AVEVA PI WORLD

Scientific tools for advanced synchrophasor data analytics with the PI System

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About PNNL

- PNNL is a U.S. Department of Energy national laboratory tasked with creating a world that is safer, cleaner, more prosperous, and more secure
  - 4,997 scientists, engineers, and professional staff
  - $1.1B in annual spending
- PNNL's grid research delivers new tools to increase system transparency and flexibility leading to unparalleled grid performance
  - Leader in wide area measurement systems
  - Staffing expertise in power system engineering (70+), energy storage (70+), and cyber security (110+)
  - $79.2M research volume

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About GPA

- GPA is a not-for-profit corporation established in 2010
- Specializes in software and services for the electric utility industry
- All software is open-source, published under the permissive MIT license
- Focus is on a robust, reliable and resilient grid
- GPAs Synchrophasor Product line includes:
  - openPDC
  - PMU Connection Tester
  - Synchrophasor Stream Splitter

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Unlocking the Potential of Synchrophasors

Challenge

- Utilities have yet to realize the full potential of their synchrophasor measurement archives due to data volume, the presence of unreliable measurements, and inflexible analysis tools

Solution

- GPA is deploying PNNL's analytics in open-source software that will enable utilities to rapidly read, process, and review synchrophasor measurements stored in AVEVA's PI System

Benefits

- Improves flexibility to effectively analyze minutes or months of data
- Enables offline tasks: model validation, stability analysis, frequency response analysis
- Faster prototyping of in-house analytics

Challenge

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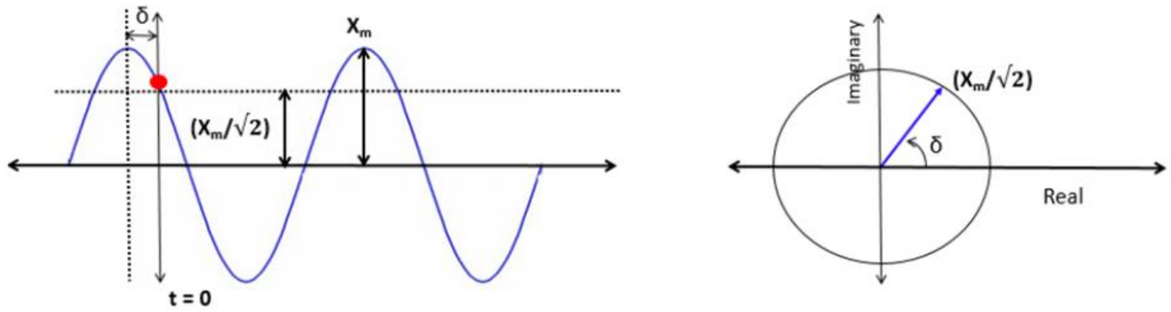
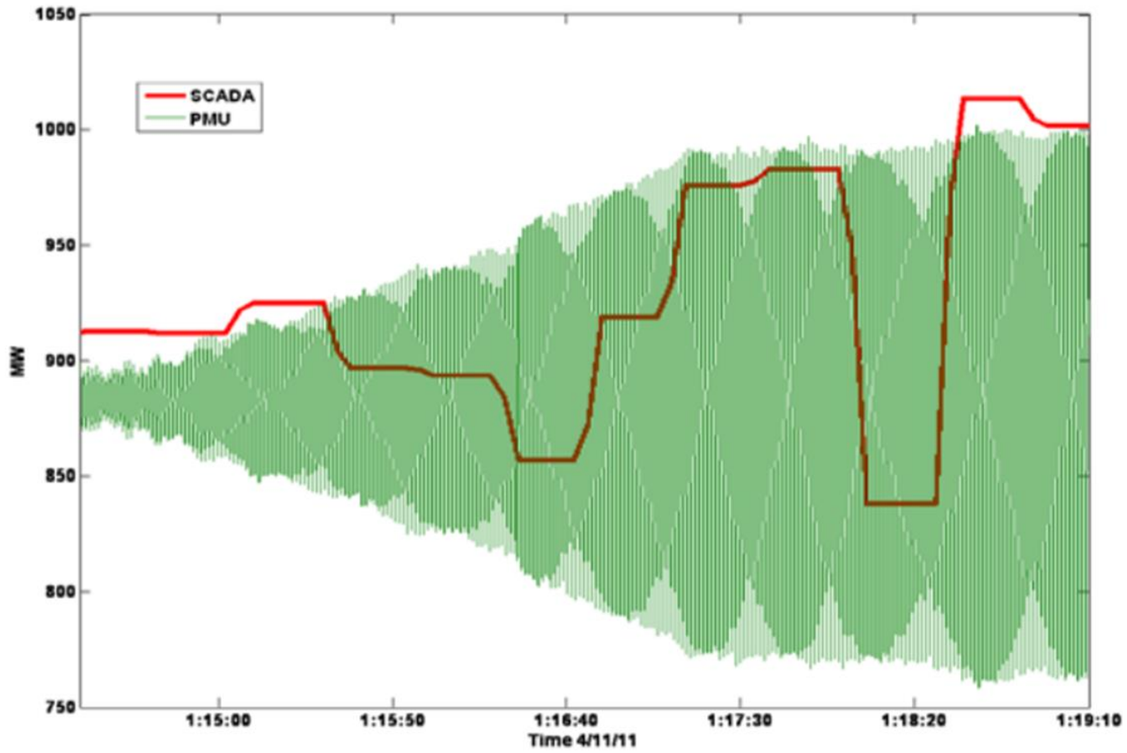
What are Synchrophasor Measurements?

- Measurements of voltage or current magnitude and angle
- Associated with a timestamp using a reference time source such as GPS
- Provide wide-area visibility
- Phasor Measurement Units (PMUs) typically report synchrophasors 30, 60, or 120 times per second



Relationship between a voltage waveform and its phasor.



PMU versus SCADA. Image courtesy of Dominion Energy.

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Synchrophasors are a Valuable Resource

- The high reporting rate and synchronization enable a wide-array of applications
- Applications motivate multi-million-dollar investments in devices, installation, communication, and storage

Applications:

- Monitoring wide-area phase angle separation
- Small-signal stability monitoring
- Oscillation detection and source localization
- System disturbance detection
- Power plant and load model validation/calibration
- Frequency response analysis
- Voltage instability monitoring
- Linear state estimation
- Fault localization
- Subsynchronous resonance detection
- Dynamic line rating
- Asset health monitoring

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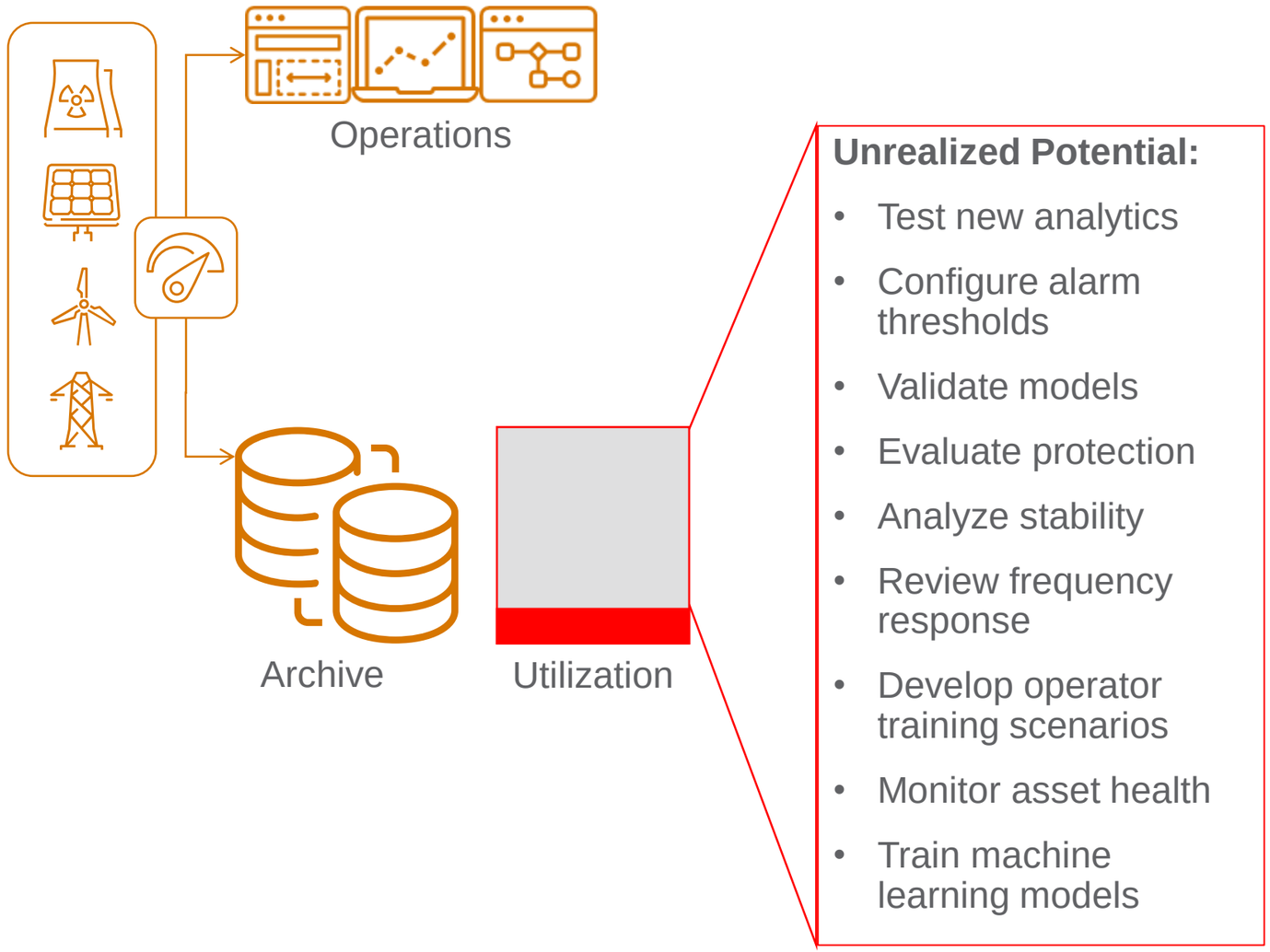
Synchrophasor Archives are Under-Utilized

- After use in real-time monitoring, PMU data is archived
- Utilities commonly store three or more years of data
- The vast majority of data is never examined again



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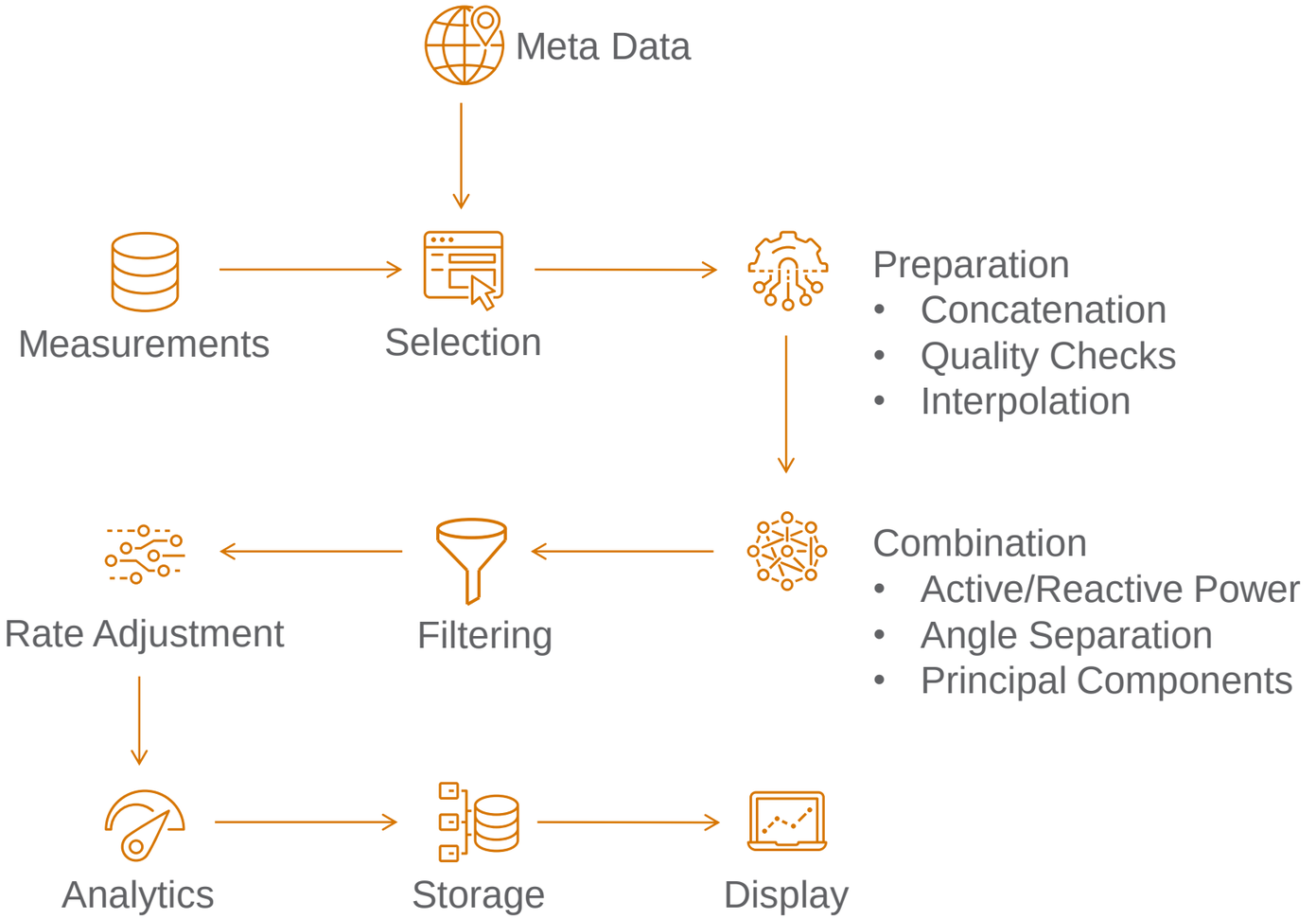
Barriers to Extracting Value from Archives

- Most existing tools offer little flexibility in the analysis chain
- The analysis chain makes developing custom tools daunting
- Large data volumes lead to long execution times and results that are difficult to manage



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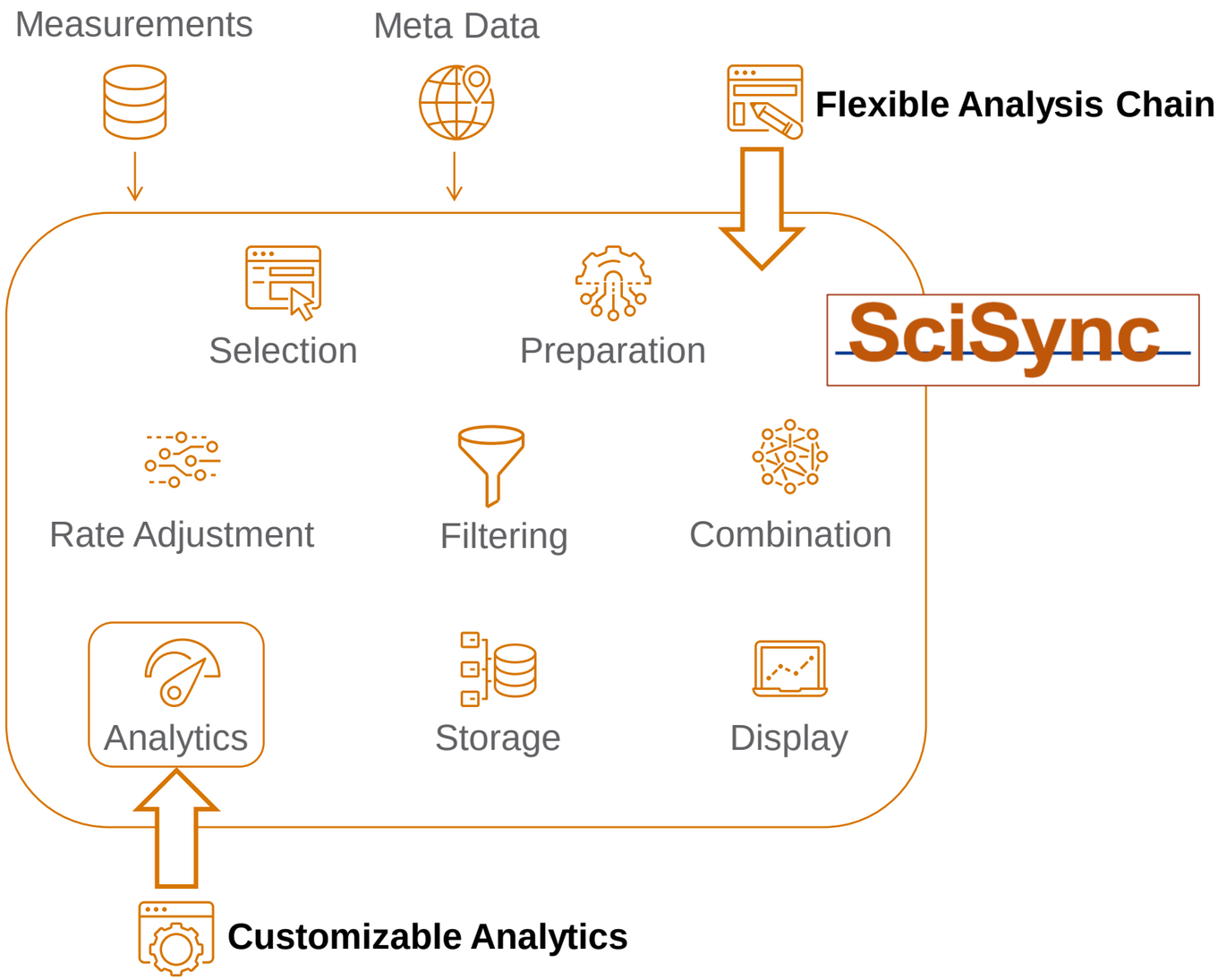
Solution Concept

- SciSync is open-source software that enables users to extract value from archived data
- Support myriad applications
- Analysis chain is accessible to user for configuration
- Users' analytics can be integrated with relative ease



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Prototype: Archive Walker

- Developed by PNNL for Bonneville Power Administration (BPA), 2016-2018
  - Identified oscillations, voltage/frequency deviations, and wind power ramping
- Enhanced under U.S. Department of Energy (DOE) funding, 2018-2020
  - Full-featured tool supporting laboratory and field research
- Technology transfer to GPA under DOE's Technology Commercialization Fund, 2021-2023

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SciSync Design

- Replicate the core functionality available in Archive Walker
- Engineering desktop application
- Improvements over Archive Walker
  - Reduced execution time
  - Seamless integration with data sources
- Build extensible analytic framework allowing third parties to implement new algorithms
- Functionality can be exported to GPA's openPDC for real-time use
- Open-source publishing under the MIT License

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Use Cases

- Targeted – Utility System Engineer
  - Case: Analyze phasor data for specific assets associated with a disturbance event
  - Data: Multiple minutes, few channels
- Exploratory – Utility System Engineer
  - Case: Analyze system-wide phasor data associated with a disturbance event
  - Data: Many minutes, many channels
- Summarizing – Utility Research Engineer
  - Case: Analyze line flows and voltage angle pair variation over multiple months
  - Data: Multiple months, multiple channels
- R&D – Laboratory and University
  - Case: Test custom algorithms
  - Data: Minutes to years, few to many channels

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Architecture

- Data Source
  - Connects to archive, e.g., the PI System
  - Incorporates meta data (geographic location, signal type, signal groups)
- Template
  - Input signal selection
  - Defines analysis chain (cleanup, preparation, event detectors)
- Task
  - Connects Data Source to a Template
  - Defines time frame for analysis
- Result
  - Runs Task
  - Provides visualization and export

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Connecting to the PI System

- Connection to PI is done via OSIsoft AFSDK
- Integration with PI Asset Framework allows PMU metadata to be obtained
- Results can be brought back into PI via Event Frames
  - Mark events detected by SciSync Analytics for other applications within PI
  - Save summary of event parameters for further investigation by engineers

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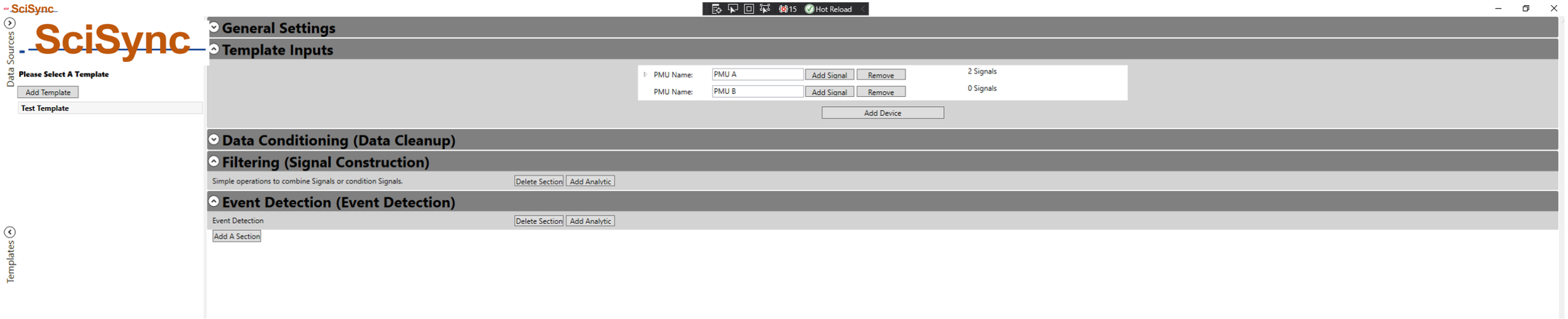
Analytics

- Out of Range Detection
  - Simple: frequency/voltage deviations
  - Complex: Sustained oscillation detection
- Transient Oscillation Detection
- Wind Power Plant Ramping Detection
- Forced Oscillation Detection and Source Localization



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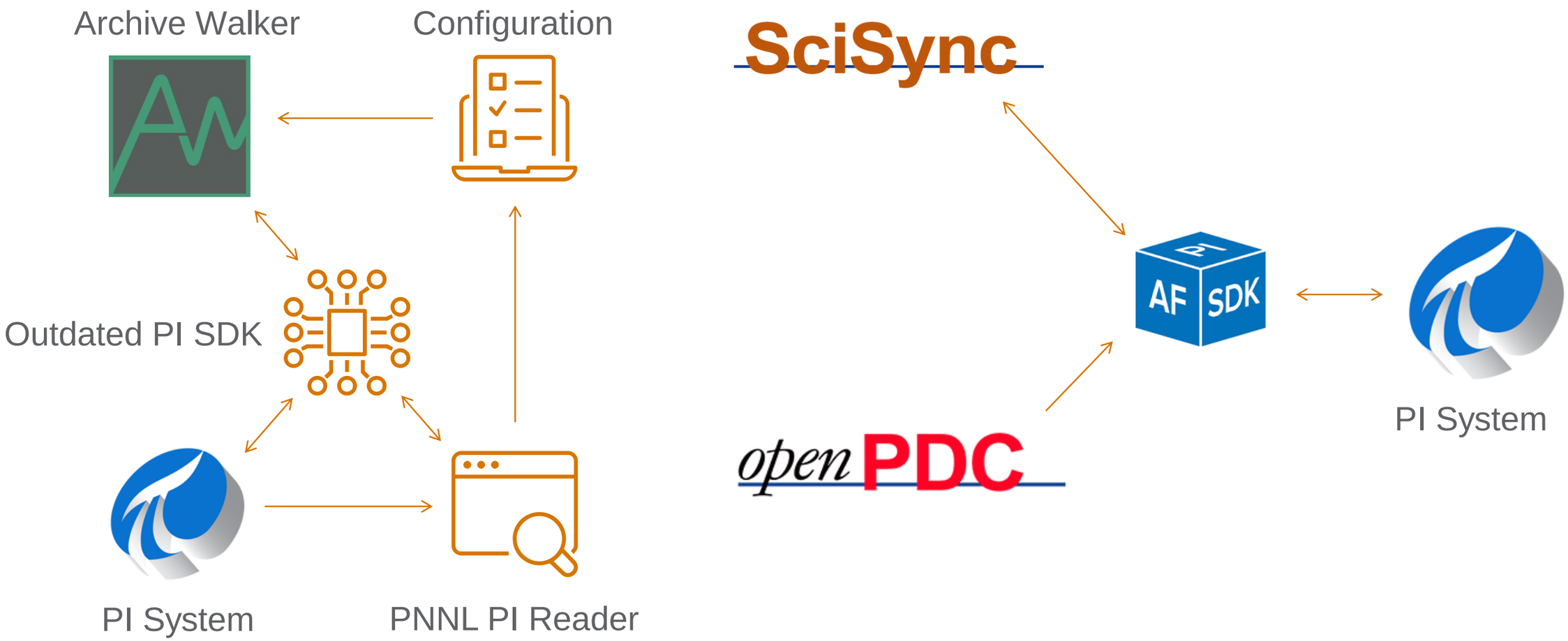
SciSync Interfaces Seamlessly with PI



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How will SciSync Benefit You?

- Leverages existing synchrophasor archiving infrastructure
- Provides flexible data analysis:
  - Short or long record lengths
  - Many or few channels
  - Known events or disturbance detection
- Enables offline tasks:
  - Model validation (NERC MOD-026-1 and MOD-027-1)
  - Frequency response analysis (NERC BAL-003-1)
  - Stability analysis (NERC IRO-002-6)
- Supports rapid prototyping for your in-house analytics

Timeline

- February 2022: Alpha version due to PNNL
- February – April 2022: Testing and refinement
- April 2022: Beta version delivered to partners for testing
- January 2023: Final version published online

Interested in becoming a beta tester? Let us know!

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