions. While time-domain inrush detection increases the speed and security of transformer protection, it also creates a need for new testing methods. Testing with superimposed harmonics (2nd, 4th, 5th, etc.) will not work anymore.

Restricted earth fault (REF) protection increases the sensitivity for internal earth faults close to the starpoint of the transformer. Testing the REF element without disabling other elements, which is considered harmful, is often challenging.

IEC 61850 Sampled Values and low power current transformers (LPCT) can eliminate the issue of CT saturation and at the same time simplify the test setup for the protection system – if the testing solution can take advantage of it.

We will present how a system-based testing approach, where the transformer non-linear behavior of inrush and overexcitation conditions are simulated, can be a simple and efficient solution for all of the cases mentioned above.

46 Participating Companies

An Engineer's Playground

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OMICRON Academy

Houston Training Center

Excellence through Education

IEC 61850 Concepts, Application and Testing

CMC Family, DANEO 400, ISIO 200 | 2 days

Get an introduction to the IEC 61850 standard, its Data Model, Services and Engineering Process. Learn how to work with the Client/Server, GOOSE and Sampled Values services for power utility automation in a combination of theoretical and hands-on sessions. Perform commissioning and functional testing of IEC 61850 based IEDs and systems.

Recloser Control Testing with ARCO 400

ARCO 400 | 1 day

Learn the theory of reclosers and their application in the distributions system. Learn how to test all kinds of recloser controls quickly and reliably with ARCO 400. Get familiar with the software guided workflow of ARCO Control and learn how to prepare test plans for standardized testing. Hands-on practice including meter checks, protective function operating characteristics, reclosing sequences and restoration schemes.

Introduction to Protection Testing

CMC Family | 2 days

This course will focus on the basic skills needed by Protection and Control Technicians/Field Engineers to perform their jobs. Topics include: technical math, fault types, introduction to CT/PT and basic relay concepts. Students will also learn the basic schemes associated with protection and control systems and techniques on how to test them.

Power System Protection Testing with the OMICRON Test Universe

CMC Family | 3 days

This course will focus on testing the most commonly used protection schemes in transmission and distribution systems. Learn how to efaficiently test overcurrent, distance and transformer differential relays with OMICRON Test Universe. Other topics include manual testing, creation of automated test plans, element testing (pick-up and delay time of relay elements) and test of relay logics. Hands-on tests will be performed on electromechanical and digital relays.

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Our customers need powerful, reliable switchgear solutions that last — for the power needs of today and tomorrow. That's why the engineers at G&W Electric take a consultative approach that require technologies for the smart grid of the future.

Our LaZer® Automation System is a technology designed to integrate aging power grid technologies with intelligent devices that support the growing smart grid. LaZer solutions can be pre-engineered or customized for any application, giving added flexibility, scalability, reliability, efficiency and easy integration. LaZer meets today's automation requirements, with capabilities including:

- Fault Isolation and Restoration
- Master Station Solutions
- Voltage Loss Reconfiguration

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