



DISTRIBUTION PMUS

THE FUTURE OF DISTRIBUTION GRID OPERATION

KEY INSIGHTS

- Distribution Phasor Measurement Units (D-PMU) excel at monitoring variable power flows over distributed areas. While it has found little use during the era of centralized generation with passive loads, its capability of monitoring active grids with solar, wind and EVs is unparalleled by other technologies.
- With major advances in computing power and data processing techniques, the D-PMU technology has reached maturity and is now readily available for digital substations and distribution control centers.
- Thanks to high-speed and time-synchronized data, D-PMUs enhance the utility's daily operation. From grid planning to real-time operation, every decision is made better, faster, and with greater confidence.

INTRODUCTION

With the ever-increasing penetration of Distributed Energy Resources (DER), distribution grid operation is becoming more complex and new responsibilities have been imposed upon the Distribution System Operators (DSO).

Historically, balancing the grid has been the sole responsibility of the TSO, while DSOs took care of delivering power to end-consumers. Today, with the shift from consumers towards prosumers, DSOs are subject to new responsibilities with respect to local energy markets, congestion management, and DER integration. DSOs are starting to see bi-directional power flow and unpredictable operating conditions for which the existing infrastructure and operational tools were not intended.

At the same time, the energy transition is happening across every sector: the customer's reliance on electricity is increasing, and the pressure on DSOs to ensure reliable supply is increasing with it. To prepare their grid for net-zero, DSOs must work hard to digitalize and modernize their existing infrastructure.

In this changing landscape, Phasor Measurement Units (PMUs) have been quietly developing into a mature technology. Since its invention in 1988, cheaper components, new data processing techniques, and advanced communication technologies have greatly increased its performance while reducing its price tag.

PMU data has significant potential for distribution grid operation and planning. The time-synchronized nature of PMU measurements enable the direct comparison of distributed measurements, which in turn ensures data coherency and the ability to directly extract phasor quantities. The high measurement speed allows accurate location of faults, continuous monitoring of power quality, and real-time analysis of DER injection.

The capabilities of PMU technology perfectly fit with the operation of active distribution grids. Zaphiro understood this and developed SynchroGuard, the first PMU-based distribution automation solution designed for active distribution grids.



DISTRIBUTION PHASOR MEASUREMENT UNITS

In power system theory, a *phasor* is a “compressed” representation of an AC voltage/current waveform, characterized by a constant amplitude and phase angle. Accordingly, a *synchrophasor* is a time-synchronized measurement of a phasor, generated by a device called *Phasor Measurement Unit (PMU)* and reported at a very high speed.

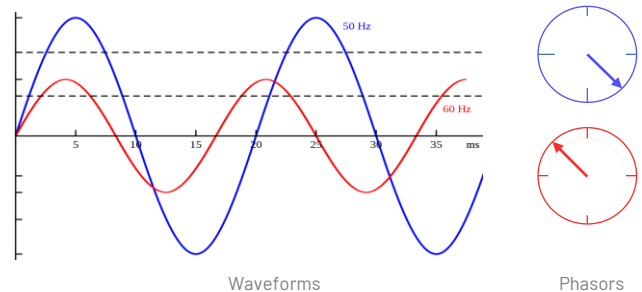


Figure 1 – Waveform compressed into phasor information

PMU time synchronization is typically achieved through GPS or optical fiber networks via the Precision Time Protocol (PTP). PMUs accurately time-stamp each measurement thus making possible to correlate synchrophasor measurements taken at different locations. This feature greatly enhances the accuracy and reliability performance of applications using these kind of measurements.

High measurement speed (up to 50/60 measurements per second) enables capturing fast events, including faults and renewable intermittency. PMU data can be treated locally or transmitted to a Phasor Data Concentrator (PDC), that stores them in a database for real-time and offline data analytics or shares them to other real-time grid applications.

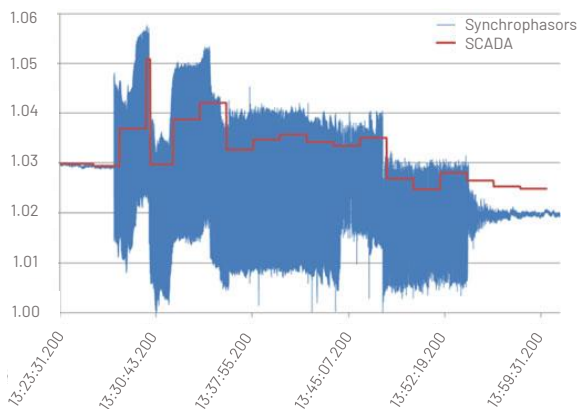


Figure 2 – Voltage dynamic captured by high-speed synchrophasors vs standard SCADA measurements

Synchrophasor measurement and data transmission are standardized by a series of IEEE/IEC Standards and Guides such as the IEC 60255-118-1 Standard (former IEEE C37.118)

PMUs are today the most advanced grid monitoring technology available. Leveraging its high sampling rate, accurate measurement algorithm, and time-synchronization, PMUs enable the operator to analyze and react to grid events like never before.

PMUs, due to their high measurement speed and time-synchronization, offer unique capabilities unavailable from typical SCADA measurements. Key advantages include:

1. **Coherent measurements across the network**, thanks to time-synchronization that ensures to have a reliable data sets to provide accurate monitoring and control schemes.
2. **Real-time monitoring of highly variable DERs**, by sending measurements every 20m. Grid perators will get full visibility of distributed generation’s dynamics and bi-directional power flows in their grid.
3. **Real-time detection of grid anomalies**, the high sampling rate from PMUs allow these devices to perform power quality measurements, fault location, and incipient fault detection.

Leveraging the high-speed and time-synchronized data provided by PMUs, Zaphiro has developed SynchroGuard, a unique application platform that transform PMU data into real-time insights with the objective of improving real-time grid operation and asset management for electrical utilities.

SynchroGuard is a software platform that seamlessly integrates into most control room solutions via standard APIs. The platform is designed with flexibility in mind, providing all the necessary features to be used either as stand-alone or integrated with ADMS/SCADA.

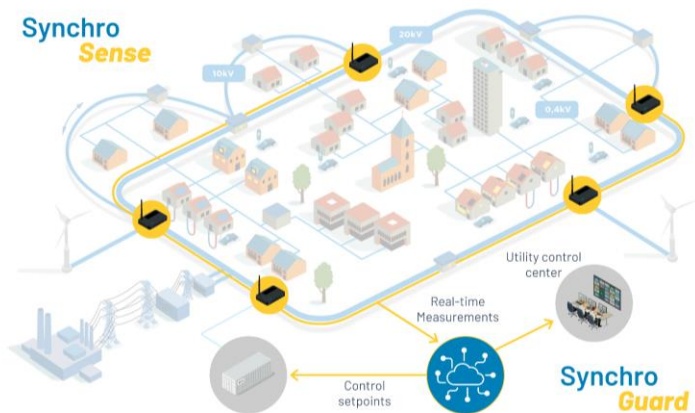


Figure 3 – Zaphiro's SynchroGuard grid monitoring solution.

With decades of experience in distribution PMUs and power systems, Zaphiro's team has developed multiple application modules that provide great value to DSOs in every aspect of their daily operation. From planning to real-time operation and forecasting, DSOs can expect to achieve great results with SynchroGuard:

- SynchroGuard includes a **PDC (phasor data concentrator)** that reads C37.118 PMU protocol and time-aligns data. It automatically removes bad data and converts the data into common formats used by control room applications.
- SynchroGuard includes a **real-time state estimator** for distribution grids that uses just a few measurement points to compute the full grid state (all voltages, currents, power flows at each node/line). Unlike conventional approaches, Zaphiro integrates multiple measurement sources (RTUs, FPIs, AMI, etc.) and uses PMU data to stabilize the state estimator's performance. The result is a state estimator that is fast (up to multiple estimations per second), always converges (non-iterative thanks to algorithm linearity), and offers consistent accuracy.
- SynchroGuard includes a **PMU-based fault locator** for distribution grids. Thanks to the use of coherent data from multiple PMUs at different locations, the fault locator is extremely robust and allows accurate fault location for both high- and low- impedance faults regardless of neutral treatment (grounded, isolated, compensated), also in presence of DERs that cause bi-directional fault currents.
- SynchroGuard includes an **intuitive HMI** with real-time grid analytics and alarms. Grid operators can receive real-time alarms, display voltages, powers, currents in real-time or display historical data over different time-spans and statistics on asset utilization.
- SynchroGuard also supports **standard APIs** for communication with other solutions (like ADMS/SCADA) from multiple vendors.

CONTACT US

Book a demo today:



Dr. Lorenzo Zanni, CTO

Zaphiro Technologies SA
Rue de Lausanne 64,
1020 Renens, Switzerland

lorenzo.zanni@zaphiro.ch
www.zaphiro.ch

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