



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

Presentation at NASPI on 4/17/2024

## Officers:

- Hamed Mohsenian-Rad, University of California, Riverside (Chair)
- Jhi-Young Joo, Lawrence Livermore National Laboratory (Chair)
- Alireza Shahsavari, San Diego Gas and Electric (Secretary)
- Chris Mullins, Power Monitors (Liaison to IEEE PES Power Quality Subcommittee)

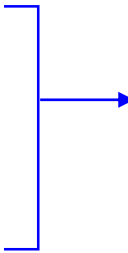
# Task Force Overview



- 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](mailto:hamed@ece.ucr.edu))
  - Jhi-Young Joo, Lawrence Livermore National Laboratory ([joo3@llnl.gov](mailto:joo3@llnl.gov))
- Website: <https://ieee-synchrowaveform.engr.ucr.edu/>
- Established: April 2023
- Meetings: Quarterly      (Next Zoom Meeting: April/May 2024)  
(Next In-Person Meeting: IEEE PESGM 2024)

- Terminology:

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



Multi-location time-synchronized waveform measurements



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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

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

- Identify and promote new data analytics methods for synchro-waveform data
- Identify and promote new applications for data analytics for synchro-waveform data
- Identify and promote opportunities for collaboration among academia and industry
- Provide a platform for industry practitioners to share experience and lessons learned
- Facilitate access to real-world waveform and synchro-waveform data to promote research
- Close the gap between synchro-waveform BDA and other BDA domains, such as synchro-phasor BDA to promote a more comprehensive view to BDA in power systems.

- **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

**<https://iee-synchrowaveform.engr.ucr.edu/>**

- Publications Library



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

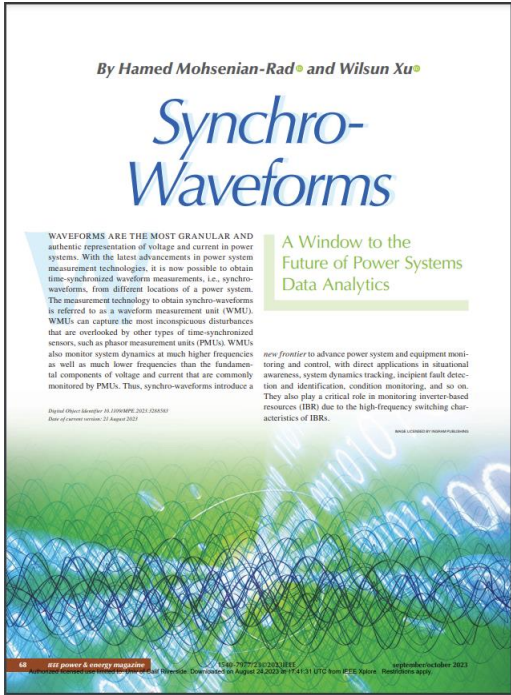
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**32 papers and industry reports have been indexed so far**

**You can suggest papers through the website or via email.**



IEEE Power and Energy Magazine, September/October 2023



- **Panels**

- **Previous Panels**

- IEEE PES General Meeting, Orlando, FL, USA, July 2023.
  - Hamed Mohsenian-Rad, University of California, Riverside, USA, [Slides](#)
  - Chester Li, Hydro One Inc., Canada, [Slides](#)
  - Jim Follum, Pacific Northwest National Laboratory, [Slides](#)
  - Wilsun Xu, University of Alberta, Canada, [Slides](#)
  - Farnoosh Rahmatian, NuGrid Power Corp, Canada [Slides](#)
  
- IEEE SGSMA, Split, Croatia, May, 2022.
  - Hamed Mohsenian-Rad, University of California, Riverside, USA, [Slides](#)
  - Wilsun Xu, University of Alberta, Canada, [Slides](#)
  - Steven Blair, Synaptec Inc., [Slides](#)
  - Alvaro Furlani Bastos, Sandia National Laboratories, [Slides](#)

- **Panels**

- **Upcoming Panels**

- **IEEE PES General Meeting, Seattle, WA, July 2024**

- Hamed Mohsenian-Rad, University of California, Riverside, USA
      - Jhi-Young Joo, Lawrence Livermore National Lab, USA
      - Lakshan Piyasinghe, Hubbell, USA
      - Yilu Liu, University of Tennessee, Knoxville, USA
      - Abder Elandalousi, Southern California Edison, USA
      - Mario Paolone, EPFL, Switzerland
      - Mladen Kezunovic, Texas A&M University, USA

- **IEEE PES Grid Edge, San Diego, CA, January 2025**

- Pending Approval

- **Tutorials**

- **Previous Tutorial**

- **IEEE PES Subcommittee on Big Data Analytics (BDA) Webinar Series**

- Hamed Mohsenian-Rad, University of California, Riverside, USA
    - **Video:** <https://www.youtube.com/embed/mD1dsXZdxOw>

- **Upcoming Tutorial**

- **IEEE PES SGSMA Conference, Washington, DC, May 2024**

- Hamed Mohsenian-Rad, University of California, Riverside, USA
    - Chris Mullins, Power Monitors Inc. (PMI), USA
    - Alex McEachern, McEachern Laboratories, USA
    - Link: <https://blogs.gwu.edu/seas-sgsma2024/>

## Technical Report: IEEE Task Force on Big Data Analytics for Synchro-Waveform Measurements

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2. Synchro-Waveform Technology and Infrastructure
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  - 2.3. Data Collection Infrastructure
    - 2.3.1. Architecture (Centralized, Decentralized, or Hybrid)
    - 2.3.2. Data Communications Requirements
    - 2.3.3. Data Storage Requirements
  - 2.4. Interaction with Existing Operation and Decision Tools
3. Synchro-Waveform Data Representation
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  - 3.2. Event Signature Extraction
  - 3.3. Frequency Spectrum and Wideband Phasors
  - 3.4. Graphical Representations
  - 3.5. Other Per-Cycle Representations
  - 3.6. Joint Analysis of Synchro-waveforms with Other Data Types (PMU, AMI, SCADA)
4. Basic Methods to Work with Synchro-Waveform Data
  - 4.1. Event Detection and Classification/Cluster
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  - 4.4. Frequency and ROCOF Estimation (Beyond FFT)
  - 4.5. Identify Instances when Synchro-waveforms are Needed Instead of synchro-phasors
  - 4.6. Addressing Big Data Challenges: Large Volume of Synchro-waveform Data
5. Case Studies and Future Applications
  - 5.1. IBRs Dynamics and Protection
  - 5.2. Incipient Faults Detection and Identification
  - 5.3. Wildfire Monitoring
  - 5.4. Network Parameter Estimation / Model Validation
  - 5.5. Cyber-security Applications
  - 5.6. Stability and Control in Micro-grids
  - 5.7. Geomagnetic Disturbances
6. Synchro-waveform Standardization Needs

**High-level overview of the state of technology, current and future applications, data analytics architecture and tools, and standardization needs**