Point on Wave Data
What and why

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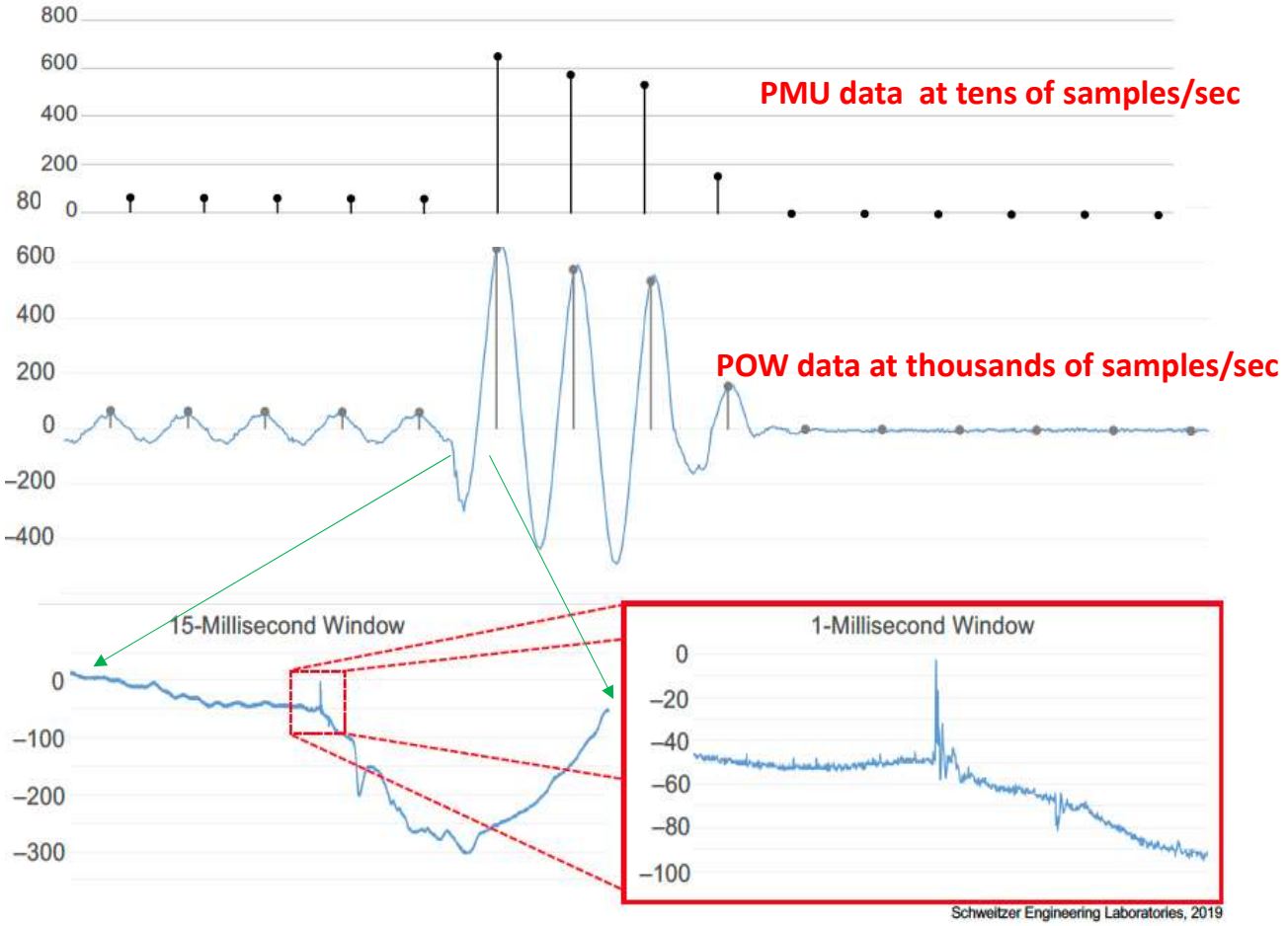
Overview

- Point on wave (POW) v. PMU data
- PMU issues – resolution, data distortion and transients
- Continuous POW (CPOW) data
- Valuable uses for CPOW data
- Application and research considerations for CPOWs

The revelatory value of measurement granularity

Remember when we used to make fun of SCADA…?



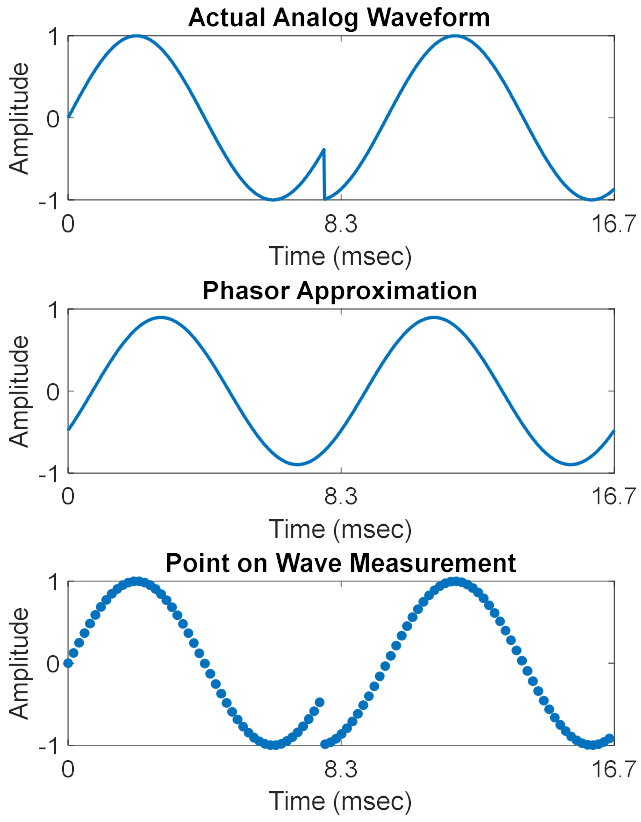
Source: Greg Zweigle, SEL, NASPI Work Group Meeting, 10/30/19

Point on wave v. PMU data

Category	PMUs	Point on wave devices DFR, DDR, relay, etc.
Waveform sampling	Filters data, then force-fits measurement to a sinusoid	Samples actual waveform with minimal filtering
Standard reporting rates	30-60 frames/sec (max 240 U.S.), µPMUs faster	>256 to 61,440 and more samples/sec
Time-synchronized to UTC	Yes	Yes
Continuous or event-triggered	Continuous	Event-triggered, sample lengths 1 – 1,200 secs
Data storage	On-board to many GB, may stream up to PDC or archive	Over-writes stored data unless it's a recognized event, then stores (many GB, TB) or streams
Accessibility	Most stream data to archive	Most addressable and poll-able, but don't stream

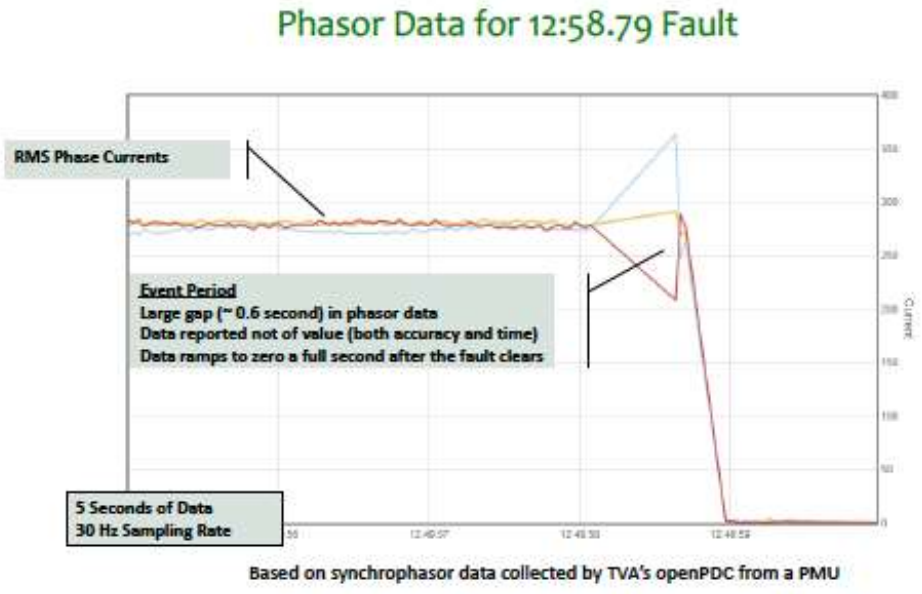
POW data can be used to calculate phasors; PMUs perform lossy compression, so PMU measurements can't be reverse-engineered to get POW data.

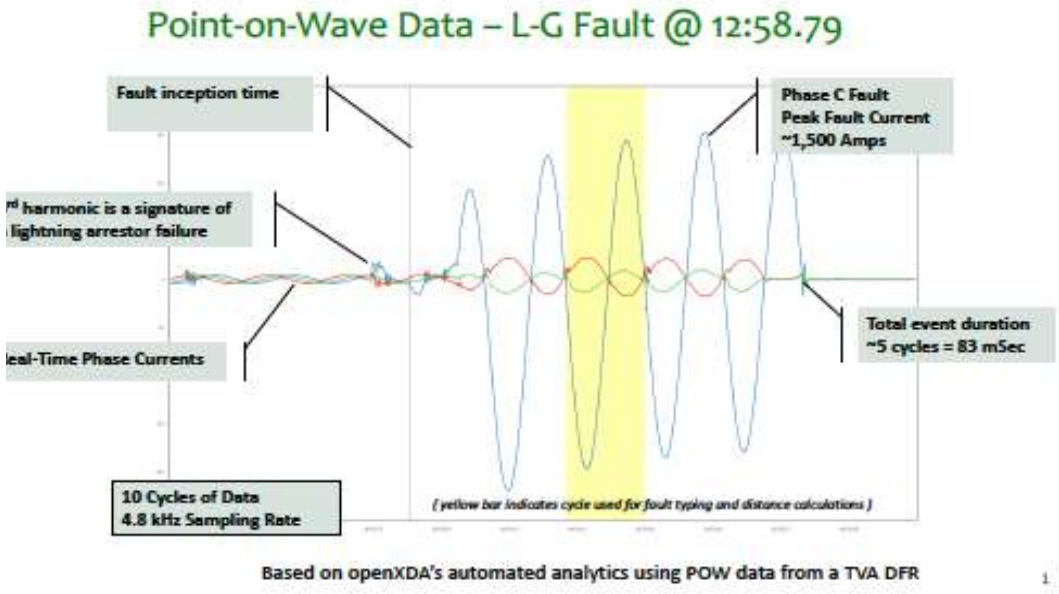
Compare PMU to POW fidelity to actual waveform



PMUs don’t perform well in transients

- We know PMUs don’t handle transients well, with both accuracy and latency issues.
- Fast electromagnetic transients (several to 50 power system cycles) typically include non-sinusoidal behavior and high- and low-frequency components. Some are too fast for PMUs, which may filter out or distort the events.
- Many PMUs in the field just stop reporting data during many transient events.

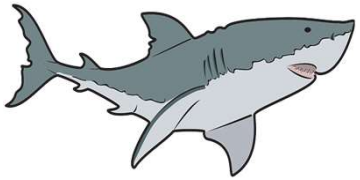




Source: Russell Robertson, GPA, using TVA data and OpenXDA software

Grid measurement devices & what they catch

You can't trigger for events you're not specifying.
We trigger and record these:



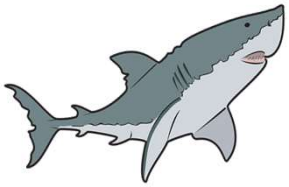
But we may not trigger and catch these because we don't know what to trigger on:

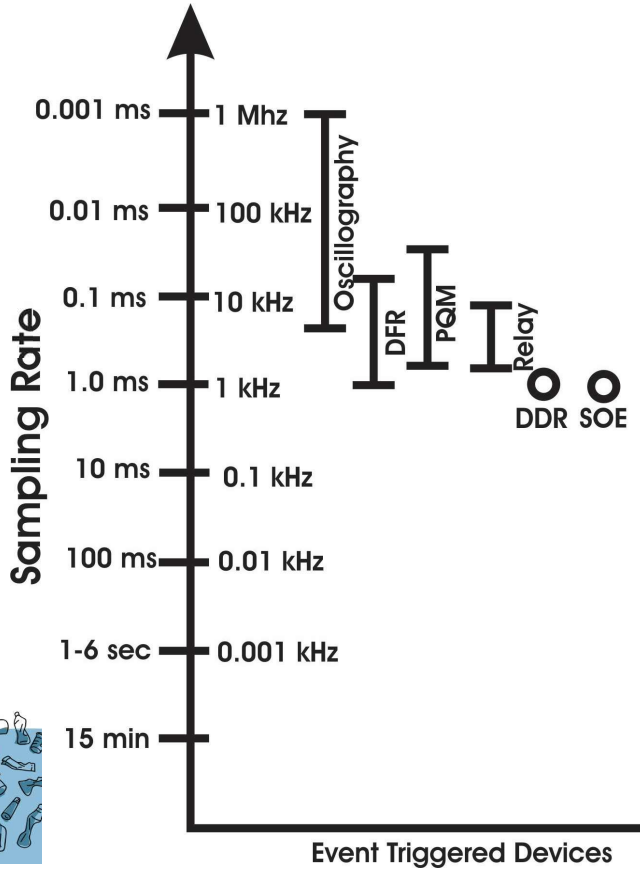


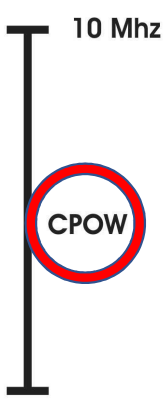
So let's try to catch <u>everything</u> with CPOWs

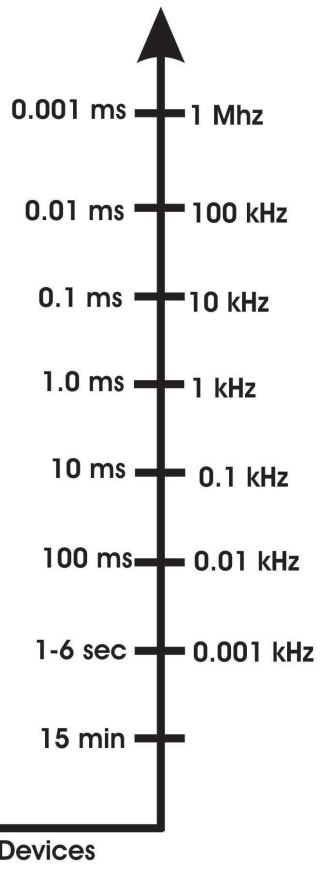
and figure out what it is later…

CPOW = Continuous point on wave









Source: PNNL

Priority uses for CPOW measurements

These use cases require high resolution and accuracy, and don't necessarily require phasors:

- Inverter-based resource (IBR -- renewables, storage) and SSR impact monitoring at transmission and distribution levels
- Load characterization & monitoring at transmission and distribution
- Harmonics and GMD
- Power quality
- Event detection & classification

Application considerations for CPOW

- How many and where do we need CPOW devices? Early on, maybe only in key locations (load centers, IBR-heavy lines, GMD look-outs)
- Where to use & analyze POW data?
  - Local (IBR management, power quality, harmonics, event recognition)
  - Centralized (data analysis, event recognition, grid management) or anomaly-specific?
  - Can expand existing deterministic tools
  - AI/ML analysis (esp. re event diagnostics) coming from ARPA-e & private research
- How to handle and store this much data? It depends…
  - On-site and cloud storage
  - Data pulls v. anomaly-triggered push v. real-time streaming of all or down-selected data

Research considerations

- Do CPOWs exist yet?
  - Darn close – lots of multi-function devices out there with growing levels of on-board storage (but fix over-write function) – Qualitrol IDM+, Candura iPSR, PQube 3, others emerging
  - DOE funding research into new high-resolution POW sensors including optical sensors
- Are there any grid phenomena for which PMU filtering and processing unacceptably distorts or obscures measurements?
- As application accuracy requirements increase, how are POW and PMU measurements affected by the quality of the PTs and CTs they're connected to, and of the connections themselves?
- How to manage and maintain data quality for the volume and speed of POW data?

Huge thanks to
Russell Robertson (GPA) & Greg Zweigle (SEL)
and other interviewees and reviewers

PNNL POW paper coming soon
by Silverstein, Follum & Tuffner

Thanks!

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