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Webinar Questions and Answers

"Synchronized Waveforms – A Frontier of Data-Based Power System and Apparatus Monitoring, Protection, and Control"

with Wilsun Xu and Francisco de Leon

Question: The example 1 is about a distribution line or a transmission line?

Answer: It is a three-terminal transmission line

Question: For Application Example 3: Traveling Wave fault location, why use voltage-traveling wave instead of current-traveling wave? Will both waveforms show the same data, or is one more susceptible to errors in measurement?

Answer: This example is from the work of reference [21], i.e. A.Tashakkori, P.J. Wolfs, S. Islam and A. Abu-Siada, "Fault location on radial distribution networks via distributed synchronized traveling wave detectors", IEEE Trans. on Power Delivery, vol. 35, No.3, pp 1553-1562, June 2020." I am not sure why the authors decided to use voltage wave instead of current wave. You can contact the authors to find out.

Question: SMU have more resolution than PMU data?

Answer: Yes. Page 7 of the presentation states that the required sampling rate is 64 sample/cycle or 3.8kHz.

Question: What are the measurable benefits to switch from a PMU to SMU environment if your control application is based on positive sequence analysis?

Answer: If your control application only needs fundamental frequency positive sequence phasor data, waveform data is not necessary. However, power systems have evolved and in many situations their behaviors cannot be characterized and controlled using phasor data anymore. See page 8 on "Three industry trends driving the need for waveform data."

Question: Where does NERC CIP requirements on the data network come into play on the 3 platform types? For example, even though situational awareness does not require a dedicated platform, if transmission system operators use them for real-time decisions, it should be NERC CIP.

Answer: The adoption of CIP requirements is likely similar to what has been done for the PMU networks. PMU networks (such as WAMS) actually have two types as well, one for monitoring purpose and another for control applications.

Question: Regarding harmonics, what are the benefits of using SMUs and not using current PQ analysers?

Answer: SMU is a generic term used to describe instruments that have synchronized waveform recording capability. It is NOT a specialized device. So advanced PQ monitors is a form of SMU.

Question: Our NASPI member are streaming synchronize wave at 0.5 sample per cycle or 1 sample per cycle. Your presentation discusses the 64 samples per cycle. Does it mean we can't use our existing archive PMU data?

Answer: A streaming rate of 0.5 or 1 sample per cycle is not sufficient to provide adequate information about a waveform. It may provide an index about a waveform at the best. (Phasor is an index suitable for representing a normal waveform). As such, the application of archived PMU data is limited. As explained in the presentation, many applications such as SSR monitoring and incipient fault detection require waveform data. Even for power system oscillation analysis, PMU data needs advanced processing to provide actionable information such as the power involved in an oscillation (shown in page 27).

Question: However, we still have a question to answer. Which attributes of that waveform give us information on which to act?

Answer: It is application dependent. If an application involves harmonic source detection, specific harmonic component derived from the waveform is sufficient. If the application is incipient fault detection, the entire waveform is needed. Action is based on information derived from synchronized analysis of the various waveforms (or their indices) received. Such information is also application dependent.

Question: Do you see more use-cases of synchrowaves in distribution or transmission applications?

Answer: Yes. Many problems can only be solved using waveform data. Once more waveform data is made available, more applications will emerge.

Question: What about communication issues to WMU. It is possible to use micro wave, Power line Carrier and fiber optic?

Answer: Yes.

Question: Has there been any analysis done on the required network infrastructure bandwidth for synchrowave data? Going from 60 messages a second with synchrophasors to at least 3,800 samples a second in synchrowave is a considerable increase in dataset and bandwidth.

Answer: This analysis has not been done by the authors. But we can have rough ideas on the requirement. In many applications, one only needs to transmit indices derived from the waveform data (called derived data in Page 9). The data transmission requirement is not that high. In addition, real-time data streaming is not needed for monitoring applications. Therefore, using sync-wave data for monitoring applications is totally practical.

Question: I'm not understanding what the authors are proposing to be the difference between the current IEEE C37.118 PMU data, and what they are labeling sync-wave data...the only difference I understood is the recording and reporting sampling rates...after the data is in a data repository (i.e., a database), then all of the applications explained are just math applications on the data in question...

Answer: You are correct from the perspective of data sampling and collection. After all, we get any type of data by sampling the physical variables. However, this simple implementation change, i.e. increasing reporting rate etc. can unleash a new generation applications that cannot be done using the PMU data. This is the point of our presentation, i.e. why limit our imagination to one phasor data? we can have the entire waveform to work with.

Question: But do These devices (PQ monitor or relys) give Access to the waveform data?

Answer: Yes. All these are commercially available devices. We have used some of them to get multi-day gapless waveform data. Some of the data can be downloaded from the website shown in page 7 of the presentation.

Question: Either method (PMU or SMU) seems highly reliant on GPS. So...what happens if GPS malfunctions or is somehow disrupted? Have there been any studies taking this phenomenon into account?

Answer: I agree this is a potential problem. However, incidents of GPS problems are rare (look at how many people are using GPS signal every day and how many incidents have been reported). On top of this, the simultaneous occurrence of GPS disruption and power system disturbances such as incipient faults are even more rare. This may explain why not many research work has been done on this subject. By the way, data collected in one substation can be synchronized using substation ethernet clock and GPS is not needed (see page 2 of our paper).

Question: PMU is in fact one step forward with respect to SMU. PMU uses synchronized point on wave data as input of its microprocessor, and turn the data into insightful information such as frequency, power, phase angle, etc.

Answer: PMU data uses one complex number to represent a simple sinusoidal waveform. SMU data uses 64 numbers to represent a complex distorted waveform. Thus, PMU data is akin to black & white video. SMU data is akin to color video. I don't think people will agree that B&W video is an advancement over color video.

Question: What are the limitation of transferring PMU data serially when CIP medium impact devices cannot use E ports?

Answer: I don't have knowledge on this subject to answer this question.