



**Summary:** The Open Synchronization Analytics and Monitoring Platform (OpenSAMPL) is an innovative toolkit that provides a comprehensive, open-source solution for clock data ingestion, management, and visualization. Using PostgreSQL with the TimescaleDB extension and Grafana, OpenSAMPL enables users to monitor timing and synchronization across critical systems such as power grids, telecommunications networks, and research laboratories. OpenSAMPL is purpose-built to enhance the reliability of time-critical systems by offering seamless integration with industry-standard clock sources such as Adtran probes and Microchip Trust Web Service Token files. By embracing open-source collaboration, OpenSAMPL eliminates reliance on proprietary systems or multiple fragmented dashboards while empowering researchers and organizations to optimize their infrastructure.

## Introducing OpenSAMPL: A Platform for Time Assurance Monitoring

### Introduction: Why Timing Assurance Matters

Many industries, such as energy and telecommunications, rely on precise timing to ensure safe, efficient operations. Timing discrepancies can result in operational challenges or even critical failures in systems dependent on synchronized devices:

- Power grids require accurate synchronization for optimal energy distribution and to prevent costly outages.
- Telecommunications networks depend on consistent timing for uninterrupted data transmission.

Although existing proprietary software or isolated dashboards from clock manufacturers can track timing data, they are often expensive and lack extensibility. OpenSAMPL addresses these issues by providing a modular, open-source solution designed to manage and analyze time-series clock data from various sources.

### What's in the Box? A Modular Platform for Timing Assurance

OpenSAMPL ingests timing data from network clock probes, standardizes disparate measurement files, and turns raw timestamps into comparable, analyzable time series. Its three core components are:

- **Data ingestion:** Ingests and normalizes timing measurements from diverse sources into a common schema.

- **Centralized storage and query:** Uses PostgreSQL with TimescaleDB to manage large time-series datasets for efficient querying and analysis.
- **Real-time visualization:** Integrates with Grafana to monitor timing stability and performance across systems.

The modular design enables users to configure OpenSAMPL for their unique needs, making it an adaptable solution for a variety of use cases. CAST has also made the toolkit easily accessible through GitHub (<https://github.com/ORNL/OpenSAMPL>) and the Python Package Index (PyPI) (<https://pypi.org/project/opensampl/>).

## Benefits of OpenSAMPL

As one of the first open-source solutions specifically focused on synchronization analytics, OpenSAMPL provides several unique advantages:

- **Accessibility:** The free and open-source nature of OpenSAMPL encourages collaboration, allowing developers and organizations to tailor it to their specific needs.
- **Comprehensive Monitoring:** OpenSAMPL bridges the gap between timing accuracy and precision by enabling timing assurance for diverse clock types and systems without reliance on proprietary software.
- **Enhanced System Optimization:** Organizations can monitor and analyze synchronization data to enhance efficiency, reliability, and safety for time-critical systems.

## Applications Across Industries

Organizations across multiple domains can benefit from OpenSAMPL:

- **Energy:** Monitor synchronization in power grids to improve resource distribution, avoid outages, and ensure efficiency.
- **Telecommunications:** Support consistent, high-quality transmission of data by analyzing and correcting timing inconsistencies.
- **Research:** Facilitate time-series analysis for experiments or technologies that require precision, such as advanced scientific studies or synchronization-dependent technologies.

## Driving Innovation Through Open Source

OpenSAMPL represents a leap forward in synchronization technology and analytics, allowing organizations to monitor, collect, and analyze timing data down to the millisecond. By offering this solution as open-source software, CAST and Oak Ridge National Laboratory enable accessibility and collaboration, reducing costs and fostering innovation. Whether users want to stabilize a power grid, ensure reliable telecommunications, or support groundbreaking scientific research, OpenSAMPL provides a powerful tool to meet the challenges of timing assurance in an increasingly interconnected world.

The Center for Alternative Synchronization and Timing (CAST) at Oak Ridge National Laboratory (ORNL) performs research, development, testing, evaluation, and technical assistance to enable resilient timing and synchronization for the power grid. Working closely with power utilities, timing hardware and software vendors, network operators, and federal stakeholders, CAST helps develop and validate alternative timing architectures to augment GPS time. CAST also translates and transfers ORNL's research and development (R&D) advances in secure timing and grid communications to power sector applications, and engages across the broader timing community to develop best practices to ensure the resilience of US critical infrastructure. CAST is sponsored by DOE's Office of Electricity. Visit <https://cast.ornl.gov> for more information.