IEEE Task Force on Big Data Analytics for Synchro-Waveform Measurements

NASPI Work Group Meeting on 4/16/2025

Co-Chairs:

- Hamed Mohsenian-Rad, University of California, Riverside (Chair)
- Jhi-Young Joo, Lawrence Livermore National Laboratory (Chair)

Task Force Overview

- PES Committee: AMPS PES Sub-Committee: BDA
- Focus: Data analytics methods and applications of high-resolution waveform and synchro-waveform measurements in power systems, facilitate industry acceptance, identify challenges and opportunities, and encourage collaborations.
- Chairs:
  - Hamed Mohsenian-Rad, University of California, Riverside (hamed@ece.ucr.edu)
  - Jhi-Young Joo, Lawrence Livermore National Laboratory (joo3@llnl.gov)
- Website: https://ieee-synchrowaveform.engr.ucr.edu/
- Established: April 2023 (Approved)
- Meetings: Quarterly (Next In-Person Meeting: IEEE PESGM 2025)

Synchro-Waveforms

- Terminology:
  - Synchro-waveforms (*comparable to synchro-phasors*)
  - [Synchronized] Waveform Measurements
  - [Synchronized] [Continuous] Point-on-Wave Measurement

→ Multi-location time-synchronized waveform measurements

- Technology:
  - Power Quality Sensors
  - Digital Fault Recorders
  - PMUs with Waveform Capture
  - New Dedicated Devices
  - …

→ Waveform Measurement Unit (WMU)

SEL

PMI

Schneider

Candura

NuGrid

GridSweep

Technical Needs

- High*er*-resolution data
  - High-speed, for real-time ingestion and analytics
  - Big data analytics (BDA) is even more crucial than synchro-phasors

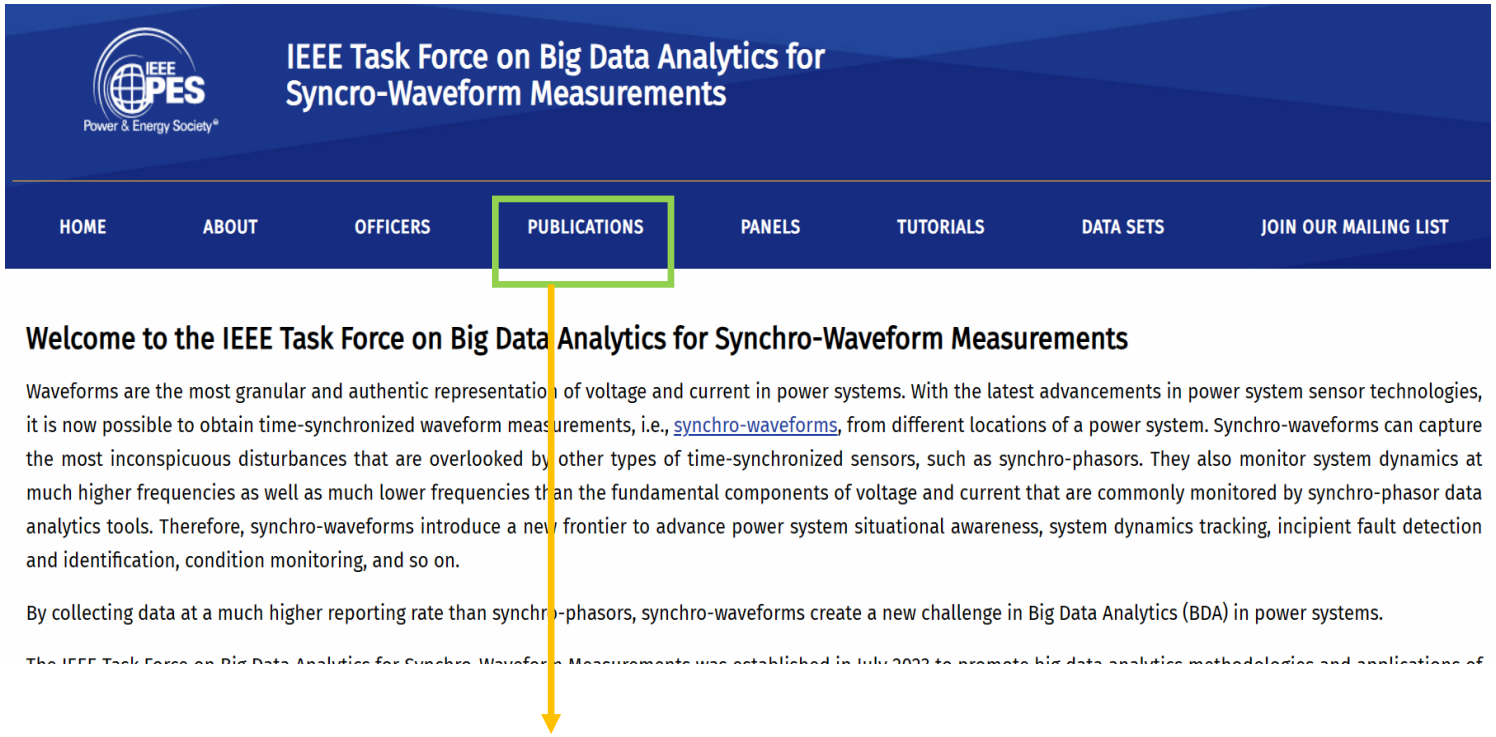
- High*er*-volume data
  - Data storage, data compression might be necessary beyond what is needed for existing data types
  - Analytics and interface to translate the data into actionable information and use cases

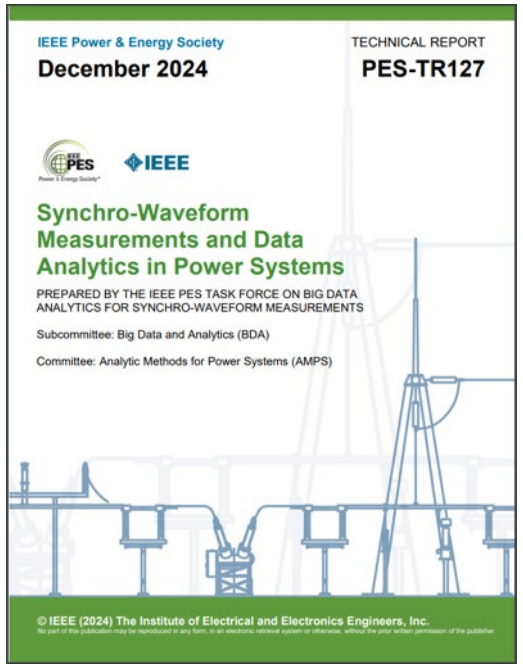
Developing new methods, tools, and techniques to ingest, store, and analyze waveform and synchro-waveform data in various power system applications is critical.

- **Scope of the TF**
  - Identify and promote new data analytics methods for synchro-waveform data through collaboration among all stakeholders and interested parties

Recent Activities

- **Publications Library**





PES-TR-127
Published in December 2024

40 papers and industry reports have been indexed so far

You can suggest papers through the website or via email.

Recent Activities

- **Panels**

- Most Recent Panel:

- **IEEE PES Grid Edge, San Diego, CA, January 2025**
  - Richard Kirby, Schweitzer Engineering Laboratories
  - Jhi-Young Joo, Lawrence Livermore National Lab
  - Alex McEachern, McEachern Laboratories
  - David Reiken, Hubbell
  - Hamed Mohsenian-Rad, University of California, Riverside

- Upcoming Panels:

- **IEEE PES General Meeting, Austin, TX, July 2025**

Synchro-Waveforms in Power Distribution Systems
- David Reiken, Hubbel
- Joe Grappe, Sentient Energy
- Hamed Mohsenian-Rad, University of California, Riverside
- Jhi-Young Joo, Lawrence Livermore National Lab
- Sungyun Choi, Korea University

Emerging Synchro-Waveforms Data Analytics and Applications
- Hassan Ghoudjehbaklou, San Diego Gas and Electric
- Hamed Mohsenian-Rad, University of California, Riverside
- Justin Gilmer, PingThings
- Shuchismita Biswas, Pacific Northwest National Lab
- Wilsun Xu, University of Alberta

Recent Activities

- **Webinars**
  - **NASPI joint webinar (Feb)** *Synchro-Waveform Data Analytics Architecture and Big Data Platform for Grid Operations and Situational Awareness* by Hamed Valizadeh and Michael Balestrieri, Southern California Edison
  - **First TF webinar (Mar)** *Why Waveform Data is Necessary for Monitoring and Analyzing Power System Oscillations* by Dr. Wilsun Xu, University of Alberta, Edmonton

NASPI

THE NORTH AMERICAN SYNCHROPHASOR INITIATIVE &
IEEE SYNCHRO-WAVEFORM TASK FORCE

JOINT WEBINAR

Synchro-Waveform Data Analytics Architecture and Big Data Platform for Grid Operations and Situational Awareness

Hamed Valizadeh and Michael Balestieri, Southern California Edison

Emerging use cases involving vast amounts of high-resolution sensor data are prompting utilities to reconsider their conventional approaches to data handling. This talk will first introduce an open-platform solution for big data analytics, designed to effectively manage large volumes of synchro-waveforms and high-resolution sensor measurements, specifically targeting substation digital fault recorders. It will then describe how augmented machine learning can be supported and leveraged to detect subtle anomalies, such as incipient faults at the distribution grid level. The discussion will also cover the extended handling of various other data streams and sensor types that help address the challenges of locating incipient faults. Additionally, data engineering pipelines and scalable device management will be covered in detail.

Hamed Valizadeh has over 15 years of experience in the power industry and research institutions. He is currently a Senior Advisor with Southern California Edison in Irvine, CA, where he leads award-winning R&D projects in grid operations and artificial intelligence applications. Hamed holds a Ph.D. in Electrical Engineering, has secured NSF and DOE grants totaling over $4.6 million, is a Senior Member of IEEE, and has published more than 40 peer-reviewed papers, including in IEEE Transactions and technical reports.

Michael Balestrieri is an engineer on Southern California Edison's Grid Technology Development team where he leads technology demonstration projects around new and innovative solutions for the electric power grid. He began his career at SCE in 2017 where he has held various roles related to DER integration, smart grid devices, and grid resiliency. Michael attended California State University, Fullerton studying undergrad in Mechanical Engineering and Computer Science followed by a post bachelor certificate at University of California Irvine's Machine Learning and Data Science program.

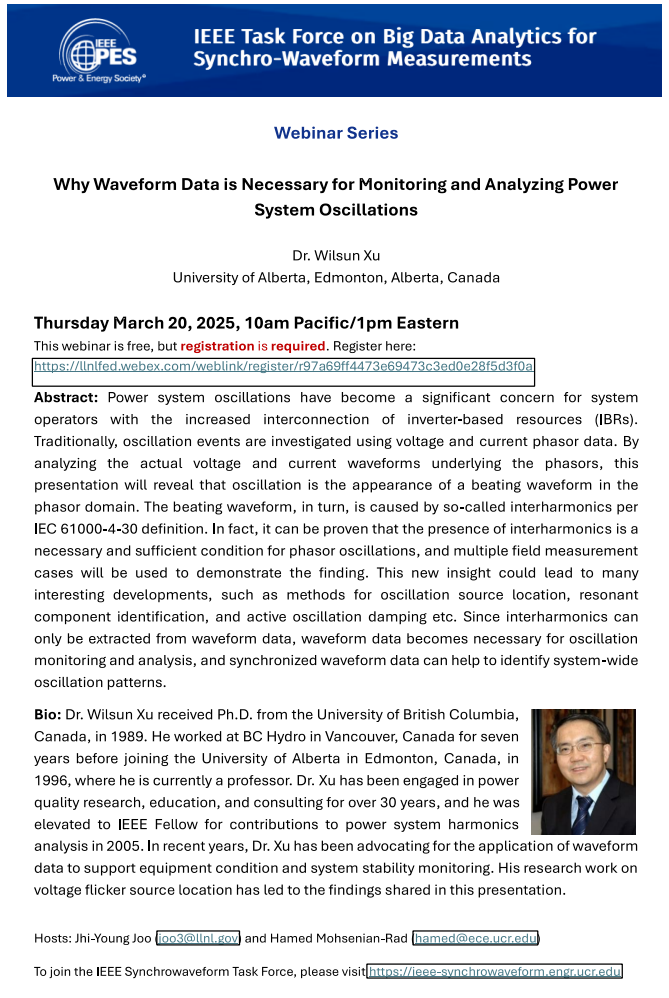
To attend this free webinar, please register at https://www.naspi.org/node/1003.

For more information on the IEEE Synchro-Waveform Task Force, visit https://ieee-synchrowaveform.engr.ucr.edu/. To join the mailing list, please email Jhi-Young Joo at joo3@llnl.gov.

Please email naspi@pnnl.gov if you would like to be on our email list. For more information about NASPI's Work Group meetings please visit www.naspi.org/work-group-meetings.

Wednesday, February 26, 2025
10:00 a.m. Pacific / 1:00 p.m. Eastern (1 hr.)
Please share with colleagues

U.S. DEPARTMENT OF ENERGY | Pacific Northwest | EPRI ELECTRIC POWER RESEARCH INSTITUTE



IEEE PES Power & Energy Society

IEEE Task Force on Big Data Analytics for Synchro-Waveform Measurements

Webinar Series

Why Waveform Data is Necessary for Monitoring and Analyzing Power System Oscillations

Dr. Wilsun Xu
University of Alberta, Edmonton, Alberta, Canada

Thursday March 20, 2025, 10am Pacific/1pm Eastern

This webinar is free, but **registration** is **required**. Register here:
https://llnlfed.webex.com/weblink/register/r97a69ff4473e69473c3ed0e28f5d3f0a

Abstract: Power system oscillations have become a significant concern for system operators with the increased interconnection of inverter-based resources (IBRs). Traditionally, oscillation events are investigated using voltage and current phasor data. By analyzing the actual voltage and current waveforms underlying the phasors, this presentation will reveal that oscillation is the appearance of a beating waveform in the phasor domain. The beating waveform, in turn, is caused by so-called interharmonics per IEC 61000-4-30 definition. In fact, it can be proven that the presence of interharmonics is a necessary and sufficient condition for phasor oscillations, and multiple field measurement cases will be used to demonstrate the finding. This new insight could lead to many interesting developments, such as methods for oscillation source location, resonant component identification, and active oscillation damping etc. Since interharmonics can only be extracted from waveform data, waveform data becomes necessary for oscillation monitoring and analysis, and synchronized waveform data can help to identify system-wide oscillation patterns.

Bio: Dr. Wilsun Xu received Ph.D. from the University of British Columbia, Canada, in 1989. He worked at BC Hydro in Vancouver, Canada for seven years before joining the University of Alberta in Edmonton, Canada, in 1996, where he is currently a professor. Dr. Xu has been engaged in power quality research, education, and consulting for over 30 years, and he was elevated to IEEE Fellow for contributions to power system harmonics analysis in 2005. In recent years, Dr. Xu has been advocating for the application of waveform data to support equipment condition and system stability monitoring. His research work on voltage flicker source location has led to the findings shared in this presentation.

Hosts: Jhi-Young Joo (joo3@llnl.gov) and Hamed Mohsenian-Rad (hamed@ece.ucr.edu)

To join the IEEE Synchrowaveform Task Force, please visit https://ieee-synchrowaveform.engr.ucr.edu

Presentations available at https://ieee-synchrowaveform.engr.ucr.edu/tutorials

Join us!

- **Task Force's Website**

To Join the Task Force

Welcome to the IEEE Task Force on Big Data Analytics for Synchro-Waveform Measurements

Waveforms are the most granular and authentic representation of voltage and current in power systems. With the latest advancements in power system sensor technologies, it is now possible to obtain time-synchronized waveform measurements, i.e., synchro-waveforms, from different locations of a power system. Synchro-waveforms can capture the most inconspicuous disturbances that are overlooked by other types of time-synchronized sensors, such as synchro-phasors. They also monitor system dynamics at much higher frequencies as well as much lower frequencies than the fundamental components of voltage and current that are commonly monitored by synchro-phasor data analytics tools. Therefore, synchro-waveforms introduce a new frontier to advance power system situational awareness, system dynamics tracking, incipient fault detection and identification, condition monitoring, and so on.

By collecting data at a much higher reporting rate than synchro-phasors, synchro-waveforms create a new challenge in Big Data Analytics (BDA) in power systems.

The IEEE Task Force on Big Data Analytics for Synchro-Waveform Measurements was established in July 2022 to promote big data analytics methodologies and applications of

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