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A DOE-EPRI Joint Initiative

April 15, 2026, Chicago D&NMTT Report out

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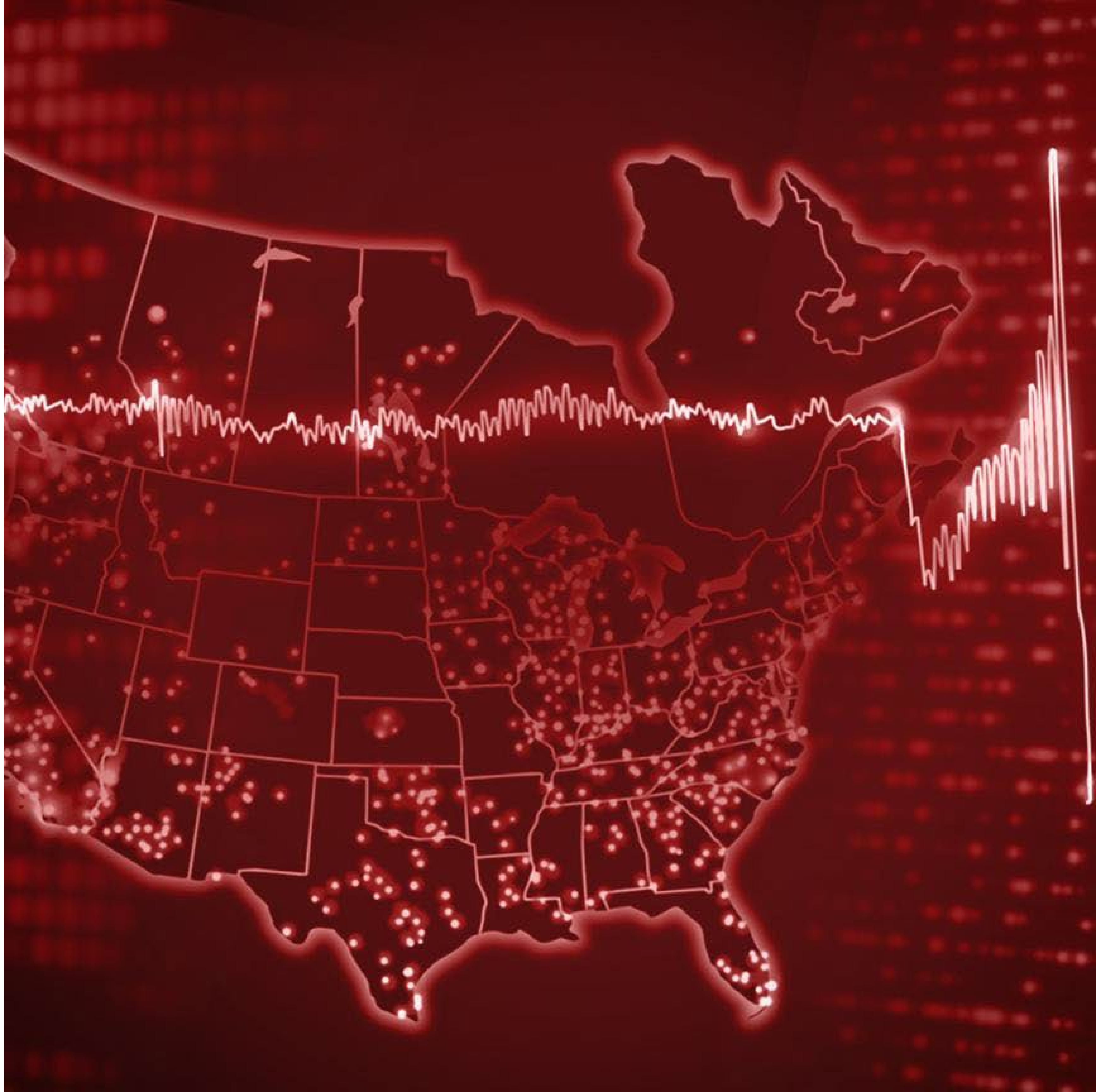

Pacific Northwest NATIONAL LABORATORY

U.S. DEPARTMENT of ENERGY

EPRI ELECTRIC POWER RESEARCH INSTITUTE

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D&NMTT Mission

- Without data, decision making shifts from informed judgment to guessing.

- The NASPI Data and Network Management Task Team advances the reliable, secure, and interoperable delivery of time-synchronized grid measurements across North America. We develop practical guidance, reference architectures, and metadata conventions for collecting, governing, and exchanging high-quality streaming data from PMUs and related sources. Through collaboration with utilities, vendors, researchers, and regulators, we promote resilient A and B data paths, cloud and hybrid deployments, and standards-based integration to enable real-time monitoring, analytics, and decision-making. We emphasize data quality and clarity, especially the correct use and distinction of sample rate and report rate and align our practices with evolving compliance expectations so operators can confidently turn measurements into actionable reliability outcomes.

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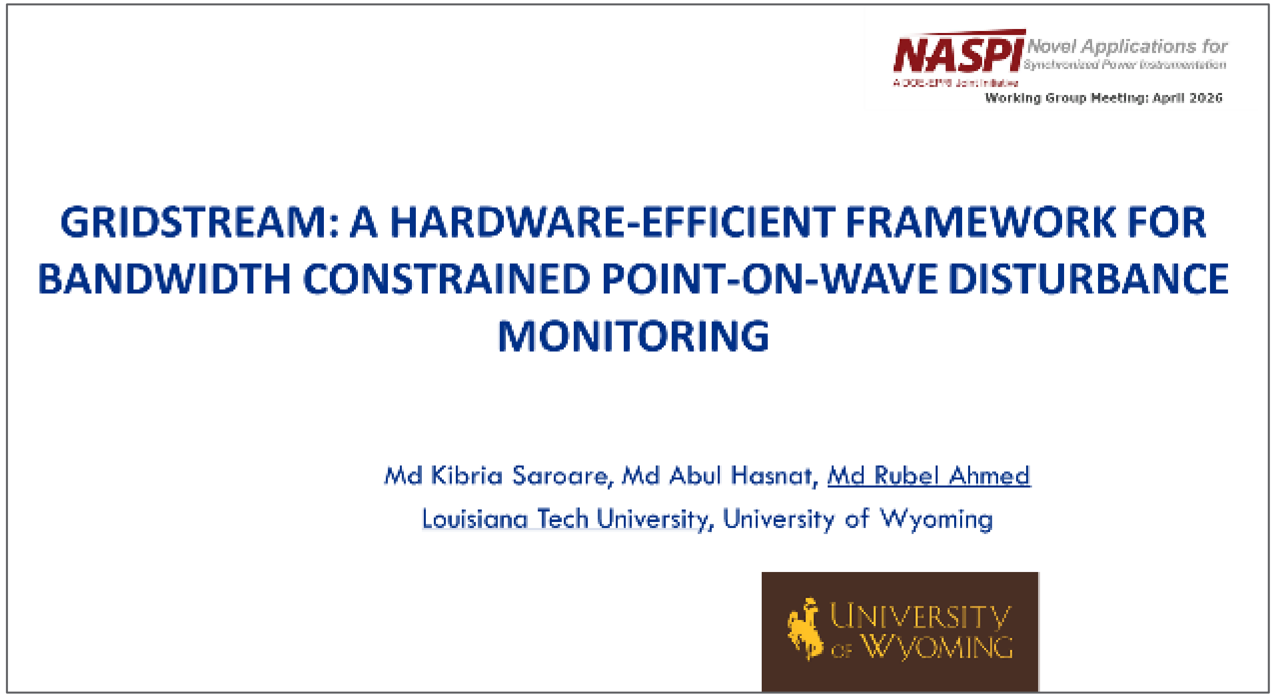
Two Presentations



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Using C37.118 Status word as a data quality indicator. This presentation evaluated whether the synchrophasor status word can serve as a reliable indicator of PMU data quality using a very large field dataset from DOE-sponsored research. The work draws on 27 TB of anonymized synchrophasor data from ERCOT, the Western Interconnection, and the Eastern Interconnection, and highlights both the computing challenges of processing such large parquet-based datasets and the practical need for better data curation. The analysis found widespread data quality problems, including missing data, unreasonable values, flat frequency measurements, wrong time tags, misplaced signals, and duplicated records. However, the status word proved to be a poor indicator of these issues because a large percentage of bad data frames still carried status bits that appeared normal. The presentation concludes that utilities and analysts should not rely on the status word alone for data quality assessment, and that additional validation and curation routines are necessary to detect field data problems that are common but not clearly flagged by PMU status bits.

GridStream is a framework for bandwidth-constrained point-on-wave disturbance monitoring in modern power grids with faster dynamics from inverter-based resources, EVs, and large variable loads. The presentation argues that traditional PMU-based monitoring cannot capture important harmonics and sub-synchronous behavior, while continuous raw point-on-wave streaming overwhelms utility communication networks. To address this, GridStream uses an event-triggered architecture with a phasor path for continuous awareness and an event path for disturbance detection. Its main innovation is a two-threshold hysteresis method that avoids noisy on-off trigger chatter and produces cleaner, continuous event windows. Hardware-software co-design results show that floating-point FPGA implementations can provide an effective balance of accuracy, speed, and resource efficiency, making the approach practical for low-cost edge devices. Future work includes adaptive threshold tuning, multi-channel scaling, and improved deterministic coordination using Lingua Franca.

The NASPI Data and Network Management Task Team breakout focused on how to improve the reliable, secure, and interoperable delivery of time-synchronized grid measurements across North America. The mission centers on developing practical guidance, reference architectures, and metadata conventions that help utilities, vendors, researchers, and regulators collect, govern, exchange, and use high-quality synchrophasor data. The major theme is that **synchrophasor value depends not only on measurements themselves, but also on the surrounding architecture, metadata, and operational practices needed to make the data understandable and actionable**.

We also emphasized four essential attributes of high-quality data: accuracy, precision, availability, and usability. **Accuracy** means measurements must correctly reflect actual system conditions. **Precision** means measurements must be consistent and repeatable. **Availability** means the data must be present when needed for operations and analysis. **Usability** means the data must have complete and clear metadata so users can interpret measured quantities, asset context, and engineering meaning without excessive manual effort.

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A key topic was the growing complexity of synchrophasor communication networks and data architectures. We discussed network behavior is often stochastic, meaning it contains variability that must be planned for rather than assumed away. We talked about protocols such as TCP/IP and UDP, which move data, and synchrophasor application protocols such as IEEE PC37.118.2-2024, IEC 61850, and STTP, which define how the data is structured and interpreted. This reinforces the need for both reliable transport and clear, standards-based data models.

Our breakout also highlighted broader architectural topics including archive systems, network design, redundancy, and cloud deployment. Archive options discussed included time-series, relational, object-oriented, NoSQL, hierarchical, and graph-based approaches, suggesting that future synchrophasor environments may require multiple storage models depending on the use case. Network architecture was considered across field, wide-area, control center, corporate, and operations domains. Redundancy was discussed for field devices, communications, and archives, including active-active and failover approaches. Cloud was addressed pragmatically through lessons learned, security concerns, costs, and practical use cases.

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We discussed the growing importance of synchronized point-on-wave data for applications that require more detail than conventional phasor measurements can provide. These included harmonics, transient events, breaker behavior, fault location, inrush current analysis, subsynchronous phenomena, and wideband power quality analysis. We also discussed future work topics for the group, including sample rate versus report rate, frequency terminology, Nyquist considerations, database performance, CIP compliant network recommendations, PTP in data and control centers, and richer metadata. A key takeaway was that future synchrophasor success will depend on better context, better architecture, and clearer industry guidance.

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Thank you

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