



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

Task Force Meeting on July 23, 2024

## Officers:

- Hamed Mohsenian-Rad, University of California, Riverside (Chair)
- Jhi-Young Joo, Lawrence Livermore National Laboratory (Chair)
- Alireza Shahsavari, San Diego and Electric (Secretary)

# Task Force Overview



- Established: April 2023
- 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))
- Secretary: - Alireza Shahsavari, San Diego Gas and Electric ([ashahsav@sdge.com](mailto:ashahsav@sdge.com))
- Website: <https://ieee-synchrowaveform.engr.ucr.edu/>
- Meetings: Quarterly                      (Next Meeting: September/October 2024)

- **Task Force Meeting**

- (Completed) Tuesday at 4 PM
- Number of Attendees: 31

- **Panel**

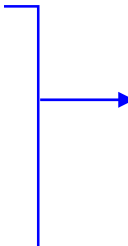
**IEEE PES General Meeting, Seattle, WA, July 2024**

- Mladen 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
- Hamed Valizadeh-Haghi, Southern California Edison, USA
- Lakshan Piyasinghe, Hubbell, USA

**Thursday  
8:00 AM - 10:00 AM  
Room 440**

- Terminology:

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



Multi-location time-synchronized waveform measurements

- 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
- ...

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**



**Join mailing list**

## 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.

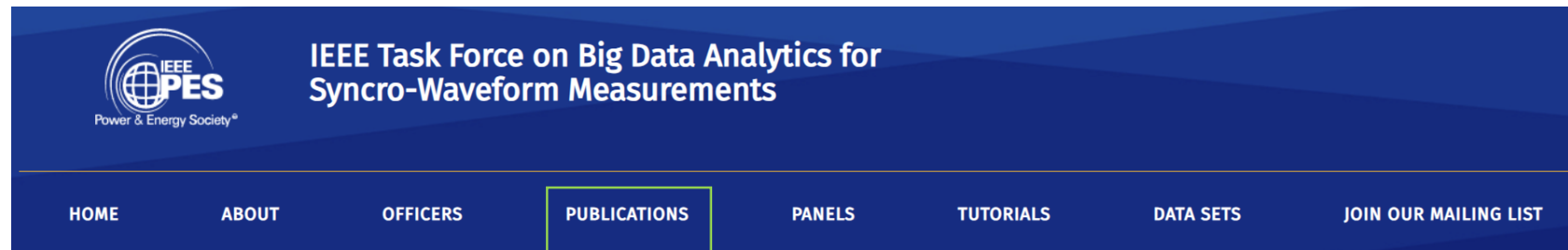
By collecting data at a much higher reporting rate than synchro-phasors, synchro-waveforms create a new challenge in Big Data Analytics (BDA) in power systems.

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/>**



- **Task Force's Website**



## 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

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

**Please suggest papers through the website or via email.**

- **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](#)

- **Recent Tutorials**

## IEEE PES Subcommittee on Big Data Analytics (BDA) Webinar Series, November 2022

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

## IEEE PES SGSMA Conference, Washington, DC, May 2024

- Synchro-waveforms - Concepts and Data Analysis (Hamed Mohsenian-Rad)
- Synchro-waveforms - Technology and Practice (Chris Mullins)
- Synchro-waveforms - Utility's Perspective (Michael Balestrieri, Hamed Valizadehhaghi)
- Synchro-waveforms - Future Vision (Alex McEachern)
- **Link to Slides:** <https://blogs.gwu.edu/seas-sgsma2024/>

- **Technical Report**

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

- Current Draft: **74 Pages** (Collection of Gathered Materials)

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

1. Background and Needs
2. Synchro-Waveform Technology and Infrastructure
  - 2.1. Sensor technology
  - 2.2. Instrumentation
  - 2.3. Data Collection and Communications Infrastructure
  - 2.4. Data Storage Infrastructure
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
4. Technical Challenges and Methods in Working with Synchro-Waveform Data
  - 4.1. Event Detection and Classification
  - 4.2. Event Location Identification
  - 4.3. Loss-less Data Compression
  - 4.4. Frequency and ROCOF Estimation (Beyond FFT)
5. Potential Applications and Case Studies
  - 5.1. IBRs Dynamics and Protection
  - 5.2. Incipient Faults
  - 5.3. Wildfire Monitoring
  - 5.4. Network Parameter Estimation
  - 5.5. Transmission Level Applications
  - 5.6. Distribution Level Applications
  - 5.7. Grid Edge Level Applications
6. Synchro-waveform Standardization Needs

**1. Background and Needs**

Waveforms are the most authentic representation of voltage and current in power systems. With the latest advancements in power system sensor technologies, it is now possible to obtain