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

Presentation at NASPI on 10/16/2024

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)
  - Jhi-Young Joo, Lawrence Livermore National Laboratory (joo3@llnl.gov)
- Website: https://ieee-synchrowaveform.engr.ucr.edu/
- Established: April 2023
- Meetings: Quarterly (Recent In-Person Meeting: IEEE PESGM 2024) (Next Zoom Meeting: November 2024)

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

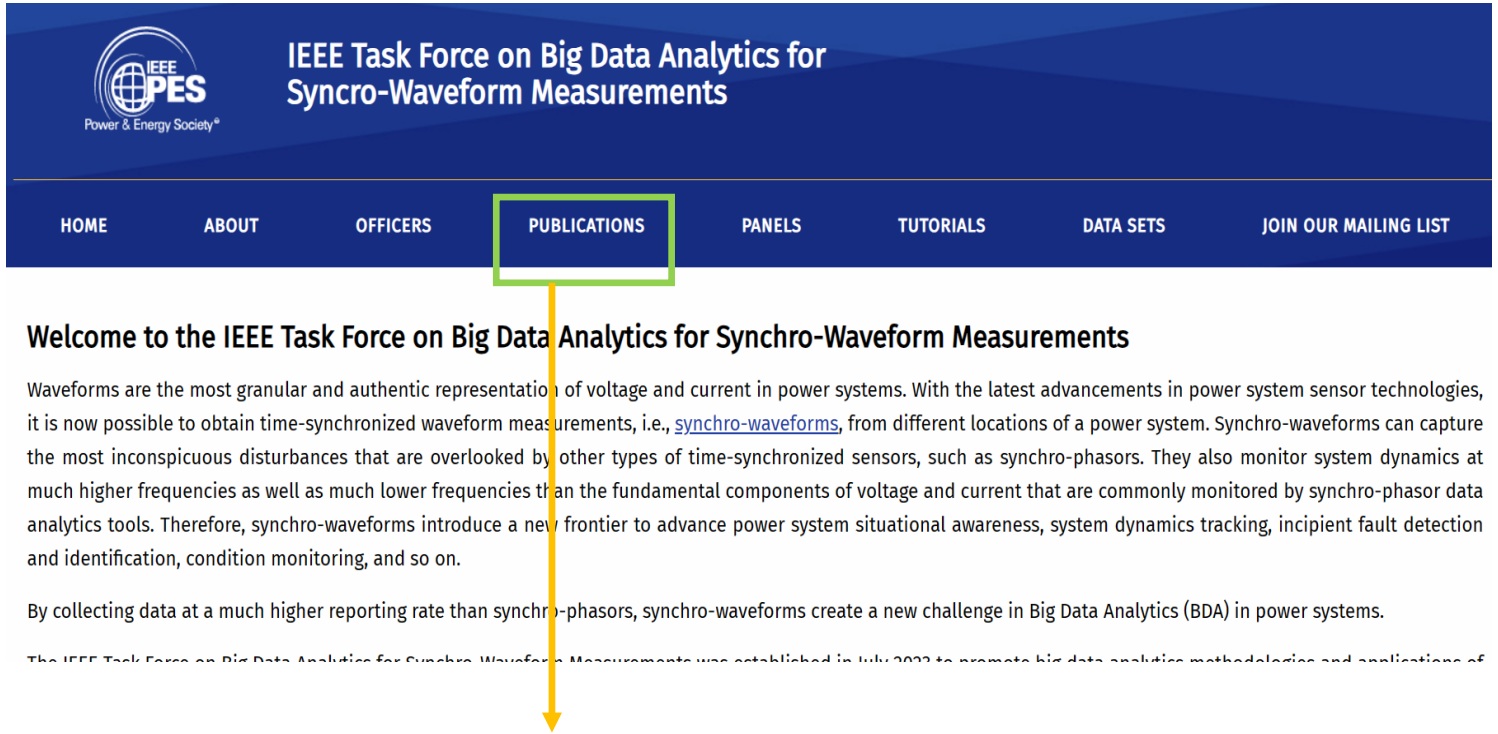
- **Task Force's Website**

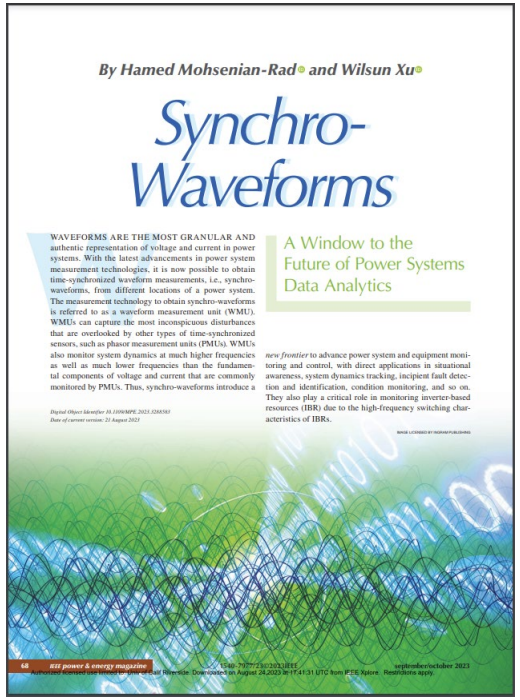
To Join the Task Force

https://ieee-synchrowaveform.engr.ucr.edu/

Recent Activities

- **Publications Library**





IEEE Power and Energy Magazine, September/October 2023

36 papers and industry reports have been indexed so far

You can suggest papers through the website or via email.

Recent Activities

- **Panels**

- Previous Panels

- IEEE PES General Meeting, Seattle, WA, July 2024.
  - MIaden Kezunovic, Texas A&M University, USA
  - Yilu Liu, University of Tennessee, Knoxville, USA
  - Jhi-Young Joo, Lawrence Livermore National Lab, USA
  - Mario Paolone, EPFL, Switzerland
  - Hamed Mohsenian-Rad, University of California, Riverside, USA
  - Lakshan Piyasinghe, Hubbell, USA
  - Abder Elandaloussi, SouthernCalifornia Edison, USA

- IEEE PES General Meeting, Orlando, FL, USA, July 2023.
  - Hamed Mohsenian-Rad, University of California, Riverside, USA
  - Chester Li, Hydro One Inc., Canada
  - Jim Follum, Pacific Northwest National Laboratory
  - Wilsun Xu, University of Alberta, Canada
  - Farnoosh Rahmatian, NuGrid Power Corp, Canada

- Upcoming Panels

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

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

Recent Activities

- **Tutorials**

  - Previous Tutorials

- **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

- **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
  - **Slides**: https://blogs.gwu.edu/seas-sgsma2024/

Technical Report (In Preparation)

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

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2. Synchro-Waveform Technology and Infrastructure
    - 2.1. Sensor Technology
    - 2.2. Instrumentation and Data Quality
    - 2.3. Data Collection Infrastructure
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        - 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
    - 3.1. Raw Waveform Samples
    - 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
    - 4.2. Event Location Identification
    - 4.3. Data Compression and Compressed Sensing (Mario)(Mir)
    - 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.