BIO for Anurag K Srivastava (anurag.k.srivastava@wsu.edu, http://sgdril.eecs.wsu.edu)

Anurag K. Srivastava is an associate professor of electric power engineering at Washington State University and the director of the Smart Grid Demonstration and Research Investigation Lab (SGDRIL) within the Energy System Innovation Center (ESIC). He also has a joint appointment as a Senior Scientist with the Pacific Northwest National Lab (PNNL). He received his Ph.D. degree in electrical engineering from the Illinois Institute of Technology in 2005. In past years, he has worked in different capacity at the Réseau de transport d´électricité in France; RWTH Aachen University in Germany; PEAK RC, Idaho National Laboratory, Pacific Northwest National Lab, PJM Interconnection, Schweitzer Engineering Lab (SEL), GE Grid Solutions, Massachusetts Institute of Technology and Mississippi State University in USA; Indian Institute of Technology Kanpur in India; as well as at Asian Institute of Technology in Thailand. His research interest includes data-driven algorithms for power system operation and control including resiliency analysis. Dr. Srivastava high impact research projects resulted in tools installed at the utility control center supported for more than $50M by US Department of Energy, National Science Foundation, Siemens Corporate Research, Electric Power Research Institute, Schweitzer Engineering Lab, Power System Engineering Research Center, Office of Naval Research and several National Labs. He is a senior member of the IEEE, chair of the IEEE Power & Energy Society's (PES) PEEC committee, co-chair of the microgrid working group, vice-chair of power system operation SC, chair of PES voltage stability working group, chair of PES synchrophasors applications working group, co-chair of distributed optimization application in power grid, vice-chair of tools for power grid resilience TF, past-chair of the IEEE PES career promotion subcommittee, past-chair of the IEEE PES student activities committee, past vice-chair of the IEEE synchrophasor conformity assessment program and member of CIGRE C4C2-58 Voltage Stability, C4.47/ C2.25 Resilience WG. He organized NSF sponsored "Data analytics workshop for the power grid resiliency" in 2018, Siemens sponsored "data analytics for the smart grid" workshop in 2017, North American Power Symposium in 2014, and IEEE sponsored workshop on Testing and validation of synchrophasor devices and applications in 2012. He also co-chaired Workshop on "Modeling and simulation of Cyber-Physical Energy Systems" supported by IEEE and IES in 2016, 2017, 2018 and 2019. Dr. Srivastava is an editor of the IEEE Transactions on Smart Grid, IEEE Transactions on Power Systems, IEEE Transactions on Industry Applications, and Elsevier Sustainable Computing and guest or past editor for numbers of other IEEE Transactions and IET Journal. He has delivered 30+ keynotes/ tutorials/ IEEE distinguished lecture in more than 15 countries. He is author of more than 275 technical publications including a book on power system security and 4 patents.

Topic 1: Integrating Physics with Machine Learning for Enabling the Resilient Electric Power Grid

Recent events such as Ukraine attack and Hurricane Maria has exposed the vulnerabilities of the cyber-physical electric grid against extreme events. There is a need for a flexible and resilient grid to minimize the impact of component failures given adverse events. Data from massive sensors deployment and availability of distributed resources enables new monitoring and control strategies such as early alarm and diagnosis, event classifications, predicative analysis, distributed and decentralized control, flexible and adaptive control for restoration. Phasor measurement units (PMUs) provide enhanced situational awareness and decision support in transmission systems. Availability of additional sensor data brings its own challenges including data anomalies, real time processing and cyber-security management. This talk will focus on integrating physics with machine learning and data analytics to develop tools and enhance situational awareness and decision support for enabling resiliency of the bulk power grid and associated challenges and opportunities. Additionally, working with human operators for cyber-physical-human nexus in control room tools for monitoring resiliency will be discussed.

Topic 2: Cyber-Physical Data Analytics to Enable Resilient Electric Grid

Keeping the power on especially to the critical facilities such as hospitals and fire department during extreme adverse operating scenarios (e.g. Ukraine cyber-attack) is essential. There is a need for a flexible and resilient grid to minimize the impact of component failures given adverse events. Availability of data from massive sensors deployment enables new monitoring and control strategies such as early alarm and diagnosis, predicative analysis, distributed and decentralized control, flexible and adaptive control. Data in power grids are largely unexploited in discovering knowledge and new solutions for critical power grid applications to enhance the resiliency. Availability of additional sensor data brings its own challenges including data anomalies, real time processing, data fusion, data management and cyber-security management. This talk will focus on real time data analytics to enhance situational awareness and decision support for enabling resiliency of the cyber-physical power grid and associated challenges and opportunities.

Topic 3: Quality-Aware Synchrophasor Applications for the Resilient Power Grid Operation and Control

With the ongoing investments in smarter electric grid, several new algorithms and devices have been developed. Synchrophasors devices provide synchronized measurements at faster rates for enhanced wide area situational awareness enabling number of new data-driven applications. Recent events such as Hurricane Maria has exposed the vulnerabilities of the electric grid against extreme events. There is a need for a flexible and resilient grid to minimize the impact of component failures given adverse events. Availability of data from Phasor measurement units (PMUs) provide enhanced situational awareness and decision support in transmission systems. Model validation, asset failure diagnosis, state estimation, load modeling, voltage stability are some of the synchrophasor applications. Data quality needs to be ensured before using this data for critical system operation and control applications. This talk will discuss about data-quality solutions and several synchrophasors data-driven algorithms for resilient transmission system.

Topic 4: Data-Driven Tools for Cyber-Physical Resiliency of the Electric Grid

Abstract: Digitalization and automation technologies enable to realize the smart grid vision but also bring vulnerabilities. It is important to analyze the impact of possible cyber-attacks on the power grid and develop defense mechanisms. Keeping the power on to critical facilities such as hospitals and fire department during cyber events is essential. There is a need for formal metrics to quantify resiliency of the electric grid, or different configurations of the same system. Number of resources are available with integration of microgrids and DER to improve the resiliency of the critical loads during cyber-attacks or extreme weather events. Additionally, sensor data availability such as smart meters, phasor measurement units and cyber data as well as weather data makes it possible to do resiliency analysis with enhanced situational awareness. This talk will cover defining resiliency, measuring resiliency, data-driven situational awareness, and a tool to study the cyber-physical resiliency of the electric grid.