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Conference program schedule

Monday, May 24	
2:30 pm – 5:00 pm	**Tutorial 1** Traceability of Synchrophasor Measurements in Power Systems: Definitions and Methods
5:00 pm – 7:30 pm	**Tutorial 2** Distribution-Level PMUs and their Applications
7:30 pm – 10:00 pm	**Tutorial 3** Tutorial on PMU and Time Series Data Analysis

Tuesday, May 25	
8:00 am – 8:30 am	**Opening session**
8:30 am – 9:45 am	**Panel 3** Synchrophasor and Monitoring data handling: A perspective of ongoing TSOs approaches
9:45 am – 10:00 am	**Break and announcement of the Keynote**
10:00 am – 11:00 am	**Keynote 1** The global green energy transformation is now and calls for accelerated electrification and targeted innovation – seen from Nordic and European TSO perspective
11:00 am – 11:15 am	**Break**
11:15 am – 12:15 pm	**Webinar 3** Time-Synchronized Measurements in Romania – Technology and Applications
12:15 pm – 1:30 pm	**Lunch Break**
1:30 pm – 2:30 pm	**Platinum Sponsorship** Hitachi ABB Power Grids
2:30 pm – 3:00 pm	**Silver Sponsorship 1** Quanta Technology
3:00 pm – 4:00 pm	**Webinar 2** O-spline FIR filters for obtaining the Synchrophasor of Real Signals
4:00 pm – 4:15 pm	**Bronze Sponsorship 1** STER
4:15 pm – 5:30 pm	**Panel 5** The use of machine learning and AI in analysis of historical and on-line synchrophasor data
5:30 pm – 5:45 pm	**Break**
5:45 pm – 7:00 pm	**Panel 1** Role and Use Cases of Real Time Simulators (RTS) Towards Advancing and Deploying Synchrophasor Based Wide Area Monitoring Protection and Control (WAMPAC) Systems
7:00 pm – 7:15 pm	**Break**
7:15 pm – 8:15 pm	**Webinar 6** Data-Driven Analytics and Use Cases for Synchronized Waveform Measurements

Wednesday, May 26	
8:30 am – 9:45 am	**Panel 7** SynchroPhasor-based Automatic Real-time Control in a Nordic perspective
9:45 am – 10:00 am	**Break**
10:00 am – 11:00 am	**Webinar 4** Implementation of EdgePMU for enabling fast and slow dynamics control services in VPP
11:00 am – 11:15 am	**Break**
11:15 am – 12:15 pm	**Webinar 7** Applications of synchronised continuous point on wave (CPOW) monitoring
12:15 pm – 12:30 pm	**Lunch Break**
12:30 pm – 1:15 pm	**Gold Sponsorship 1** Končar
1:30 pm – 2:45 pm	**Panel 9** International Experiences in synchrophasor applications
2:45 pm – 3:00 pm	**Break and announcement of the Keynote**
3:00 pm – 4:00 pm	**Keynote 2** Benefits of Deploying Synchronized Measurements in the T&D Systems - Key Success Factors and Examples
4:00 pm – 4:15 pm	**Break**
4:15 pm – 5:30 pm	**Panel 8** The Experiences on the Applications of Synchronized Measurements in South America
5:30 pm – 5:45 pm	**Break**
5:45 pm – 7:00 pm	**Panel 6** Synchrophasor Deployment: A North American Perspective
7:00 pm – 7:45 pm	**Gold Sponsorship 2** V&R Energy
7:45 pm – 8:45 pm	**Webinar 1** Implementation of State Estimation: A Multi-Scale Framework

Thursday, May 27	
8:15 am – 9:15 am	**Webinar 5** Switch Status Identification in Distribution Networks using Harmonic Synchrophasor Measurements
9:15 am – 9:45 am	**Silver Sponsorship 2** Zaphiro
9:45 am – 10:00 am	**Break and announcement of the Keynote**
10:00 am – 11:00 am	**Keynote 3** A Full-view Synchronized Measurement System for Renewables, Loads, and Power-electronics-enabled Power Grids
11:00 am – 11:15 pm	**Break**
11:15 am – 12:15 pm	**Webinar 8** Impact, advancement, and challenges of clock synchronization on PMUs and their applications
12:15 pm – 1:30 pm	**Lunch Break**
1:30 pm – 2:15 pm	**Gold Sponsorship 3** Siemens
2:15 pm – 2:45 pm	**Silver Sponsorship 3** Pro Integris
2:45 pm – 3:00 pm	**Break**
3:00 pm – 3:45 pm	**Gold Sponsorship 3** SEL - Schweitzer Engineering Laboratories
3:45 pm – 4:00 pm	**Bronze Sponsorship 2** NuGrid
4:00 pm – 4:15 pm	**Break**
4:15 pm – 5:30 pm	**Panel 2** Synchrophasor Measurements at Distribution Systems - Use Cases and Path Forward
5:30 pm – 5:45 pm	**Break**
5:45 pm – 7:00 pm	**Panel 4** Synchronized Measurements in the Utility Control Center: San Diego Gas & Electric
7:15 pm – 7:45 pm	**Silver Sponsorship 4** Electric Power Group

Conference event details

Opening Session:

Tuesday, May 25 **8:00 am – 8.30 am (CEST)**

1.)	Mladen Kezunovic, Chair, SGSMA Executive Committee	**Welcome**
2.)	Lars Nordström, Chair, SGSMA Technical Program Committee	**Technical Program Report**
3.)	Mario Paolone, Chair, SGSMA Steering Committee	**Role and actions of the Steering Committee**

Keynotes:

Keynote 1: The global green energy transformation is now and calls for accelerated electrification and targeted innovation – seen from Nordic and European TSO perspective

Tuesday, May 25 **10:00 am – 11:00 am (CEST)**

Name and title of the speaker: Håkon Borgen

Email: hakon.borgen@statnett.no

Organisation: Statnett, Norway

Biography of the speaker: Håkon Borgen is Executive Vice President Technology & Development, at Statnett SF, the Norwegian TSO. In 2019, he was appointed Chair of the Research, Development and Innovation Committee in ENTSO-E. Mr Borgen holds a Master of Science in Electrical Engineering from the Norwegian University of Science and Technology.

Abstract: This talk focuses on the need for targeted innovation to accelerate electrification of the energy sector. From a Norwegian and European perspectives the challenges and role of transmission system operators (TSOs) are presented. This includes an overview of the R&D road map set out by ENTSOE. New solutions are required to enable a smart and secure operation of the power grids. In view of this, the potential of wide area monitoring and control solutions is highlighted and exemplified.

Download presentation

Keynote 2: The global green energy transformation is now and calls for accelerated electrification and targeted innovation – seen from Nordic and European TSO perspective

Wednesday, May 26 **3:00 pm – 4:00 pm (CEST)**

Name and title of the speaker: Damir Novosel

Email: DNovosel@quanta-technology.com

Organisation: Quanta Technology, USA

Biography of the speaker: Damir Novosel is president and founder of Quanta Technology, a subsidiary of Quanta Services, a Fortune 250 company. Previously, he was vice president of ABB Automation Products and president of KEMA T&D US. Dr. Novosel is also an adjunct professor of Electrical Engineering at North Carolina State University. Dr. Novosel was elected to National Academy of Engineers in 2014. He served as President of the IEEE Power and Energy Society and VP of Technical Activities. Damir is a member of the IEEE Standards Association Standards Board. He also chairs IEEE Industry Technical Support Leadership Committee. Damir is a member of the CIGRE US National Committee and received the CIGRE Attwood Associate and the Distinguished Member awards. Damir holds 17 US and international patents, published over 190 articles and reports, and contributed to 5 books. He has led development and implementation of pioneering concepts, methods, and products related to Synchronized Measurement technology, including the Application and Industry Roadmap study for California Energy Commission and US Department of Energy which became blueprint for significant DOE Synchrophasor investment. Damir also chaired the North American Synchrophasor Initiative Performance and Standards (NASPI) Task Team (2004-2011). Damir is an IEEE Fellow since 2003, holds PhD, MSc, and BSc degrees in electrical engineering from Mississippi State University (where he was a Fulbright scholar), the University of Zagreb, Croatia, and the University of Tuzla, Bosnia and Herzegovina, respectively. Dr. Novosel was selected as Mississippi State University Distinguished Engineering Fellow.

Abstract: Synchronized measurements have been providing important benefits for transmission system planners and operators through various applications, such as situational awareness, post-event analysis, model validation, real-time operational support, and advanced protection and control, among others. As the power industry is presently moving towards carbon-neutral with Distributed Energy Resources and storage, there is a need for improved sensor technology, including synchronized measurements. The distribution system has a history of low visibility due to lack of high-fidelity sensors. Deploying synchronized measurements is becoming very important to large number of applications in distribution systems to facilitate deployment of inverter-based resources. This presentation will address recent synchronized measurement development initiatives and practical implementation examples for both transmission and distribution systems, as well as key success factors to successfully deploy the technology. It will also address needs to create a framework and a roadmap for deploying synchronized measurement applications to provide optimal benefits and deploy reliable and cost-effective system infrastructure.

Download presentation

Keynote 3: A Full-view Synchronized Measurement System for Renewables, Loads, and Power-electronics-enabled Power Grids

Thursday, May 27 **10:00 am – 11:00 am (CEST)**

Name and title of the speaker: Tianshu Bi

Email: tsbi@ncepu.edu.cn

Organisation: North China Electric Power University, China

Biography of the speaker: Prof. Bi received her Ph. D degree from the University of Hongkong in 2002 and currently is a Professor of Electrical Engineering at North China Electric Power University. She also serves as the Vice President of North China Electric Power University and Executive Director of the State Key Lab of Alternate Electrical Power System with Renewable Energy Sources. She got the honor of "Distinguished Young Scholars supported by NSFC(National Natural Science Foundation of China)" in 2017. Her main area of expertise is synchronized measurement technology and its applications, power system protection and control. She is PI of NSFC projects, including National Major Research Instrument Development Project, Major International Joint Research Project and MOST (Ministry of Science and Technology) Projects, including 973, 863 and Key Basis Research Subprojects. And she has published over 200 academic papers. One National Science and Technology Progress Awards (2nd class), three Ministry and Provincial Science and Technology Progress Awards (1st class), and four Ministry and Provincial Science and Technology Progress Awards (2nd class) have been conferred. She also got the honor of Outstanding Contribution Award for Chinese Power Industry Science and Technology Development. She has established broad research collaborations with research institutes and universities in US and EU.

Abstract: With the rapid development of renewables, DC transmission, and active loads, increasingly more power electronics are and will be introduced into power grids. This has led to an increasing need for a new synchronized measurement system that covers different scenarios and applications to improve the stability and reliability of power-electronics-enabled power grids. Therefore, a full-view synchronized measurement system (SYMS) for renewables, loads, and grids is established by our group, which is composed of different types of synchronized measurement devices (SMDs) and a data center. A general design method for synchrophasor estimation of the SMDs in different scenarios is proposed by deducing phasor measurement error models. This is further applied in combination with the design of hardware and a communication protocol to develop SMDs for the measurement of the renewables, loads, and power-electronics-enabled power grids. Then, the framework of the data center of the SYMS, as well as several potential applications based on real-time measurements, are presented and discussed.

Download presentation

Panels:

Panel 1: Role and Use Cases of Real Time Simulators (RTS) Towards Advancing and Deploying Synchrophasor Based Wide Area Monitoring Protection and Control (WAMPAC) Systems

Tuesday, May 25 **5:45 pm – 7.00 pm (CEST)**

Name of the organizer: Evangelos Farantatos

Email: efarantatos@epri.com

Organisation: EPRI – SR. Project Manager, USA

Short biography of the chair: Evangelos Farantatos received the Diploma in Electrical and Computer Engineering from the National Technical University of Athens, Greece, in 2006 and the M.S. and Ph.D. degrees from the Georgia Institute of Technology, Atlanta, GA, USA, in 2009 and 2012, respectively. He is a Senior Project Manager with the Grid Operations and Planning R&D Group at EPRI, Palo Alto, CA. He is managing and leading the technical work of various R&D projects related to synchrophasor technology, power systems monitoring and control, power systems stability and dynamics, renewable energy resources modeling, grid operation and protection with high levels of inverter-based resources. He is a Senior Member of IEEE. In summer 2009, he was an intern at MISO.

Abstract: Phasor Measurement Units providing synchrophasor measurements as well as Wide Area Monitoring, Protection and Control (WAMPAC) systems are being widely deployed in power systems worldwide, and have proven to be a very valuable resource to observe the power system dynamics in the control room and provide advanced situational awareness and dynamic security assessment. Meanwhile, many utilities and research organizations are establishing advanced laboratory facilities to create, model and test new technologies for power systems including WAMPAC systems. Real time simulators are a critical component of these facilities and are expected to benefit and accelerate the advancement and deployment of WAMPAC systems. This panel will discuss the role of RTS in advancing and deployment of WAMPAC systems, and will provide example use cases from representative international lab facilities.

Download presentation

Panelist 1:

Name and title: Georgios Stefopoulos, Director

Organisation: New York Power Authority, USA

Short biography: George Stefopoulos is the Director of the Advanced Grid Innovation Laboratory for Energy (AGILe) at the New York Power Authority (NYPA). He has been with NYPA since 2009 initially as a Research and Technology Development Engineer and then as NYPA's Smart Grid Solutions Architect. He is a senior member of the Institute of Electrical and Electronics Engineers (IEEE) and an associate member of Institute of Engineering Technology (IET). George received his Diploma in Electrical and Computer Engineering from the National Technical University of Athens, Greece in 2001 and he also holds Master's and Ph.D. degrees from the Georgia Institute of Technology (2002 and 2009 respectively) as well as a MBA degree from Pace University of New York (2015).

Title of presentation: Real-time modeling and simulation of synchrophasor systems at the New York Power Authority: Use cases and applications

Abstract: Wide-area monitoring and closed-loop control systems are a key operational component of the integrated T&D grid of the future. However, although research in these areas has been ongoing for many years and a lot of innovative schemes have been proposed, in practice the industry is significantly lagging with respect to the current the state-of-the-art. This talk will describe some of the current efforts and future plans at the New York Power Authority that explore the use of realistic real-time simulation environments to extensively demonstrate and test such ideas as well as other synchrophasor applications in an attempt to contribute towards bridging this gap between research and field applications.

Download presentation

Panelist 2:

Name and title: Ian Cowan – Lead Simulation Engineer

Organisation: The National HVDC Centre, UK

Short biography: Ian L. Cowan has long had an interest in Transmission systems and is excited to be at the forefront of HVDC, one of the latest developments in that field. As the Lead Simulation Engineer, Ian not only undertakes simulation studies, but also coordinates the activities of the Simulation team at the Centre. He is an experienced electrical engineer who has worked at the HVDC Centre from its opening in 2017, he brings technical consultancy experience combined with strong management skills to his role as Lead Simulation Engineer at the Centre. He has an MEng in Electronic and Electrical Engineering (with a focus on power systems) from the University of Strathclyde. He originally joined the National HVDC Centre as a Simulation Engineer from Mott MacDonald where he worked in the Power Systems Analysis team carrying out a variety of offline simulations on multiple platforms. Since joining the HVDC Centre he has led the delivery of the following key projects: '[HVDC] Protection Systems Demonstration (WP9)' as work package leader within the PROMOTioN project; Caithness-Moray Project Support; and Eastern Link Project Support.

Title of presentation: Study of WAMPAC to De-Risk HVDC Integration

Download presentation

Panelist 3:

Name and title: Hjörtur Jóhannsson – Senior Scientific Consultant

Organisation: Denmark Technical University, Denmark

Short biography: Dr. Hjörtur Jóhannsson received the M.Sc. and the PhD degree in Electrical Engineering from Technical University of Denmark (DTU), in 2007 and 2011 respectively. From 2011 to 2014 he was an Assistant Professor at the Center of Electric Power and Energy (CEE) at DTU. From 2014 he has been serving as a Senior Scientific Consultant at CEE, with the main responsibility of leading large research projects, supervising PhD students and teaching graduate students about power system stability and control. Dr. Jóhannsson's professional interests are within research and development of methods that enable power system stability and security assessment in real-time and of methods for automatically determining control actions that regain system security when an insecure operation has been detected. This includes a work on theoretical derivation of power system stability limits and development of effective algorithms for wide-area assessment and control of power systems. Special focus is on the development of methods that can cope with assessment of systems where a high share of the power production is based on fluctuating renewable energy sources.

Title of presentation: Use of RTDS in R&D of Wide-Area Early-Warning and Early-Prevention Systems

Abstract: This talk will provide an overview of the activities carried out at the Technical University of Denmark that aim towards development of methods for real-time stability monitoring and control, and how the method development process is advanced further by deployment of RTDS for validation of concepts in laboratory environment.

Download presentation

Panel 2: Synchrophasor Measurements at Distribution Systems – Use Cases and Path Forward

Thursday, May 27 **4:15 pm – 5.30 pm (CEST)**

Name of the organizer: Panayiotis Moutis, Phd (Systems Scientist, Scott Institute for Energy Innovation)

Email: pmoutis@andrew.cmu.edu

Organisation: Carnegie Mellon University, USA

Short biography of the chair: Panayiotis (Panos) Moutis, PhD, is a Systems Scientist at the Scott Institute for Energy Innovation at Carnegie Mellon University (CMU), USA, since Aug. 2018 (Postdoc Electrical & Computer Engineering – ECE, CMU 2016). He served as a Marie Curie fellow with DEPsys SA, Switzerland, in 2018-2020. In 2014 he was awarded a fellowship by Arup, UK (through the University of Greenwich), on the "Research Challenge of Balancing Urban Microgrids in Future Planned Communities". Between 2007 and 2015, as part of the research group SmartRUE, at the National Technical University of Athens (NTUA), Greece, he contributed to many R&D projects funded by the European Commission. Panos studied at the School of ECE at the NTUA, Greece (Dipl. 2007, PhD 2015). He has published more than 30 papers and contributed to 3 book chapters, while also has over 10 years of experience as a technical consultant on and developer of projects of Renewable Energy Sources and Energy Efficiency. He is the CTO of Proterima Energy Consultants, Greece, and technology advisor to Xeal (ex EVE Energy), USA, an electric vehicle charging platform start-up. He is a senior member of multiple IEEE societies, associated editor in IEEE & IET journal publications, task-group chair in two IEEE standards working groups, Chair of the IEEE Smart Grid Publications Committee, Editor-in-Chief of the "IEEE Smart Grid Newsletter" and has served as the Editor-in-Chief of the "IEEE Smart Grid Compendium of Journal Publications, vol. 1".

Abstract: Utilities in the US have been gradually deploying phasor measurement units (PMUs) to monitor synchrophasors at selected parts of their distribution systems. In Europe, distribution system operators are exploring and, in some cases, testing synchronized measurements of their feeders. Most typical use cases of said applications are power quality monitoring, inverse or high power flows, and wildfire detection and mitigation measures. As there is no specific standardization or consensus about the minimum value expected by deploying PMUs at distribution systems, it is important to gather existing experiences, quantify the impact of on-going efforts, define aspirations for potential use-cases and determine a framework for PMU performance. This panels comprises utility, vendor and academic experts on the subject matter, who will offer insights, review on-going initiatives and propose actions for the path forward.

Download presentation

Panelist 1:

Name: Sascha von Meier

Organisation: UC Berkeley – Adjunct Professor, USA
North American Synchro-Phasors Initiative – Distribution Task Team Lead

Short biography of the chair: Alexandra "Sascha" von Meier is an Adjunct Professor in the Department of Electrical Engineering and Computer Science at UC Berkeley and the Director of the California Institute for Energy and the Environment's Electric Grid program area, which focuses on power distribution systems, Smart Grid issues, and the integration of distributed and intermittent generation. Her current research projects center on the use of high-precision micro-synchrophasor measurements for situational awareness, diagnostics and control applications in distribution grids. Sascha is the author of the textbook "Electric Power Systems: A Conceptual Introduction." Until 2011, she was a Professor of Energy Management & Design in the Department of Environmental Studies and Planning at Sonoma State University. Sascha received a B.A. in physics in 1986 and a Ph.D. in Energy and Resources in 1995 from UC Berkeley.

Title of presentation: Distribution Synchrophasors for Control Applications

Abstract: This presentation introduces a new Phasor-Based Control approach developed at the University of California, Berkeley to coordinate distributed energy resources for grid services, and discuss this in the context of measurement data requirements.

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Panelist 2:

Name: Ken Martin

Organisation: Electrical Power Group – Senior Principal Engineer
USA
North American Synchro-Phasors Initiative – Distribution Task Team Lead

Short biography of the chair: Ken Martin is a Synchrophasor Technology Leader and Senior Principal Engineer. Ken has over 30 years of experience in the electric utility industry. He has extensive experience with SCADA and time-synchronized phasor data collection and use, including collection, system communications, system architecture and design, and applications for protection, control, monitoring, data management and display. Ken's work covers instrumentation and measurement systems for research, test, validation and controls.

Title of presentation: What can phasor measurement units (PMUs) provide and what are the challenges in developing a standard for them in the distribution environment.

Abstract: What can PMUs offer? What have their most typical applications been? Existing standards will be reviewed and the differences with distribution systems will be pointed out to describe what is needed to address said differences in the context of standard development.

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Panelist 3:

Name: Paul Pabst

Organisation: Smart Grid & Technology Manager – ComEd, USA

Short biography of the chair:Paul Pabst, P.E., is the manager of project execution within ComEd's Smart Grid Department. He has 14 years of power system project experience ranging from renewable energy, microgrids, distribution automation, and traditional medium voltage power systems. He is the Distribution PMU Program Manager for ComEd, responsible for the multi-year deployment and analysis effort at both ComEd-owned substations and distribution feeders. He has held multiple executive roles within the IEEE PES Chicago chapter is the current IEEE PES Awards Chair.

Title of presentation: Distribution PMU Deployment and Analytics

Abstract: ComEd has deployed about 200 PMUs in substations and on distribution feeders and is actively analyzing the aggregated data. This presentation will outline the programs' roadmap, objectives, lessons learned and the value of the PMUs on the ComEd system.

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Panelist 4:

Name: Omid Alizadeh-Mousavi

Organisation: DEPsys SA – Director R&D, Switzerland

Short biography of the chair: Omid Alizadeh-Mousavi received his Ph.D. degree in electrical engineering from the Swiss Federal Institute of Technology, Lausanne, Switzerland, in 2014. From 2014 to 2015, he was a scientist in power and energy systems group, ABB Corporate Research Center in Baden-Dättwil, Switzerland. Since 2016, he has been a research and development director at DEPsys in Puidoux, Switzerland. His research interests are in power systems with particular reference to optimal system operation and planning, and security and risk assessment. He is the author or coauthor of more than 30 scientific papers in peer-reviewed journals and international conferences.

Title of presentation: Edge computing monitoring infrastructure for scalable distribution grid monitoring

Abstract: Deploying real-time monitoring in distribution grids with sophisticated, cost effective and technically feasible edge computing is imperative to make data-based decisions in systems that traditionally lack visibility. Precise and fast fault identification and localization, accurate power quality monitoring and compliance analysis can be readily enabled by said monitoring.

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Panelist 5:

Name: Greg Zweigle

Organisation: Schweitzer Engineering Laboratories – R&D Fellow Engineer, USA

Short biography of the chair: Greg Zweigle serves as a Schweitzer Engineering Laboratories fellow engineer and leads a research team developing wide-area power system analysis and control solutions. He holds a Ph.D. in electrical engineering and computer science, a Master of Science degree in (physical) chemistry, and a Master of Science degree in electrical engineering from Washington State University. He also holds a Bachelor of Science degree in physics from Northwest Nazarene University. Greg is a senior member of the IEEE.

Title of presentation: Distribution Time-Synchronized Measurements: Sensors and Applications

Abstract: Distribution places unique requirements for time-series systems. Inverter based resources, proximity to loads, and shorter lines result in higher frequency signal content along with smaller signal changes. This presentation will share research in high-speed time-synchronized sensors and associated applications.

Download presentation

Panel 3: Synchrophasor and Monitoring data handling A perspective of ongoing TSOs approaches

Tuesday, May 25 **8:30 am – 9.45 am (CEST)**

Name of the organizer: Dr Rafael Segundo

Email: segu@zhaw.ch

Organisation: Zurich University of Applied Sciences, Switzerland

Short biography of the chair: Dr Segundo, received a PhD degree from Imperial College London, United Kingdom in 2013. From 2007 to 2008, he worked in the Automation and Control group in the Corporate Research Centre of ABB, in Switzerland. From January 2013 to July 2014, Dr Segundo was a postdoctoral research fellow at the school of electrical engineering of the KTH Royal Institute of Technology in Stockholm, Sweden. Since summer 2014, he is research associate in the Electric Power Systems and Smart Grid Lab at ZHAW. Dr. Segundo is Senior Member of the IEEE, chair of the IEEE Task Force ” Application of Big Data Analytic on Transmission System Dynamic Security Assessment” and chair of the international annual workshop DynPOWER. He is responsible for several national and international projects and some of his areas of interest include control, dynamics, stability and quantification of the impact of renewable energies in large transmission networks, as well as data analysis techniques in advanced metering infrastructure such as PMUs and smart meters.

Abstract: Energy transitions worldwide are pushing towards more sustainable societies demanding for more environmentally friendly power generation and urging to reduce the use of nuclear and carbon based energy technology to a minimum. Moreover, future energy systems are evolving to low-inertia networks where utilities are staring to face new challenges associated to the dramatic increase of inverter connected devices. Consequently, utilities require higher degree of observability in the network and thus are becoming more dependent of advanced metering infrastructure, monitoring systems and high frequency synchronized wide-area devices in order to improve the decision making and situational awareness of the transmission system. As solution, utilities have adopted methods to handle, process and analyze the information acquired. Since the characteristics of the power systems are considerably different due to the diverse geographical locations, dimension of the systems and nature of the loads, the current handling processes are not necessarily the same nor the most advanced solution. In the context of the IEEE Task Force Application of Big Data Analytic on Transmission System for DSA, a data handling survey to different utilities around the world was recently completed. This panel presents the most important findings of the survey with key authors of the document with experience on power systems from diverse geographical locations and it will be a platform to debate about how the current practices could be improved.

Download presentation

Panelist 1:

Name: Prof. Hector Chavez

Organisation: Universidad de Santiago de Chile (USACH) – Associated Professor, Chile

Short biography: He received his BSc and MSc in Electrical Engineering from the University of Santiago, in the city of Santiago, Chile in 2004 and 2006 respectively and in 2013 he received his Ph.D. degree in Electrical Engineering from the University of Texas at Austin, Austin TX. Subsequently, he was a Postdoctoral fellow during one year in the Department of Electric Power Systems, at the KTH Royal Institute of Technology, Stockholm, Sweden. He is currently an Associate Professor and since 2021, head of the Department of Electrical Engineering at the University of Santiago, in Chile

Title of presentation: Towards inertia forecasting based on data-driven power system models.

Abstract: Data-driven models are being proposed as a simple solution to dynamic modelling, particularly for frequency stability. This talk presents new perspectives and some work done towards implementing an inertia forecasting system through PMU data-driven frequency dynamics models.

Download presentation

Panelist 2:

Name: Dr. Walter Sattinger

Organisation: Swissgrid – Principal Grid Studies Engineer, Switzerland

Short biography: Dr Sattinger is currently a Principal Grid Studies Engineer at Swissgrid, where he is working at the interface between planning and operation and is responsible for the implementation of concepts to enhance system security. Dr Sattinger has extensive experience in power system dynamic analysis and has been working for 32 years in the field of power system modelling and power system control. In several studies he has worked in all required project stages from the onsite data collection to the organisation and execution of system tests, dynamic model identification, system modelling, performing of studies, reports and finally the presentation of the study results.

Title of presentation: Use of WAM Tools for the Secure Operation of the Continental European Power System

Abstract: Based on the permanent exchange of PMU measurements, the CE transmission system operators have established a monitoring system for the power system dynamic behaviour. With the help of detailed analysis of several significant events, the work of common working group and similar activities on international level will be presented.

Download presentation

Panelist 3:

Name: Dr. Emil Hillberg

Organisation: Research Institutes of Sweden (RISE), Sweden

Short biography: Dr Emil Hillberg is an expert in analysis of power system dynamic phenomena, with a research background in smart transmission grid solutions and mitigation of blackouts. He has a twenty-year long international career within the power system area, including previous positions at ABB, SINTEF and STRI, in Switzerland, Norway and Sweden.

Title of presentation: Development of SIPS for enhanced security and capacity of the power systems

Abstract: System Integrity Protection Schemes (SIPS) are in use to increase secure power transfer in regions or cases where N-1 operation cannot be maintained. Utilization of PMU data in the development and deployment of solutions, enable SIPS to become response-based and thus providing increased security for a broader range of scenarios.

Download presentation

Panelist 4:

Name: Dr. Robert Eriksson

Organisation: Svenska Kraftnät – System development, Sweden

Short biography: Robert Eriksson is team leader at the Swedish National Grid (Svenska kraftnät), Department of Power Systems. Since 2020, he also holds a position as Adjunct Professor at the KTH Royal Institute of Technology

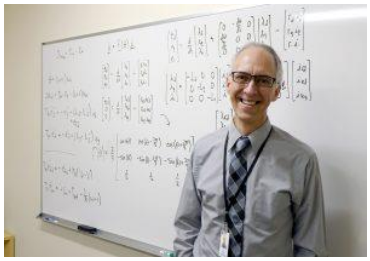
Title of presentation: Use of WAM Tools for the Secure Operation of the Nordic Power System

Abstract: Collaboration over many years within the Nordics and exchange of data has established an open environment for development of innovative solutions. Ongoing activities, developments and concepts of control room applications are explored.

Download presentation

Panel 4: Synchronized Measurements in the Utility Control Center San Diego Gas & Electric

Thursday, May 27 **5:45 pm – 7.00 pm (CEST)**



Name of the organizer: Dr. Greg Zweigle, SEL Fellow Engineer

Email: Greg_Zweigle@selinc.com

Organisation: Schweitzer Engineering Laboratories, USA

Short biography of the chair: Gregary C. Zweigle is a fellow engineer at Schweitzer Engineering Laboratories, Inc. (SEL) and leads a research team to develop wide-area power system analysis and control solutions. He holds a Ph.D. in electrical engineering and computer science and master's degrees in (physical) chemistry and electrical engineering from Washington State University, and he holds a bachelor's degree in physics from Northwest Nazarene University.

Abstract: San Diego Gas & Electric (SDG&E®) is presently working on Phase 2 of the Wide Area Situational Awareness (WASA) synchronized measurement program. While Phase 1 explored new technologies in collaboration with engineers and operators, the goal of Phase 2 is a production-grade, fully regulatory compliant Visualization Software System (VSS) for use by grid operators, operations support engineers, reliability engineers, and managers. The system provides a single information source for visualization and navigation of all time-series applications. It is integrated with the real-time operations system and facilitates exchange of data with neighboring utilities and the ISO to provide operators a wide area view of the entire regional grid. As part of Phase 2, the WASA development team is working directly with system operators to get their feedback on synchrophasor applications providing the most value for their daily work and for SDG&E. This panel will share synchronized measurement applications, system architecture, data standards, along with testing, commissioning, and implementation challenges.

Download presentation

Panelist 1:

Name: Tariq Rahman

Organisation: San Diego Gas & Electric, USA

Title of presentation: Vision, applications, and roadmap

Abstract: San Diego Gas & Electric (SDG&E) installed its first PMU in 2007 as a pilot project and soon realized its potential to be a technology that could revolutionize the way the electric grid is monitored and operated. The impact of 2007 wildfire and 2011 blackout to SDG&E service area further solidified SDG&E's vision to invest in this technology as part of an overall smart grid roadmap. In 2011 SDG&E formally launched the Transmission Synchrophasor Project to develop and build a production-grade wide-area situational awareness (WASA) system. WASA system aims to give the operators and engineers a tool with advanced applications that would provide complete visibility of entire WECC grid, and early warning capabilities on potential threats to SDG&E system.

Download presentation

Panelist 2:

Name: Dan Brancaccio

Organisation: Quanta Technologies, USA

Title of presentation: WASA architecture, data representation, bad data detection, and system design

Abstract: SDG&E is now focused on integrating real-time collection of synchrophasor data as well as visualization and operator interface systems to aid in real-time systems operations. Additional PMU's deployed since the completion of the first phase in 2013, covering all 500 kV, 230 kV and most 69 kV tie lines, has been challenging with the additional coverage and commensurate increase in the communication and data archiving infrastructure. However, the additional coverage, as well as sharing of synchrophasor data with neighbors using the WISP WAN, will unlock additional benefits, ultimately enabling a full coverage WASA visualization tool. The presentation will review the challenges supporting the increase in PMU deployment including network communications, data availability, and archiving strategies.

Download presentation

Panelist 3:

Name: Bill Cook

Organisation: San Diego Gas & Electric – retired, USA

Title of presentation: Operator training, operational procedures, and operator acceptance strategies

Abstract: The project team created a use case document to demonstrate the value of using the WASA system in analyzing SDG&E system events of different types. System Operator acceptance is straightforward when the Operators can see the WASA application used to monitor high-resolution voltage, current, power flow and phase angle data that is not available on the SCADA system. Using the earlier WASA system, we were able to review voltage oscillation data for disturbances involving a Statcom system and inverter-based resources (IBRs). Using the earlier system, a 500kV interconnection line trip was reviewed, and it was quickly determined the line tripped due to a relay mis-operation, and the line could be readily restored since there was no fault on the line. In the testing of the current system, we were able to assess the operation of IBRs during a 500kV line fault, where the IBR power output dropped to zero for one second after fault clearing, and then immediately returned to pre-fault levels.

Download presentation

Panelist 4:

Name: Dr. Md Arif Khan

Organisation: Schweitzer Engineering Laboratories, USA

Title of presentation: Synchronized Measurement Analytics Being Deployed – Modal Analysis, Automated Disturbance Detection, Disturbance Source Location, and Many More.

Abstract: As PMU and WAMS technology has reached a high degree of maturity and synchrophasor measurement-based applications are gaining more credibility, many utilities have started deploying such applications in control rooms for power system operations. Time-synchronized and high-rate PMU data enables wide-area monitoring and detailed investigation of power system events, which was not possible before with SCADA data. Modal analysis, disturbance detection, disturbance source location, wide-area voltage stability and frequency monitoring, dynamic line rating, phase angle monitoring, and islanding detection are a few examples of such applications that are providing more insight into the power system states.

Download presentation

Panel 5: The use of machine learning and AI in analysis of historical and on-line synchrophasor data

Tuesday, May 25 **4:15 pm – 5.30 pm (CEST)**

Name of the organizer: Mladen Kezunovic, Regents Professor

Email: kezunov@gmail.com

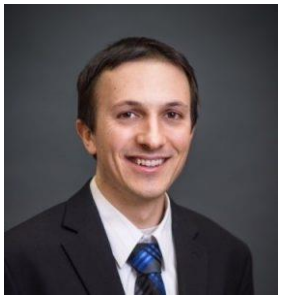
Organisation: Texas A&M University, USA

Short biography of the chair: Mladen Kezunovic (S'77–M'80–SM'85–F'99– LF'17) received the Dipl. Ing. from University of Sarajevo, Sarajevo, Bosnia, and M.Sc. and Ph.D. degrees in electrical engineering from University of Kansas, Lawrence, KS, in 1974, 1977, and 1980, respectively. He has been with Texas A&M University, College Station, TX, USA since 1986, where he is currently Regents Professor, Eugene E. Webb Professor, and the Site Director of "Power Engineering Research Center" consortium. For over 25 years he has been the Principal Consultant of XpertPower Associates, a consulting firm specializing in power systems data analytics. His expertise is in protective relaying, automated power system disturbance analysis, computational intelligence, data analytics, and smart grids. He has authored over 600 papers, given over 120 seminars, invited lectures, and short courses, and consulted for over 50 companies worldwide. Dr. Kezunovic is a CIGRE Fellow, Honorary and Distinguished member. He is Registered Professional Engineer in Texas.

Abstract: The synchrophasor network in the USA has been expanding over the last decade and has reached over 3000 PMUs installed in the three interconnections: The West, East and ERCOT. The Transmission Operators and Independent System Operators have collected large amounts of historical PMU data. The challenges in searching through the data, detecting events of interest, an classifying them have been recognized. The Department of Energy has funded eight on-going projects to develop Artificial Intelligence (AI) and Machine Learning (ML) techniques to analyze and classify the events automatically. This panel will be focusing on sharing the experiences from four projects that have focused on different issues associated with the automation of synchrophasor data analytics: data wrangling, bad data detection and removal, reconstruction of missing data, data mislabeling, supervised, semi-supervised, unsupervised and transfer learning, deep learning, etc.

Download presentation

Panelist 1:



Name: Philip Hart

Organisation: GE Research, USA

Short biography: Philip J. Hart (S'13–M'18) received the B.Sc. degree (Hons.) in electrical engineering from Clarkson University, Potsdam, NY, USA, in 2011, and the M.Sc. and Ph.D. degrees in electrical engineering from the University of Wisconsin–Madison, Madison, WI, USA, in 2013 and 2017, respectively.,He was a Research Assistant with the Wisconsin Electric Machines and Power Electronics Consortium (WEMPEC). He is currently a Lead Electric Power Systems Engineer with GE Global Research, Niskayuna, NY, USA. His research interests include power systems engineering, microgrids, grid-tied power electronics, and power systems cybersecurity. His PhD work focused on the modeling and analysis of next-generation power systems composed of power-electronics-based resources such as solar, wind and battery energy storage. He has researched advanced microgrid control techniques that address network voltage and frequency regulation, and optimal control of microgrid resources. He has practical experience in validating microgrid controller systems in hardware, using experimental testbeds and real-time hardware-in-the-loop platforms.

Title of presentation: PMU-Based Data Analytics Using Digital Twin and Phasor Analytics Software

Abstract: Application of a powerful, industry-validated signature identification strategy to a large PMU dataset is described. The event signatures generated using the semi-supervised strategy are derived from an over-abundance of features calculated in a transparent manner, and can be efficiently applied to either historical or streaming PMU data. The signatures can be used to quantify the relative severity, location, and duration of each event, and show promise for integration into tools that provide enhanced power systems reliability, operational efficiency and resiliency.

Download presentation

Panelist 2:

Name: Bruno Leao

Organisation: Siemens Technology, USA

Short biography: Bruno Leao is a Data Scientist with Siemens, CT, Princeton, New jersey. Bruno Leão received the B.S. degree in control and automation engineering from the Universidade Federal de Minas Gerais, Belo Horizonte, Brazil, in 2004, and the M.S. degree in aeronautical engineering and D.Sc. degree in electronics engineering and computer science from the Instituto Tecnológico de Aeronáutica (ITA), São José dos Campos, Brazil, in 2007 and 2011, respectively. He was with Embraer S.A., Brazil, São José dos Campos, from 2005 to 2012. He has been with the PHM Research Group, Embraer, where he has been researching PHM solutions for aircraft systems. He was a System Engineer in flight controls and automatic flight controls

Title of presentation: MindSynchro: innovation and challenges in application of ML to PMU big data

Abstract: The presentation describes recently developed innovations associated to the application of ML methods to real world PMU big data. Flagship innovation comprises semi-supervised learning approaches for detection of relevant grid events which can be applied to a very broad PMU fleet. Other innovations and challenges are also discussed, especially concerning the relevance of adequately labeling PMU data for proper extraction of its value and approaches for overcoming existing limitations in such information.

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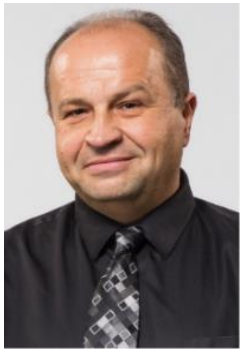
Panelist 3:



Name: Zoran Obradovic

Organisation: Temple University – L.H. Carnell Professor, USA

Short biography: Zoran Obradovic is a L.H. Carnell Professor of Data Analytics at Temple University, Professor in the Department of Computer and Information Sciences with a secondary appointment in Statistics, and is the Director of the Center for Data Analytics and Biomedical Informatics. He is the executive editor at the journal on Statistical Analysis and Data Mining, which is the official publication of the American Statistical Association and is an editorial board member at eleven journals. He is the chair at the SIAM Activity Group on Data Mining and Analytics for 2014 and 2015 years, was co-chair for 2013 and 2014 SIAM International Conference on Data Mining and was the program or track chair at many data mining and biomedical informatics conferences. His work is published in more than 300 articles and is cited more than 15,000 times (H-index 48). In 2015, he became an elected member of Academia Europaea (the Academy of Europe).

Title of presentation: BDSmart: Automated Analysis of Large synchrophasor datasets

Abstract: We will discuss tradeoffs in machine learning and AI applications to automated PMU data analysis: preprocessing vs raw data, feature engineering vs inaccurate labels, computational implicity vs complexity, supervised vas unsupervised learning. We will then present some comparative results from different algorithms adopted by us to the problem at hand. Some lessons learned will be shared and discussed.

Download presentation

Panelist 4:

Name: Nanpeng Yu

Organisation: University of California, Riverside, USA

Short biography: Dr. Yu received his B.S. in Electrical Engineering from Tsinghua University, Beijing, China, in 2006. Dr. Yu also received his M.S. degrees in Electrical Engineering and Economics and Ph.D. degree from Iowa State University in 2010. Before joining University of California, Riverside, Dr. Yu was a senior power system planner and project manager at Southern California Edison from Jan, 2011 to July 2014. Currently, he is an associate professor of Electrical and Computer Engineering at the University of California, Riverside, CA. Dr. Yu is the recipient of the Regents Faculty Fellowship and Regents Faculty Development award from University of California. He received multiple best paper awards form IEEE Power and Energy Society Grand International Conference and Exposition Asia and the Second International Conference on Green Communications, Computing and Technologies. Dr. Yu also received three best paper finalist awards from IEEE Power and Energy Society General Meeting. Dr. Yu is the director of Smart City Innovation Laboratory at UC Riverside. Dr. Yu is also a cooperating faculty member of department of computer science and engineering, department of Statistics and Center for Environmental Research & Technology. He currently serves as the vice chair distribution system operation and planning subcommittee of IEEE Power and Energy Society and the co-chair for IEEE Big Data Applications in Power Distribution Networks Task Force. Dr. Yu currently serves as the associate editor for IEEE Transactions on Smart Grid, IEEE Transactions on Sustainable Energy, and International Transactions on Electrical Energy Systems.

Title of presentation: Physics-Informed Machine Learning for Power System Event Detection and Identification with Synchrophasor Data

Abstract: Three recent breakthroughs in physics-informed synchrophasor data analytics will be reported in this panel presentation. First, we will talk about how to construct a graph Laplacian using off-line training data and detect power system events using graph signal processing techniques. Second, we will talk about how to leverage deep neural networks enhanced augmented by information loading and graph-based sorting to classify power system events based on PMU data.

Download presentation

Panel 6: Synchrophasor Deployment A North American Perspective

Wednesday, May 26 **5:45 pm – 7.00 pm (CEST)**

Name of the organizer: Jeff Dagle, Chief Electrical Engineer

Email: jeff.dagle@pnnl.gov

Organisation: Pacific Northwest National Laboratory, USA

Short biography of the chair: Jeff Dagle is an electrical engineer at the Pacific Northwest National Laboratory for over 31 years and has been leading the North American SynchroPhasor Initiative (NASPI) since its inception in 2006 on behalf of the U.S. Department of Energy.

Abstract: Since 2006 the North American SynchroPhasor Initiative (NASPI), with support from the U.S. Department of Energy and the Electric Power Research Institute, has been promoting the deployment and utilization of synchrophasor technology. NASPI has grown into a community of experts working to advance the implementation of networked phasor measurement devices. This panel is comprised of the leadership of the five technical task teams that comprise NASPI.

Download presentation

Panelist 1:

Name: Jim O'Brien

Organisation: Duke Energy, USA

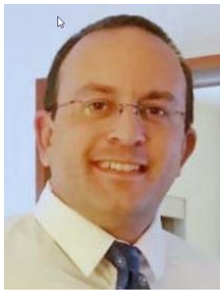
Short biography: Jim O'Brien is an electrical engineer at Duke Energy for 45 years in the area of Protection and Control and has been active the North American SynchroPhasor Initiative (NASPI) since 2014 as a co-lead of the Performance Requirements, Standards & Verification Task Team.

Title of presentation: The NASPI Performance Requirements, Standards & Verification

Abstract: The NASPI Performance Requirements, Standards & Verification Task Team (PRSVTT) is a group of professionals from utilities, academia, manufacturers and government. Our aim is to help the adoption of phasor measurement technology through standardization. We provide a forum for discussing, developing and monitoring requirements. We identify areas where synchrophasor technology would benefit from guidelines and standards. We coordinate the development of these guidelines with other NASPI task teams and, as appropriate, migrate those guides to IEEE Power & Energy Society (PES) Working Groups.

Download presentation

Panelist 2:



Name: Matthew Rhodes

Organisation: Salt River Project, USA

Short biography: Matthew Rhodes is a principal electrical engineer at the Salt River Project, an agency of the state of Arizona that serves as an electrical utility for the Phoenix metropolitan area. Matt joined SRP in 2007, and has a master's degree in electrical engineering from Arizona State University. Matt currently serves as the co-lead for the NASPI Data & Network Management Task Team.

Title of presentation: The NASPI Data & Network Management Task Team

Abstract: The mission of the NASPI Data & Network Management Task Team (DNMTT) is to provide guidance for synchrophasor data networking, archiving and access issues and to review new archiving and networking technologies for the best fit to synchrophasor application realization.

Download presentation

Panelist 3:

Name: Alexandra "Sascha" von Meier

Organisation: University of California – Berkeley, USA

Short biography: Dr. Sascha von Meier is an adjunct professor in the Department of Electrical Engineering and Computer Science at the University of California, Berkeley and directs electric grid research at the California Institute for Energy and Environment (CIEE). She is also a faculty scientist at the Lawrence Berkeley National Laboratory. Her research is driven by the vision of a nimble, adaptable and resilient electric power infrastructure that effectively recruits renewable resources, energy storage and demand response. She holds a B.A. in Physics and a Ph.D. in Energy and Resources from UC Berkeley. Sascha is the author of a textbook, Electric Power Systems: A Conceptual Introduction.

Title of presentation: The NASPI Distribution Task Team

Abstract: The mission of the NASPI Distribution Task Team (DisTT) is to foster the use and capabilities of networked PMUs at the medium-voltage distribution level, beyond the substation. This group works to share information in support of effective research, development and deployment of distribution PMUs and their emerging applications. These diverse applications and use cases range from engineering analysis and planning to real-time operations, especially in the context of increasing activity and uncertainty associated with distributed energy resources. Along with sharing novel research and best practices from the field, the Task Team is interested in understanding the particular requirements that distribution system applications pose for PMU technology.

Download presentation

Panelist 4:

Name: James Kleitsch

Organisation: American Transmission Company, USA

Short biography: Jim Kleitsch is a System Operations Engineer at American Transmission Co. Jim currently serves on the leadership team of the North American SynchroPhasor Initiative (NASPI) representing the Control Room Solutions Task Team. He received his electrical engineering degree from Iowa State University and has served in varying roles within the electric utility system operations arena throughout his 33 year career.

Title of presentation: The NASPI Control Room Solution Task Team

Abstract: The NASPI Control Room Solution Task Team's (CRSTT) mission is to work collectively with other NASPI task teams to advance the use of real-time synchrophasor applications for the purpose of improving control room operations and grid reliability. The CRSTT will use its experience and regional diversity to provide advice, direction, support and guidance to NASPI stakeholders and other organizations involved in the development and implementation of real-time synchrophasor applications.

Download presentation

Panelist 5:

Name: Shaun Murphy

Organisation: PJM Interconnection LLC, USA

Short biography: Dr. Shaun Murphy is a Senior Business Solutions Engineer at PJM Interconnection. PJM Interconnection is a regional transmission organization (RTO) that coordinates the movement of wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and the District of Columbia. Dr. Murphy joined PJM in 2012, and has PhD and MS degrees in electrical engineering from Drexel University, and a BSEE from Virginia Tech. He currently serves as the co-chair of the NASPI Engineering Analysis Task Team.

Title of presentation: The NASPI Engineering Analysis Task Team

Abstract: The NASPI Engineering Analysis Task Team (EATT) facilitates the development, testing, and validation of engineering applications that use synchronized measurements systems. The EATT develops recommended practices and guidelines for PMU placement, including application-specific recommendations. In addition, the EATT regularly updates the broader NASPI community and relevant industry shareholders on the state of synchrophasor technology and its deployment. The EATT focuses on the utilization of synchronized wide-area measurement applications. The EATT also formulates recommended R&D activities

related to the advancement of wide-area synchronized measurement systems and their applications.

Download presentation

Panel 7: SynchroPhasor-based Automatic Real-time Control in a Nordic perspective

Wednesday, May 26 **8:30 am – 9.45 am (CEST)**

Name of the organizer: Salvatore D'Arco, Senior scientist

Email: Salvatore.darco@sintef.no

Organisation: SINTEF Energy Research, Norway

Short biography of the chair: Salvatore D'Arco received the M.Sc. and Ph.D. degrees in electrical engineering from the University of Naples "Federico II," Naples, Italy, in 2002 and 2005, respectively. From 2006 to 2007, he was a postdoctoral researcher at the University of South Carolina, Columbia, SC, USA. In 2008, he joined ASML, Veldhoven, the Netherlands, as a Power Electronics Designer consultant, where he worked until 2010. From 2010 to 2012, he was a postdoctoral researcher in the Department of Electric Power Engineering at the Norwegian University of Science and Technology (NTNU), Trondheim, Norway. In 2012, he joined SINTEF Energy Research where he currently works as a Senior Research Scientist. He is the author of more than 120 scientific papers and is the holder of one patent. His main research activities are related to control and analysis of power-electronic conversion systems for power system applications, including real-time simulation and rapid prototyping of converter control systems

Abstract: The panel will present results on applications of Synchrophasors for automatic control and protection obtained in Nordic cooperative projects. The panel will focus on WAMPACS and on the application of PMUs to improve the operation of the power system. The objective is to showcase research activities and development progress in the Nordic area.

Download presentation

Panelist 1:

Name: Kjetil Uhlen

Organisation: NTNU, Norway

Title of presentation: Research on Wide area control and system protection at NTNU

Abstract: The role of System protection schemes is, as the words indicate, to protect the integrity of the power system as a whole. Many of these are essentially wide area control systems in the sense that remote measurements or indicators are communicated and used to initiate control actions such as shedding load or generation. As more system protection schemes are implemented (basically to secure system operation), they may themselves represent a risk if not properly coordinated. This presentation makes an introduction to the research on coordination and optimization of system protection schemes by utilizing synchrophasors information and model based methods. Other experiences and ongoing research on wide are control will be mentioned.

Download presentation

Panelist 2:

Name: Professor Mehrdad Ghandhari

Organisation: KTH, Sweden

Title of presentation: Power system stability assessment based on PMU data

Abstract: This presentation gives a short summary of an on-going research project in which the application of PMU data to real-time monitoring of transient stability in Sweden is explored.

Download presentation

Panelist 3:

Name: Mohammadreza Maddipour Farrokhifard

Organisation: General Electric Digital, USA

Title of presentation: PMU data anomaly detection, classification, and prediction using Machine Learning and Artificial Intelligence

Abstract: In this panel, challenges of implementing Artificial Intelligence (AI) and Machine Learning (ML) for anomaly detection and classification from practical viewpoint will be presented. AI/ML techniques have been showing promising outcomes in PMU-based applications and specifically in bad data detection and mitigation, event detection, classification, and localization. This panel will mostly focus on the challenges of implementing such applications in offline and real-time PMU data analysis tools.

Download presentation

Panelist 4:

Name: Salvatore D'Arco

Organisation: SINTEF, Norway

Title of presentation: A laboratory research platform for validating WAMPACS solutions

Abstract: Laboratory testing of WAMPACS could facilitate the transition from research to industrial development. The panel presentation will describe the research platform for WAMPACS in the National Smart Grid Laboratory, the capabilities offered and lesson learnt from the experience matured in the development and testing phase.

Download presentation

Panelist 5:

Name: Knut Hornnes

Organisation: Statnett, Norway

Short biography: MSc and PhD in Electrical Engineering from NTNU in 1983 and 1995 respectively. From 1984 to 2001 he worked at SINTEF Energy Research with optimization models and system analysis in Nordic and European power systems. The PhD thesis was focused on integration of market models and power flow models. From 2001 to 2011 he worked in Powel, now Volue, as consultant and developing of optimization models for hydropower. From 2011 he have worked at the Norwegian TSO Statnett with power system development and operation, both in Norway and in the Nordic synchronous system. He have also attended various work groups within Entso-E.

Title of presentation: Development and integration of PMU-based WAMPAC systems in Statnett

Abstract:

Download presentation

Panel 8: SynchroPhasor-based Automatic Real-time Control in a Nordic perspective

Wednesday, May 26 **4:15 pm – 5.30 pm (CEST)**

Name of the organizer: Glauco Taranto

Email: tarang@coep.ufrj.br

Organisation: Federal University of Rio de Janeiro – COPE, Brazil

Short biography of the chair: Glauco N. Taranto obtained the B.Sc. degree from State University of Rio de Janeiro (1988), the M.Sc. degree from Pontifical Catholic University of Rio de Janeiro (1991), and the Ph.D. degree from Rensselaer Polytechnic Institute, Troy, NY, USA (1994), all in Electrical Engineering with emphasis in power systems. In 2006 he was a visiting fellow in Centro Elettrotecnico Sperimentale Italiano, Milan, Italy. Dr. Taranto is a Professor in the Electrical Engineering Department at COPPE/Federal University of Rio de Janeiro. He is the chair of the Power System Stability Subcommittee of the IEEE PES PSDP Technical Committee, and chair of the Task Force on "Integrating Relay Models in RMS Dynamic Simulations". He was Editor of the IEEE Transactions on Power Systems (2016-2020). Dr. Taranto was the general chair of four International Workshops on Synchrophasor Applications in Rio de Janeiro, 2012-2015. He was awarded by FAPERJ – Rio de Janeiro R&D Agency – as distinguished scientist of Rio de Janeiro State three times in the last decade. Dr. Taranto is member of the steering committee of the SGSMA conference and member of the technical program committee of PSCC.

Abstract: The panel, comprised with five panelists, will focus on real applications of synchronized measurements in power systems of four South American countries – Brazil, Peru, Ecuador and Colombia. The applications range from simple enhanced monitoring of the system, to wide-area monitoring, protection and control (WAMPAC) of voltage, angle, and frequency stability assessment. The challenges of integration of different PMU suppliers "talking" to a single phasor data concentrator (PDC) will be exploited. Finally, the panel will present a laboratory setup to carry out reference tests for PMUs certification.

Download presentation

Panelist 1:

Name: Jaime Cristóbal Cepeda

Organisation: CENACE – The National System Operator, Quito, Ecuador

Title of presentation: Ecuadorian experiences in development and implementation of specialized applications using synchronized phasor measurement technology

Abstract: Currently, the operation of electric power systems experiences several technical challenges related to some pre-defined security constraints established to prevent the system from facing partial or total blackouts. In this new context, real time monitoring, protection and control of the power system plays a fundamental role as part of the processes of Control Centers. As this regards, the Wide Area Monitoring, Protection and Control System (WAMPAC) has been conceived for helping the operators to mitigate potentially harmful stress conditions in the system. In this context, the Ecuadorian ISO, CENACE, has undertaken a project to implement a WAMPAC infrastructure in Ecuador that facilitates the real time monitoring, supervision and control of the Ecuadorian National Interconnected System (SNI by its acronym in Spanish) with the usage of synchrophasor measurements. The WAMPAC has been configured, adapted and applied for monitoring and tackling possible issues related to steady-state angle stability, voltage stability, as well as oscillatory stability risks. This presentation focuses on sharing the Ecuadorian experiences on PSS tuning and the implementation of an Operator's Training Environment using synchrophasor measurements and a real-time digital simulator, as part of the WAMPAC solutions

Download presentation

Panelist 2:

Name: Hector Andres Rodriguez Volskis

Organisation: ONS – The Brazilian Independent System Operator, Rio de Janeiro, Brazil

Title of presentation: Synchrophasor Measurement Systems in Brazil

Abstract: An overview of synchrophasors uses in the operation of the Brazilian interconnected Power System: the challenge of each utility be able to install PMUs from different suppliers by sending information to the same PDC – adjustments in IEEE C37.118 standard; requirements for the first system based purely on synchrophasor measurements for the Brazilian Independent System Operator (ONS) – CC-PMS (Control Center Phasor Measurement System); applications available for this system; characteristics and challenges for the upcoming years.

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Panelist 3:

Name: Jorge Luis Cabrera Chirre

Organisation: COES SINAC, Peruvian System Operator – WAMS & DSA Specialist, Peru

Title of presentation: Phasor Measurement Pilot Project in Peru: Experiences and future proposals

Abstract: At the beginning of 2017, the Phasor Measurement Pilot Project began in Peru. Specified and deployed in that year, the development of applications based on phasor measurements with the aim of improving the capacity of dynamic analysis of the SEIN in our Control Center has been of interest. In addition to the ORGANON Dynamic Monitoring System, the WAMS System provides the ability to detect very low frequency, interarea, local oscillations and there is even a pilot project for monitoring Sub-synchronous Resonance. Thanks to the WAMS and DSA System, the CCO-COES operation has increased its response capacity in the analysis of dynamic real-time phenomena, as well as it has taken a preventive stance in situations that may put the SEIN at risk.

Download presentation

Panelist 4:

Name: Jose Eduardo da Rocha Alves Jr.

Organisation: CEPEL – Brazilian Electric Energy Research Center, Rio de Janiero, Brazil

Title of presentation: Experiences and recent achievements of Cepel, with focus on the Synchronous Phasor Measurement Laboratory (LabPMU)

Abstract: The presentation will bring experiences and recent achievements of Cepel, with focus on the Synchronous Phasor Measurement Laboratory (LabPMU). The lab carries out reference tests on PMUs and advanced research in synchrophasor systems, considering all the requirements and advantages of the technology and working with distinct utilities operating in the Brazilian Interconnected Power System. LabPMU main resources consist of a high precision reference test set for PMUs, an integrated environment created to test PMUs applications, comprising a real time simulator associated with a SCADA system (SAGE, which is extensively used in Brazil), opening opportunities to develop new algorithms for WAMPAC visualization, test and simulation using synchrophasor data.

Download presentation

Panel 9: International Experiences in synchrophasor applications

Wednesday, May 26 **1:30 pm – 2.45 pm (CEST)**

Name of the organizer: Mladen Kezunovic, Regents Professor

Email: kezunov@gmail.com

Organisation: Texas A&M University, USA

Short biography of the chair: Mladen Kezunovic (S'77–M'80–SM'85–F'99– LF'17) received the Dipl. Ing. from University of Sarajevo, Sarajevo, Bosnia, and M.Sc. and Ph.D. degrees in electrical engineering from University of Kansas, Lawrence, KS, in 1974, 1977, and 1980, respectively. He has been with Texas A&M University, College Station, TX, USA since 1986, where he is currently Regents Professor, Eugene E. Webb Professor, and the Site Director of "Power Engineering Research Center" consortium. For over 25 years he has been the Principal Consultant of XpertPower Associates, a consulting firm specializing in power systems data analytics. His expertise is in protective relaying, automated power system disturbance analysis, computational intelligence, data analytics, and smart grids. He has authored over 600 papers, given over 120 seminars, invited lectures, and short courses, and consulted for over 50 companies worldwide. Dr. Kezunovic is a CIGRE Fellow, Honorary and Distinguished member. He is Registered Professional Engineer in Texas.

Abstract: Deployment of phasor measurement units (PMUs) in the US grid has surpassed 3,000. Other countries such as China, Russia and India are deploying PMUs at a rapid pace widely as well. Combined, the mentioned countries have deployed or are planning to deploy over 10,000 PMUs so far. This panel will be focused on the discussions of how the synchropahsor systems are used today to monitor, control and protect power system. The representatives from the USA, China, Russia and India will discuss their experiences and share the lessons learned.

Download presentation

Panelist 1:

Name: Dmitry Dubinin

Organisation: System Operator of United Power System of Russia – Head of the Wide Area Monitoring Division, Russia

Short biography: Dmitry Dubinin received a diploma of electrical engineer (1992 – 1997, State Power University, Ivanovo, Russia). He worked at the Kola Nuclear power plant (1998 – 2010) by leading engineer of relay protection Department and implementation of automated monitoring and control systems. Since 2010 he has been working as the Head of the Wide Area Monitoring Division in the System Operator (SO UPS). He is responsible for: a) development of regulatory and guidance documentation providing WAMS deployment and operation in the United Power System of Russia, and b) deployment of the automated PMU data acquisition system and synchrophasor applications in control centers of the System Operator. He is a member of CIGRE. He has authored over 10 papers.

Title of presentation: Synchrophasor application experience in Russia

Abstract: The presentation describes the creation and current deployment of WAMS in Russia. The implementation of the automated PMU data acquisition system in 22 control centers of the System operator will be considered. The following issues will also be discussed: a) deployment in control centers of synchrophasor applications: online low frequency oscillation monitoring, System for Monitoring the Operation of System Regulators, b) 3D-visualization, data quality monitoring, c) PMU&PDC certification procedures in Russia; d) prospects for the development of new synchrophasor applications.

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Panelist 2:

Name: Huafeng Zhou

Organisation: China Southern Power Grid, Power Dispatching & Control Center – Vice Director of Automation Division, China

Short biography: Huafeng Zhou received his Bachelor's and Master's Degrees from the University of Huazhong University of Sci. & Tech.(1995-2001). After that He worked as an engineer at an EMS vendor in China for 3 years. He got his PhD Degree from the University of Hong Kong (2004-2008). Since 2008, he has been working at the dispatching & control center of China Southern Power Grid (CSG). His interests include the research and development of EMS, WAMS and MMS (Power Spot Market System).

Title of presentation: Experiences and future development for synchrophasor technology

Abstract: The presentation will discuss: (1) State-of-the-art Experiences: a) Online monitoring: Voltage stability monitoring, Hybrid state estimation, Oscillation detection & wide area monitoring, Frequency disturbance event detection, Islanding detection, b) Parameter identification: Generator model validation, Load model validation, Network validation and topology estimation, c) Post-event analysis: Low frequency oscillation analysis, Accurate fault positioning and restoration, and d) Application in distribution network: Integrating renewable and distributed resources, Automatic controls of demand response, Automatic fault positioning of distribution network, Power quality analysis; and (2) Future development: a) Power system wide-frequency measurement technology: Able to monitor and measure low frequency oscillation, subsynchronous oscillation, hyper-synchronous oscillation and 100-300Hz wide-frequency oscillation, b) Multi-functional measurement and control device: A multi-functional device which integrates PMU, metering unit, measurement and control unit, and c) 5G and PMU: Using 5G mobile network for high speed, high frequency and high precision PMU data transmission.

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Panelist 3:

Name: Teboho Machabe

Organisation: Transmission System Operator, ESKOM – Senior Engineer, South Africa

Short biography: Teboho graduated with a BSc Electrical engineering degree from the University of the Witwatersrand, Johannesburg, South Africa in 2010. He began employment in 2011 at BMW Rosslyn plant as a trainee for one year working at the Analysis and Test Centre. He then joined Eskom System Operator in 2012 as a trainee and in 2014 he was appointed as an engineer working in the Specialized System Studies section of the System Operator Operations Planning department. In 2017 he was appointed as a Senior Engineer in the area of Specialized Systems with particular focus on Wide Area Monitoring System (WAMS) which utilizes Phasor Measurement Units (PMUs). He became a member of South African Institute of Electrical Engineers in 2016 and subsequently was elected as a secretary of the Central Gauteng Centre of SAIEE in 2017. In 2018 he was elected to be Deputy Chairperson of the Central Gauteng Centre. He is the immediate past chairperson of the SAIEE Central Gauteng Centre that achieved the Centre of the Year award in the 2019/2020 term and has served in the SAIEE Council during that period. He is a registered Professional Engineer with the Engineering Council of South Africa (ECSA) and is a member of ECSA reviewers for Professional Engineer registrations. He is also part of the CIGRE Working Group – Wide Area Monitoring Systems – Support for Control Room Applications. Teboho is presently employed at the System Operator operations planning department as a Senior Engineer executing the WAMS project and is also a candidate MSc graduate with the at the University of the Witwatersrand.

Title of presentation: The Advantages of PMU Data Analytics in Power Systems with High Renewable Energy Penetration

Abstract: Renewable energy sources are mostly inverter based generators that harness either the solar radiation or the energy in the wind for the production of electrical energy. Inverter based energy sources have very little inertial response and thus inherently contribute very little to the system inertia. This implies that the displacement of synchronous generators to accommodate the renewable energy sources will result in low system inertia. The change in the system inertia may result in an increase or decrease in the number of dominant modes of the power system. The frequency range of the oscillation may increase from the traditional known range of 0.2 Hz to 3 Hz. It therefore becomes important for the operator of the power system to be able to have full visibility of the dynamic system behavior. The traditional Supervisory Control and Data Acquisition (SCADA) visualization tool of the power system becomes inadequate as it does not show the transient behavior of the power system due to its inherent low data resolution. PMU based visualisation tool is better equipped to monitory the dynamic instabilities of the power system.

Download presentation

Panelist 4:

Name: Rajiv Porwal

Organisation: Power System Operation Corporation Limited (POSOCO) – Chief General Manager, India

Short biography: Working at National Load Dispatch Centre (NLDC), POSOCO, the Power System Operator of the Country. Within RLDC & NLDC, has worked in Grid Management, Operational Planning, Scheduling, Operation Services, MIS, Energy Metering & Settlement system and Commercial departments. Has worked as Open Access Coordinator of NRLDC. Has also taken up responsibility as Reliability Coordinator of the Northern Region as well as at National level. Specialties: Good understanding of Indian Power Sector especially power system operation, regional settlement system, Open Access, working of the market mechanism in India.

Title of presentation: Synchrophasor Applications in Indian Power System

Abstract: India started deploying Wide Area Monitoring System (WAMS) as a pilot since 2010 for improving Situational Awareness (SA) of the power system with a high resolution data availability at control centres. The number of phasor measurement units (PMUs) available in the system at present has increased to more than 1400. This Synchrophasor technology is being utilized by power system operators as an analytical tool for better system operation such as monitoring of frequency, Rate of change of frequency, Voltage, Power flows and Angle differences. The different applications at control centre are fault identification, islanding, stress on the transmission system, intra and inter area oscillation detection, voltage imbalances, model validation, linear state estimation. These synchrophasors have also been used in post-dispatch analysis of events. These aspects and some of the applications of synchrophasor displays and data as used in Indian power system operation would be discussed.

Download presentation

Webinars:

Webinar 1: Implementation of State Estimation: A Multi-Scale Framework

Wednesday, May 26 **7:45 pm – 8:45 pm (CEST)**

Name and title of the speaker: Shaobu Wang, Senior Research Engineer

Email: shaobu.wang@pnnl.gov

Organisation: Pacific Northwest National Lab, USA

Biography of the speaker: Shaobu Wang received the Ph.D. degree in electrical engineering from Zhejiang University, Hangzhou, Zhejiang province, China, in 2009. From March 2009 to March 2010, he worked as a postdoctoral fellow in the Department of Electrical and Computer Engineering, University of Alberta, Edmonton, AB, Canada. From April 2010 to April 2011, he worked as a postdoctoral research associate in the Center for Energy Systems Research, Tennessee Technological University, Cookeville, TN, USA. He joined Pacific Northwest National Laboratory as a research engineer in 2011, Richland, WA, USA. His research interests include PMU-based monitoring and control of power systems and renewable energy integration.

Abstract: The behavior of modern power systems is becoming more stochastic and dynamic due to the increased penetration of variable generation, demand response, new power market structures, extreme weather conditions, contingencies, and unexpected events. It is critically important to understand the current operational issues in the power system, and predict those in the near future, to reinforce system resilience and reliability so that grid planners and operators can take preventive actions to mitigate their negative effects, e.g., lack of operational reserves. Dynamic state estimators based on phasor measurement units (PMUs) can track dynamic states in near-real time. However, current PMU installation is insufficient to provide full network observability in the North American power grid; (The North American SynchroPhasor Initiative estimated that around 2,000 PMUs had been installed or planned by the year 2018). Therefore, it is unrealistic to perform dynamic state estimation (DSE) for the whole system. To bridge this gap, the presentation proposes a multi-scale framework that combines the strengths of static state estimation (SSE) and DSE. The proposed approach can be summarized as follows: we perform SSE in a large portion of a grid when the system is in a steady state, and we switch from SSE to DSE in a small portion that has PMU coverage when the system is in a transient state. In other words, when a dynamic event is detected, we switch from SSE to DSE; when the event is over, we switch back to SSE. The proposed framework includes two basic topics: (1) when to switch between SSE and DSE; (2) how to switch. For the first one, we need to address event detection using measurement data, and judge whether the transient response is big enough to launch DSE when an event is detected. In contrast, if we need to switch from DSE to SSE, we need to develop criteria to judge whether the system goes into a steady or quasi-steady state. For the second one, we need to address how to determine the initial values for the DSE when switch from SSE to DSE. In the proposed

framework, the switching logic between SSE and DSE is determined by the system event/disturbance. In this presentation, we will discuss how to use the singular spectrum analysis (SSA) method to analyze time series of PMU measurements to detect changes of system operational conditions. The SSA is a powerful, nonparametric method for time-series analysis. The basic idea is to perform singular value decomposition of the trajectory matrix that is obtained from the original series. The distance between the subspace spanned by certain eigenvectors and the lagged vectors will increase if an event happens. A power systems event will change the temporal and spatial correlations of the PMU measurement time series, which will be captured by the SSA method. The proposed framework aims to enhance grid reliability and resilience, which is key for the next-generation energy management system of the power grid, using the hybrid state estimator to track system states in both steady and transient states. The developed framework can track changes in system states over wide temporal and spatial ranges and significantly enhance the operator's situational awareness, yielding better system monitoring, protection, and control.

Download presentation

Webinar 2: O-spline FIR filters for obtaining the Synchrophasor of Real Signals

Tuesday, May 25 **3:00 pm – 4:00 pm (CEST)**

Name and title of the speaker: Prof. Jose Antonio de la O Serna

Email: jdelao@ieee.org

Organisation: Universidad Autonoma de Nuevo Leon UANL, Mexico

Biography of the speaker: Jose Antonio de la O Serna (SM'03) received his Ph.D. degree from Telecom ParisTech, France, in 1982. In 1987 he joined the Ph.D. program in electrical engineering at the Autonomous University of Nuevo Leon (UANL), where he was a member of the Doctoral Committee. Currently he is research professor at the UANL, Monterrey, Mexico. He was also professor at Monterrey Institute of Technology (ITESM) from 1982 to 1986. From 1988 to 1993, he was with the Electrical Department at the Polytechnic School in Yaounde, Cameroon. Mr. de la O Serna is a member of the Mexican Research System.

Abstract: Nowadays Phasor Measurement Unit (PMU) performance evaluation depend on the a priori knowledge of the synchrophasors of the analyzed signals. Since synchrophasors are available only for the few benchmark signals of the standard IEC/IEEE 60255-118-1:2018, such assessment is impossible for other signals, such as those occurring in a real event of a substation. A new method for obtaining the synchrophasor of real signals is proposed in this webinar. A finite impulse response (FIR) filter, designed with the nonic O-spline is proposed to obtain phasor estimates asymptotically close to those of the ideal bandpass filter. The phasor estimation accuracy of one or several PMUs can then be assessed using the standard. In addition, it is possible to design two FIR differentiators to obtain frequency and ROCOF estimates close enough to those provided by the corresponding ideal differentiator filters, and largely compliant with the standard. This new set of filters opens the way to apply the synchrophasor standard to assess estimates of PMUs of different brands, when they process the signals of the same power system event. Furthermore, these filters can also be used to separate oscillating modes of power oscillations.

Download presentation

Webinar 3: Time-Synchronized Measurements in Romania – Technology and Applications

Tuesday, May 25 **11:15 am – 12:15 pm (CEST)**

Name and title of the speaker: Florin Balasiu – Director Operational Planning Unit – National Dispatching Center

Email: florin.Balasiu@transelectrica.ro

Organisation: Romanian Power Grid Company – Transelectrica Country: Romania

Biography of the speaker: Florin Balasiu received his diploma in electrical engineering from Technical University of Bucharest, Romania and his PhD from Technical University of Timisoara. He started to work as a protection engineer for the Romania TSO (Transelectrica), dealing with protection and control equipment. After 2008 he joined the Romanian National Dispatching Centre team, being involved in protection, control and automation parameters calculation and establishing of protection philosophies for high voltage power plants and substations. He was in charge to assist the commissioning of the first synchrophasors system installed by Transelectrica.

Abstract:Transelectrica is the electric power transmission system operator for Romania. As system operator, Transelectrica is responsible for the safe and reliable operation of the Romanian power system. The system must meet quality standards and allow fair and transparent access to all participants. In recent years a large amount of wind and solar energy resources have been added to the Romanian power system. Total power generation is 6GW and since 2009 a total of 3GW wind and 1.5GW solar has been added. Renewable resources present challenges for frequency and voltage stability, and for reliability during contingencies. To address these challenges, Transelectrica installed and has been operating a modern synchrophasor system. This webinar will present the architecture of the time-synchronized measurement, monitoring, and control system. Several example events will be shared, along with how the synchrophasor system aided in the response and analysis of the events. These events include a system separation after 400kV line tripping in 2014, a blackout in neighboring Turkey in 2015, a generation unit trip in 2016, and the performance of a hydropower plant during a disturbance in 2020.

Download presentation

Webinar 4: Time-Synchronized Measurements in Romania – Technology and Applications

Wednesday, May 26 **11:15 am – 12:15 pm (CEST)**

Name and title of the speaker: Antonello Monti, Professor

Email: amonti@eonerc.rwth-aachen.de.

Organisation: University of Aachen, Germany;

Biography of the speaker: Antonello Monti received his PhD in Electrical Engineering from Politecnico di Milano, Italy in 1994. He held positions in Industry and then in Academy in Italy and US. Since 2008 he is the director of the Institute for Automation of Complex Power System within the E.ON Energy Research Center at RWTH Aachen University. Since 2019 he is also part of Fraunhofer FIT where he is coordinating the joined development with RWTH of the Center for Digital Energy in Aachen. Dr. Monti was the recipient of the 2017 IEEE Field Medal Award Innovation in Societal Infrastructure.

Name and title of the speaker: Lorenzo Peretto, Professor

Email: lorenzo.peretto@unibo.it.

Organisation: University of Aachen, Germany; University of Bologna, Italy

Biography of the speaker: Lorenzo Peretto is Full Professor of Electrical and Electronic Measurements at the University of Bologna. He received the M.sc degree in Electronic Engineering at the University of Bologna in 1993 and the Ph.D degree in Electrical Engineering in 1997. Since 2018 he is Full Professor of Electrical and Electronic Measurements. At present he is President of both the Electrical Engineering Program and Master Program and of Electric Vehicle Engineering Master Program at University of Bologna.

Abstract: With the dramatic growth of renewables, VPPs need to support not only the promotion of intermittent renewables (RES) but also the integration of all Distributed Energy Resources (DER) into the full scope of grid operations. Such a leap raises challenges: optimal combination of DER and RES in a new generation of VPPs is needed to jointly provide grid supportive flexibility with realtime reaction time to provide fast frequency, inertial response and dynamic-phasor driven voltage control ancillary services. Short reaction times can be addressed by 5G-powered edge clouds linking remote Edge-Synchrophasors Units in near real-time. In this respect, a new concept of VPPs, with fast communications of synchronous measurements and fast and flexible response becomes possible. In the paper measurement models and control algorithms of VPPs with high penetration of RES and DER will be presented along with the results of field trials in Medium Voltage Networks.

Download presentation

Webinar 5: Switch Status Identification in Distribution Networks using Harmonic Synchrophasor Measurements

Thursday, May 27 **8:15 am – 9:15 am (CEST)**

Name and title of the speaker: Dr. Lei Chen

Email: chenleithu@hotmail.com

Organisation: Tsinghua University, China

Biography of the speaker: Dr. Lei Chen is now a Research Associate with Department of Electrical Engineering, Tsinghua University. He received Ph.D. degree from Tsinghua University in 2020. He was a visiting Ph.D. student at University of California, Riverside, CA, USA and supervised by Prof. Hamed Mohsenian-Rad. His research interests are power system measurement and measurement-based power system applications. He received the Best Doctoral Dissertation Award from Tsinghua University. He has published over 15 peer-reviewed papers, including multiple papers in IEEE Trans. Smart Grid and IEEE Trans. Instrumen. and Meas.

Abstract: Switch status identification (SSI) in distribution networks is a challenging task due to the limited measurement resources and therefore the inevitable need is to use pseudo-measurements that are often inaccurate. In this Webinar, I will introduce a new method which integrates harmonic synchrophasors into the SSI problem in order to enhance SSI accuracy in distribution networks. In this method, switch status identification is done jointly based on both fundamental synchrophasor measurements and harmonic synchrophasor measurements. This is done by formulating and then solving a mixed-integer linear programming (MILP) problem. Furthermore, I will provide an analysis to capture the number of and the location of harmonic sources and sensors that are needed to ensure full observability.

Download presentation

Webinar 6: Data-Driven Analytics and Use Cases for Synchronized Waveform Measurements

Tuesday, May 25 **7:15 pm – 8:15 pm (CEST)**

Name and title of the speaker: Professor Hamed Mohsenian-Rad

Email: hamed@ece.ucr.edu

Organisation: University of California, Riverside, USA

Biography of the speaker: Dr. Hamed Mohsenian-Rad is a Professor of Electrical and Computer Engineering and a Bourns Family Faculty Fellow at the University of California, Riverside. His research interests include developing data-driven and model-based techniques for monitoring, control, and optimization of power systems and smart grids. He is the author of an upcoming textbook on smart grid sensors: principles and applications. Dr. Mohsenian-Rad has received the United States National Science Foundation (NSF) CAREER Award, a Best Paper Award from the IEEE Power and Energy Society General Meeting, and a Best Paper Award from the IEEE Conference on Smart Grid Communications. Two of his papers are currently ranked as the two most cited articles in the IEEE Transactions on Smart Grid. Dr. Mohsenian-Rad is the Director of the UC-National Lab Center for Power Distribution Cyber Security, a cyber-security research initiative across four University of California campuses and two DoE National Labs. He also serves as the Associate Director of the Winston Chung Global Energy Center, an endowed research center in the area of energy and sustainability at UC Riverside. He has served as the PI for over $10 million smart grid research projects. He received his Ph.D. in Electrical and Computer Engineering from the University of British Columbia, Vancouver, Canada in 2008. Dr. Mohsenian-Rad is a Fellow of the IEEE.

Abstract: Waveform measurement units (WMUs) are an emerging class of smart grid synchronized measurement technologies that provide synchronized measurements for voltage and current waveforms. Since WMUs provide synchronized waveform measurements, as opposed to synchronized phasor measurements that are provided by phasor measurement units (PMUs), the data from WMUs is much more granular than the data from PMUs. This call for fundamentally new methodology to analyze WMU data. In this webinar, we cover three pillars in this area. First, we discuss the key differences between WMU measurements and PMU measurements through multiple illustrative examples. Second, we discuss both data-driven and model-based (as well as hybrid) methodologies to study measurements from WMUs, covering theoretical challenges and the practical considerations. Third, we will discuss some of the important use cases of synchronized waveform measurements, with primary focus on the applications in power distribution systems; and the lessons learned from recent case studies. This webinar can be offered as a pre-recorded presentation or as a live presentation to also answer questions.

Download presentation

Webinar 7: Applications of synchronised continuous point on wave (CPOW) monitoring

Wednesday, May 26 **11:15 am – 12:15 pm (CEST)**

Name and title of the speaker: Steven Blair, Head of Power Systems Technologies

Email: steven.blair@synapt.ec

Organisation: Synaptec, UK

Biography of the speaker: Steven Blair is the Head of Power Systems Technologies at Synaptec, UK, where he leads Synaptec's software and data analytics strategy. He holds a PhD in Electronic & Electrical Engineering and an MEng in Computer & Electronic Systems from the University of Strathclyde. He has been both a researcher and academic at the University of Strathclyde, including holding the Nokia lectureship position. He is experienced in power system protection, power quality, real-time systems, and communications technologies, and is widely published in these areas. Dr Blair is a member of IEC TC57 Working Group 10 which manages the IEC 61850 standards.

Abstract: To address major industry needs for greater visibility while supporting "net-zero" carbon emission targets, new tools are emerging to deliver and analyse sample-by-sample waveforms of voltages and currents. This approach, which has been dubbed continuous point-on-wave (CPOW) monitoring, goes well beyond the capabilities of conventional synchrophasor or supervisory control and data acquisition (SCADA)-based measurements by providing two or three orders of magnitude more detail. This is similar to having networked fault recorders, with the data readily available to users in real-time. Until recently, this has not been possible to achieve cost-effectively. CPOW monitoring, typically providing data sampled at rates of at least 4 kHz, is critical for understanding and diagnosing some events which are "hidden" in relatively coarse synchrophasor or SCADA data. For example, transients during switching events or electrical faults, which may include stressful electrical arcing, could be detected and logged within the condition monitoring profile of critical assets, such as circuit breakers. The entire transient may simply be unobservable using synchrophasor data. Similarly, power quality phenomena such as voltage and current harmonics are not captured through synchrophasor measurements. Such advanced monitoring capabilities are especially important in power systems with high levels of converter-connected generation, due to the relatively high switching rates and other fast-acting phenomena. This session will examine several compelling applications of CPOW monitoring. This includes transient event classification, waveform-based condition monitoring, distributed synchronised power quality monitoring of wind farms, wide-area protection, and detailed post-event analysis. The session will highlight the improvements and new possibilities offered by CPOW monitoring, compared to synchrophasor-based systems. It will also explore existing data acquisition and analytics tools for practical deployment and efficient data management, and the major ongoing worldwide R&D efforts to fully take advantage of CPOW monitoring schemes.

Download presentation

Webinar 8: Impact, advancement, and challenges of clock synchronization on PMUs and their applications

Thursday, May 27 **11:15 am – 12:15 pm (CEST)**

Name and title of the speaker: Prof. David Macii

Email: david.macii@unitn.it

Organisation: University of Trento

Biography of the speaker: David Macii was born in Perugia, Italy, in 1974. He received a 5-year (B.S.+M.S.) Degree (summa cum laude) in Electronic Engineering and the Ph.D. Degree in Information Engineering from the University of Perugia in 2000 and 2003, respectively. Also, he received the Master Degree of Advanced Studies in Embedded System Design from the University of Lugano, Lugano, Switzerland, in 2005. David Macii worked as FPGA designer at the German Aerospace Centre DLR, Oberpfaffenhofen, Germany, in 2000. He was a visiting Ph.D. Student at the Department of Electronic Network and Computer Engineering (DSP and VLSI group) of the University of Westminster, London, UK, between 2002 and 2003. Afterwards, he was a research fellow at the University of Trento, Trento, Italy and a visiting researcher at the Advanced Learning and Research Institute (ALARI), Lugano, Switzerland, between 2003 and 2005. Between 2005 and 2012 he was an Assistant Professor first with the Department of Information Engineering and Computer Science and then with the Department of Industrial Engineering of the University of Trento. Between 2009 and 2010, he was at the Berkeley Wireless Research Centre (BWRC) of the University of California Berkeley, CA, USA, as a Fulbright Research Scholar. At the moment he is an Associate Professor with the Department of Industrial Engineering of the University of Trento. He was the Coordinator of the Euro-regional mobility project "E3 – EUREGIO Training Network on Energy". He was a keynote speaker at the "2nd International Conference on Measurement Instrumentation and Electronics" (ICMIE), Prague, Czech Republic, in 2017 for the talk "Distributed synchronous measurement systems for smart grids: opportunities and challenge" and an invited speaker at the "Workshop Engineering trends and business opportunities for smart cities," Trento, Italy, in2016 for the talk "Energy management systems in the context of smart cities." Also, he was General Co-chair, Publication Chair and Program Co-chair of the IEEE Workshop on Environmental, Energy and Structural Monitoring Systems (EESMS) in 2013, 2014 and 2015, respectively. David Macii is an Author or a Co-Author of about 150 papers published in books, scientific journals and peer-reviewed international conference proceedings. Among others, he received the best academic paper award as a co-author of the paper "A Clock State Estimator for PTP Time Synchronization in Harsh Environmental Conditions" presented at the ISPCS 2011 Conference, Munich, Germany, in 2011. His research interests comprise the design, implementation and characterization of digital signal processing algorithms and embedded systems for measurement applications, with a special emphasis on measurement techniques for smart grids and energy monitoring systems.

Name and title of the speaker: Prof. Stefano Rinaldi

Email: stefano.rinaldi@unibs.it

Organisation: University of Trento, University of Brescia, Italy

Biography of the speaker: Stefano Rinaldi was born in Seriate (BG), Italy, in 1982. He received the M.S. degree (summa cum laude) in electronic engineering and the Ph.D. degree in electronic instrumentation from the University of Brescia, Italy, respectively in 2006 and 2010. He is author or co-author of more than 150 scientific papers. In 2014, he joined the Department of Information Engineering of the University of Brescia where he is presently Senior Assistant Professor. Stefano Rinaldi received “Premio Carlo Offelli” in 2011 for the best Italian Ph.D. thesis in the field of electrical and electronic instrumentation assigned by the Electrical and Electronic Measurement National Scientific Society (GMEE). He received the best work in progress at ETFA 2008 for his studies about the coexistence of several synchronization techniques on industrial Real Time Ethernet networks. He received the best paper at the 2nd EAI International Conference on ICT Infrastructures and Services for Smart Cities, IISSC 2017. He is inventor of two national patents and one international patent. He takes part to IEEE 1588 standardization Working Group IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems”, for the definition of the next release of IEEE 1588 protocol. He took part to NIST Cyber-Physical Systems Public Working Group (CPS PWG), on the topic of the time synchronization of cyber-physical systems. He was involved as reviewer of the final results of UNI-SET Energy Cluster Event project, funded by the European Union. His research activity is mainly devoted to: industrial real-time Ethernet network; communication in smart grids; wireless sensor network and smart sensors; time synchronization methods; Internet of Things; Smart Grid; Smart Buildings and Smart City; design of Field-Programmable Gate Array system-on-a-chip; Linux-embedded and real-time software development..

Abstract: As known, the magnitude, phase, frequency and rate of change of frequency (ROCOF) of voltage or current waveforms measured by a PMU have to be properly synchronized to the Coordinated Universal Time (UTC). Often, the signals used for clock synchronizaton (usually generated by a GPS receiver) are also used for syntonization, i.e. to discipline the PMU sampling rate. Of course, the clock synchronization fluctuations affect the waveform parameters to be estimated and they tend to accumulate when the PMU data are gathered, time-aligned and processed by a Phasor Data Concentrator (PDC). Therefore, an upper bound to clock synchronization uncertainty must be found to ensure not only that its contribution to the Total Vector Error (TVE), the frequency error (FE) and the ROCOF error (RFE) is kept under control, but also that the phase measurement errors are much smaller than the phasors inherent angle offsets measured in different points of the grid at the same time. While 1-us accuracy is currently regarded as a standard requirement at the transmission level, an extensive debate is currently ongoing on the synchronization requirements at the distribution level. The proposed webinar, after a brief introductory overview of clock synchronization, syntonization and their uncertainty contributions, first will provide a detailed analysis of how such uncertainty contributions affect PMU measurement results; then it will recall the typical clock synchronization techniques that can be adopted for PMU implementation as well. They usually include: classic GPS-based solutions, the IRIG-B protocol, the IEEE 1588 Precision Time Protocol (PTP) along with the PTP power profile (standardized as IEEE C37.238-2017)

and software message timestamping and finally White Rabbit (referred to as “high-accuracy profile” in the IEEE Standard 1588-2019). This represents indeed the evolution of PTP when extreme accuracy is needed, as it requires hardware message timestamping and a real-time Ethernet infrastructure. A critical analysis of the advantages and disadvantages of such techniques with an outlook on some research works, activities and standardization efforts will complete the webinar.

Download presentation

Tutorials:

Tutorial 1: Traceability of Synchrophasor Measurements in Power Systems: Definitions and Methods

Monday, May 24	2:30 pm– 5:00 pm (CEST)

Abstract: The tutorial investigates the main theoretical and technological aspects related to the rigorous definition and characterization of synchronized phasor measurements.

Background material can be found here: A. Goldstein, G. Frigo, "Determination of Digitizer Absolute Phase Using Equivalent Time Sampling"

In this sense, the tutorial consists of three sections:

Section 1 Prof. Pegoraro – The first Section introduces the mathematical definition of the measurand, namely synchrophasor, frequency and rate of change of frequency, and discusses their possible application in power systems' monitoring and control applications. In this context, we present the importance of the measurement model, by illustrating alternative estimation approaches that rely on static and dynamic phasor model. The sources of uncertainty in the PMU measurement chain are discussed highlighting the pros and cons of each approach and focusing on estimation accuracy in standard and real-world operating conditions.

Section 2 Dr. Frigo – The calibration of phasor measurement units (PMUs) and the improvement of the associated normative documents are key points to support the deployment of such devices in the power systems. In particular, the rigorous and traceable metrological characterization of PMUs is still an open issue for national metrological institutes. In this Section, we describe the software and hardware architecture of the PMU calibrator currently being developed at the Swiss Federal Institute of Metrology (METAS). In particular, we characterize the uncertainty sources related to the voltage and current signal chains and discuss the role of different time and frequency sources.

Section 3 Dr. Goldstein – The rigorous characterization of the "absolute phase" in digitization systems still represents an open issue for national metrological institutes, research laboratories and manufacturers. In this Section, we present a new method for the determination of absolute phase, based on curve fitting a model of a filtered square wave, in order to determine its phase related to the phase of a sampled sine wave at the same frequency. The Equivalent Time Sampling (ETS) technique is used to capture the shape of the filtered rising and falling edges of the signal and the ETS captured signal is modeled. The proposed method should enhance the time resolution of the absolute phase determined for each system component. Taking as device under test the NIST PMU calibration system, we carry out an experimental validation and are able to determine correction factors for phase reference values with a worst-case uncertainty in the order of few microradians at 50 Hz.

Name and title: Dr. Guglielmo Frigo

Organisation: Swiss Federal Institute of Metrology (METAS), 3003 Bern-Wabern, Switzerland

Email: guglielmo.frigo@metas.ch

Short biography of the chair: 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 in 2008 and 2011, respectively, and the Ph.D. degree from the School of Information Engineering in 2015, with a dissertation about compressive sensing (CS) theory applications to instrumentation and measurement scenario. He served as PostDoc researcher at the Electronic Measurement Research Group, University of Padova (2015-2017), and at the Distributed Electrical Laboratory, Swiss Federal Institute of Technology of Lausanne (2018-2020). In 2020 he was foreign guest researcher at NIST, Gaithersburg, USA and he is currently scientist at METAS, Wabern, Switzerland. His current research interests include the development of enhanced measurement infrastructures for electrical systems.
Download presentation

Name and title: Dr. Allen Goldstein

Organisation: National Institute for Standards and Technology (NIST), Gaithersburg, MD, US

Email: allen.goldstein@nist.gov
Short biography of the chair: Allen Goldstein was born in Brooklyn New York, 1957, B.S. electrical engineering, University of Southern California, Los Angeles, CA, 1982. He enlisted in the U.S. Navy in 1976, served as an aviation electronics technician in 1982, served as a Navy Submarine officer. 1987, joined Peavey Electronics, Meridian, MS, as a Digital Design Engineer designing products utilizing draft international standards MIDI and Digital Audio while contributing to the drafting of those standards. Also did graduate coursework at the University of Mississippi. 1992, Director of Engineering at Symetrix, Inc. in Seattle, WA, leading design of high speed, high resolution A/D and D/A converters as well as DSP equipment. 1997 joined Digital Harmony, architected A/V ASIC compliant with draft IEEE 1394 (Firewire) while contributing to the drafting of that and related 1394 standards. 2004, he became Chief Architect at Numark, Incorporated's Seattle design center, designed products based on the ASIC architected at Digital Harmony. 2006, worked as an electronics design consultant, designing an early PVR system, a digital audio analysis system, and several other digital audio/video products. In 2008, after seeing Al Gore's "An Inconvenient Truth," switched fields to work on electrical power equipment and standards, working on a "smart" micro-inverter, and with Fluke Calibration to lead the design of the first commercially available PMU calibration system. In 2012, joined NIST and presently works in the Synchrometrology Laboratory, the NIST Smart Grid Testbed and with IEC and IEEE. Allen is vice-chair of the joint IEEE/IEC working group for synchrophasor performance standard, IEEE/IEC TC95 JWG1, chair of the IEEE Conformity Assessment Program (ICAP) Synchrophasor Conformity Assessment Committee, and chair of IEC PSRC WG C28 requirements of PMU performance.
Download presentation

Name and title: Prof. Paolo Attilio Pegoraro

Organisation: University of Cagliari, Electrical and Electronic Engineering Dept., Cagliari, Italy

Email: paolo.pegoraro@unica.it

Short biography of the chair: Paolo Attilio Pegoraro received the M.Sc. (summa cum laude) degree in telecommunication engineering and the Ph.D. degree in electronic and telecommunication engineering from the University of Padova, Padua, Italy, in 2001 and 2005, respectively. From 2015 to 2018 he was an Assistant Professor with the Department of Electrical and Electronic Engineering, University of Cagliari, Cagliari, Italy, where he is currently Associate Professor. He has authored or co-authored over 110 scientific papers. His current research interests include the development of new measurement techniques for modern power networks, with attention to synchronized measurements and state estimation. Dr. Pegoraro is a member of IEEE Instrumentation and Measurement Society TC 39 (Measurements in Power Systems) and of IEC TC 38/WG 47 (Evolution of Instrument transformer requirements for the modern market). He is an Associate Editor of the IEEE Transactions on Instrumentation and Measurement.

Download presentation

Tutorial 2: Distribution-Level PMUs and their Applications

Monday, May 24 **5:00 pm– 7:30 pm (CEST)**

Abstract: The visibility of the transmission grid have been transformed over the past decade with the deployment of phasor measurement units (PMUs). Similar new information sources are now becoming available at the distribution grid, by using distribution-level PMUs (D-PMUs), also called micro-PMUs. D-PMUs provide voltage and current measurements at higher resolution and precision to facilitate a level of visibility into the distribution grid that was previously not achievable. In this tutorial we will discuss the latest advancements, industry applications, and standardization efforts in the area of synchrophasor measurements in power distribution systems. The tutorial will take 2.5 hours. It will be presented by four speakers. The presentations will discuss the following subjects: 1) data-driven analysis of events in power distribution synchrophasors; 2) D-PMU-based situational awareness systems for the monitoring, protection and control of active distribution networks; 3) Field Implementation of micro-PMU and deep graph learning for real-time event identification; and 4) performance requirements for Distribution systems. Several examples based on real-world field implementations of D-PMus will be discussed.

Organizer:

Name and title of the organizer: Professor Hamed Mohsenian-Rad
Organisation: University of California, Riverside, USA
Email: hamed@ece.ucr.edu

Presentation 1:

Name: Hamed Mohsenian-Rad

Organisation: University of California, Riverside, USA

Title: Data-Driven Analysis of Events in Power Distribution Synchrophasors

Abstract: Synchrophasor measurements offer an unprecedented level of visibility in power distribution infrastructure. These are time-synchronized single-phase or three-phase voltage and current phasor measurements on medium and low voltage distribution circuits. However, data availability alone is not enough to enhance operational intelligence. In this talk, we make the case that the analysis of "events" is a key to translate the data from distribution synchrophasors into useful high-level information. An event in this study is defined rather broadly to include any major change in any component across the distribution feeder. The real data that is used in this study is obtained from a pilot distribution feeder in Riverside, CA. The goal is to enhance situational awareness in distribution grid by keeping track of the operation (or misoperation) of various grid equipment, assets, distribution energy resources, loads, etc. A combination of data-driven machine learning tools and hybrid model-based methodologies are discussed to automatically (and often remotely) detect, classify, and identify the causes of events and their characteristics in power distribution systems. Use cases are diverse and may include asset monitoring, non intrusive load modeling, analysis of system dynamics, cybersecurity, etc.

Short biography of the presenter: Dr. Hamed Mohsenian-Rad is a Professor of Electrical and Computer Engineering and a Bourns Family Faculty Fellow at the University of California, Riverside. His research interests include developing datadriven and model-based techniques for monitoring, control, and optimization of power systems and smart grids. He has received the NSF CAREER Award, a Best Paper Award from the IEEE Power and Energy Society General Meeting, and a Best Paper Award from the IEEE Conference on Smart Grid Communications. Two of his papers are currently ranked as the two most cited articles in the IEEE Transactions on Smart Grid. Dr. Mohsenian-Rad is the Director of the UC-National Lab Center for Power Distribution Cyber Security, a cyber-security research initiative across four University of California campuses and two DoE National Labs. He also serves as the Associate Director of the Winston Chung Global Energy Center, an endowed research center in the area of energy and sustainability at UC Riverside. He has served as the PI for over $10 million smart grid research projects. He received his Ph.D. in Electrical and Computer Engineering from the University of British Columbia, Vancouver, Canada in 2008. Dr. Mohsenian-Rad is a Fellow of the IEEE.

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Presentation 2:

Name: : Mario Paolone

Organisation: École Polytechnique Fédérale de Lausanne (EPFL), Switzerland

Title: PMU-based situational awareness systems for the monitoring, protection and control of active distribution networks

Abstract: : In the operation of power transmission systems, the knowledge of the system state, or state estimation (SE), is required by several fundamental functions, such as security assessment, voltage control and stability analysis. Traditionally, the SE has been performed at a relatively low refresh rate of a few minutes, dictated by the time requirements of the related functions together with the low measurement acquisition rate of remote terminal units (RTUs). Nowadays, the emerging availability of phasor measurement units (PMUs) allows to acquire accurate and time-aligned phasors, known as synchrophasors, with typical streaming rates in the order of tens of measurements per second. This technology is experiencing a fast evolution, which is triggered by an increasing number of power system applications that can benefit from the use of synchrophasors. SE processes can exploit the availability of synchrophasor measurements to achieve better accuracy performance and higher refresh rate (subsecond). PMUs already compose the backbone of wide area monitoring systems in the context of power transmission networks to which several real-time functionalities are connected, such as inter-area oscillations, relaying, fault location and real-time SE. However, PMU-driven situational awareness systems may represent a fundamental monitoring tool even in the context of distribution networks for applications such as: SE, grid-aware optimal power flow controls, fault identification and location, synchronous islanded operation. In this respect, the lecture illustrates fundamental methodological aspects for the development of PMU-based situational awareness systems for the monitoring, protection and control of active distribution networks.

Short biography of the presenter: Prof. Dr. Mario Paolone received the M.Sc. (with Hons.) and Ph.D. degrees in electrical engineering from the University of Bologna, Italy, in 1998 and 2002, respectively. In 2005, he was appointed Assistant Professor in power systems with the University of Bologna, where he was with the power systems laboratory until 2011. In 2010, he received the Associate Professor eligibility from the Polytechnic of Milan, Italy. Since 2011, he joined the Swiss Federal Institute of Technology, Lausanne, Switzerland, where he is currently Full Professor, Chair of the Distributed Electrical Systems Laboratory, Head of the Swiss Competence Center for Energy Research Future Swiss Electrical infrastructure and Chair of the EPFL Energy Centre Directorate. He has authored or co-authored over 300 papers published in mainstream journals and international conferences in the area of energy and power systems. His research interests focus on power systems with particular reference to real-time monitoring and operation aspects, power system protections, dynamics and transients. Dr. Paolone was the founder Editor-in-Chief of the Elsevier journal Sustainable Energy, Grids and Networks.

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Presentation 3:

Name: Ken Martin

Organisation: Electric Power Group, USA

Title: PMU standardization: performance requirements for Distribution systems

Abstract: : Phasor measurement system operation and performance has been standardized since 1995. The current standard for synchrophasor measurement unit (PMU) performance is IEC/IEEE 60255-118-1, jointly created by the IEC and the IEEE. It includes both steady-state and dynamic measurement aspects of phasors, frequency, and rate of change of frequency (ROCOF). Elements for this standard have been mostly drawn from transmission system applications, though the standard is not specifically targeted for transmission. PMU use in distribution systems is growing and there is concern that this standard does not adequately address the needs for distribution applications. This talk will review the current standard requirements and discuss the changes that may be needed and the impacts of these changes.

Short biography of the presenter: Ken Martin is a Synchrophasor Technology Leader and Senior Principal Engineer. Ken has over 30 years of experience in the electric utility industry. He has extensive experience with SCADA and timesynchronized phasor data collection and use, including collection, system communications, system architecture and design, and applications for protection, control, monitoring, data management and display. Ken's work covers instrumentation and measurement systems for research, test, validation and controls.

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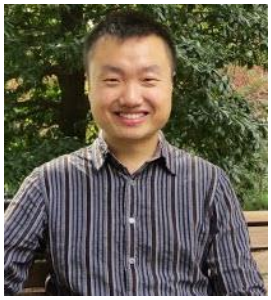
Presentation 4:



Name: Zhaoyu Wang

Organisation: Iowa State University, USA

Title: Field Implementation of MicroPMU and Deep Graph Learning for Real-Time Event Identification

Abstract: This talk will introduce field implementation experience of microPMUs at an Iowa distribution utility, including the setup of sensors, communication, and data collection. Then we will discuss how to leverage PMU data to identify events. In particular, we will address PMU data quality issues using a spatial pyramid pooling (SPP)-aided convolutional neural network (CNN). Then we will present a deep graph learning-based event identification method using measurements from multiple PMUs. Unlike previous methods that rely on a single PMU and ignore the interactions between different PMUs, the new method performs data-driven interactive graph inference. Meanwhile, to ensure the optimality of the graph learning procedure, our method learns the interactive graph jointly with the event identification model. Moreover, instead of generating a single statistical graph to represent pair-wise relationships in different events, our approach produces event-specific graphs, which handles the uncertainty of event locations.

Short biography of the presenter: Dr. Zhaoyu Wang is the Harpole-Pentair Assistant Professor with Iowa State University. He received the B.S. and M.S. degrees in electrical engineering from Shanghai Jiaotong University in 2009 and 2012, respectively, and the M.S. and Ph.D. degrees in electrical and computer engineering from Georgia Institute of Technology in 2012 and 2015, respectively. He was a Research Aid at Argonne National Laboratory in 2013 and an Electrical Engineer Intern at Corning Inc. in 2014. His research interests include optimization and data analytics in power distribution systems and microgrids. He is the Principal Investigator for a multitude of projects focused on these topics and funded by the National Science Foundation, the Department of Energy, National Laboratories, PSERC, Iowa Energy Center, and Industry. Dr. Wang received the IEEE PES Outstanding Young Engineer Award in 2020, PES General Meeting Best Paper Award in 2017 and 2019, and the IEEE Industrial Application Society Prize Paper Award in 2016. Dr. Wang is the Secretary of IEEE Power and Energy Society (PES) Award Subcommittee, Co-Vice Chair of PES Distribution System Operation and Planning Subcommittee, and Vice Chair of PES Task Force on Advances in Natural Disaster Mitigation Methods. He is an editor of IEEE Transactions on Power Systems, IEEE Transactions on Smart Grid, IEEE Open Access Journal of Power and Energy, IEEE PES Letters, and IET Smart Grid.

Download presentation

Tutorial 3: Tutorial on PMU and Time Series Data Analysis

Monday, May 24 **7:30 pm– 10:00 pm (CEST)**

Abstract: This tutorial is designed to train researchers and practitioners on data analysis methods and applications for synchrophasor and point on wave data. The course is divided into three sections, covering (1) fundamentals of synchrophasor measurement, (2) data analysis tools and techniques, and (3) practical applications in industry. The course will help attendees put concepts from power engineering and data science into practice to establish efficient workflows for analyzing and visualizing time series data at scale.

Part 1: Fundamentals synchrophasor measurement (15 min)

Alexandra von Meier, PhD

The first part of the course describes foundational concepts for phasor measurement units (PMUs) and synchrophasors. This portion will cover concepts from physics and power engineering to provide intuition about how PMU measurements relate to physical phenomena on the grid. We'll offer a quick refresher of relevant concepts for attendees familiar with power engineering and PMU data, and provide a brief introduction for attendees who are new to the field.

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Part 2: Data analysis and machine learning workflows (60 min)

Mohini Bariya and Miles Rusch

The second part of the course will demonstrate analytics performed on synchronized measurement data from distribution systems. The focus is on showing methods that participants can reproduce on open access data, as well as applying and adapting algorithms to their specific purposes and needs. We discuss methods for unsupervised event detection and classification with time series clustering of voltage magnitude and frequency; these algorithms prioritize transparency and communication to the human user. Panellists will show how they use the PredictiveGrid platform in their work. PredictiveGrid (detailed in Part 4) is a state-of-the-art data analytics platform designed to increase the efficiency of data analysis workflows including data exploration, algorithm development, and data visualization.

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Part 3: PMU applications in industry (60 min)
Chetan Mishra, Phd and Kevin Jones, Phd

The third part of the course will cover case studies from a recent initiative at Dominion Energy to uncover dynamics observed under ambient conditions using synchrophasor data. Traditional methods for integrating new resources onto the grid rely on generic models which fail to account for the reality of the dynamics that can occur in operation. Utilities often lack transparent models for characterizing the dynamic behaviors of certain devices — including solar inverters, FACTS devices, DERs, and industrial loads. This motivated an initiative to use continuous monitoring data to improve visibility and inform advancements in grid integration and controller design. Findings reveal that devices are often deployed with poorly set controllers which may become unstable. Panellists will describe the use of signal processing techniques to alert the utility to possible issues occurring under ambient conditions which would typically be brushed off as “noise”. The tutorial will cover the challenges faced when working with actual measurements as opposed to simulation data where often, the existing analysis techniques need to be adapted due to violation of underlying assumptions.

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Part 4: Putting it to practice with open access data (15 min)
Laurel Dunn, Phd

NI4AI is a 3-year ARPA-E funded project led by PingThings’ which provides open access to a cloud-based data visualization and analysis platform to support rapid data exploration and application development. This talk will give an overview of open access PMU and point on wave data sets which attendees can use to advance their work. The session will provide an overview of resources available to attendees via the project and will describe how attendees can leverage these resources to streamline their workflows and build partnerships to advance practical applications for time series data.

Download presentation

Organizer:

Name and title of the organizer: Laurel Dunn, PhD
Organisation: UC Berkeley, USA, lndunn@berkeley.edu
Short biography of the chair: Laurel recently received her PhD in Civil Engineering from UC Berkeley on risk-aware decision making. She has worked closely with industry and with regulators about putting state-of-the-art methods from statistics and data science into practice. Currently, she is working to advance the use of next generation sensors that can remove guess-work from decision making processes. She is working with a startup called PingThings to lead an initiative called NI4AI. NI4AI is an ARPA-E funded project which provides data, computational tools, and educational content to advance the use of time series data for grid applications.

Instructors:

Alexandra "Sascha" von Meier (University of California, Berkeley) is an Adjunct Professor in the Department of Electrical Engineering and Computer Science, where she teaches a course on Electric Power Systems. She is also Director in CIEE's Electric Grid program area focusing on power distribution systems, Smart Grid issues, and the integration of distributed and intermittent generation. Her current research projects center on the use of high-precision micro-synchrophasor measurements for situational awareness, diagnostics and control applications in distribution grids.

Kevin Jones (Dominion Energy) received his Ph.D. in Electrical Engineering from Virginia Tech as a Harry Lynde Bradley Fellow in 2013. He created and helped commercialize the open source linear state estimator and has led the development and integration of a variety of innovative technology solutions in his role at Dominion Energy including the cloud deployment of PredictiveGrid for synchrophasor analytics in Electric Transmission. He currently serves as Manager of ET Operations Engineering Support leading the Fault Analysis, Sensor Data Communication/Engineering/Analytics, Special Studies, and Web Development teams.

Chetan Mishra (Dominion Energy) is an electric transmission engineer with research interests in nonlinear dynamics and control, synchrophasors and renewable energy. He earned his PhD in Electrical Engineering from Virginia Tech in 2017 and has been with Dominion for over five years.

Mohini Bariya (University of California, Berkeley) is a PhD candidate focusing on the use of novel, high-resolution measurements for improved situational awareness in the electric grid. She has worked extensively with real PMU datasets. She has experience teaching science and engineering concepts to different audiences, including as a graduate student instructor for the Electric Power Systems course at Berkeley.

Miles Rusch (University of California, Berkeley) is a PhD student in Electrical Engineering at UC Berkeley. His research involves using unsupervised learning algorithms to perform data analysis on electric power systems.


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