NASPI Work Group Meeting
CRSTT, DisTT and PRSVTT
Joint Breakout Session Recap
from October 29, 2019

Co-Leads
CRSTT: Mike Cassiadoro & Jim Kleitsch
DisTT: Dan Dietmeyer & Sascha von Meier
PRSVTT: Jim O'Brien & Farnoosh Rahmatian

NASPI North American SynchroPhasor Initiative

CRSTT, DisTT, PRSVTT Joint Breakout Agenda

1. Introductions
2. Review mission, goals and objectives for each Task Team
3. CRSTT: Work Products Review, Operations Use Cases
4. PRSVTT: Revised PMU Standard
5. DisTT: European Distribution Operators' Perspective
   Distribution PMU Use Case Survey
6. Train the Trainer Recap/Summary
7. Discussion: Synchrophasors for wildfire mitigation

DisTT Mission Statement

The mission of the Distribution Task Team (DisTT) is to foster the use and capabilities of networked PMUs at the medium-voltage distribution level, beyond the substation.

This group will share information in support of effective research, development and deployment of distribution PMUs and their applications.

We aim to create a community to solve technical and other challenges specific to distribution PMU technology and context.

See www.naspi.org/distt

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DisTT Activity Context

Over the past two years, DisTT has produced a White Paper, several Use Case Papers, and updated priorities of use cases for synchrophasor data.

Of special interest:

- Fire Risk Mitigation (e.g., broken conductor, falling conductor)
- Load disaggregation on circuits with distributed generation
- Monitoring of distributed generation
- Distribution system state estimation & model validation
- Equipment health diagnostics (e.g., tap-changers, reactive compensation)
- Microgrid automation

DisTT Near Term Goal

Shift from academic to practitioner focus

Produce a well-researched, updated study to

- describe needs and priorities of transmission and distribution grid operators that motivate use of time-synchronized measurements
- summarize opportunities and barriers as of today
- present a strategic vision for advancing the use of high-frequency measurement data in distribution systems
- inform decisions to deploy available measurement technologies in a way that addresses urgent needs of real-world practitioners
- support further development of the sensor hardware, data visualization, and analytic software necessary to address the identified needs.

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DisTT Action Plan

Conduct a series of focused interviews with transmission and distribution operators to

- clarify needs and priorities
- ascertain most important areas where time-synchronized measurement data can have a major near-term impact

  incl. Synchrophasor, Time-synchronized, and Point-on-wave data

Collect and synthesize responses

Delegate sections of study writing

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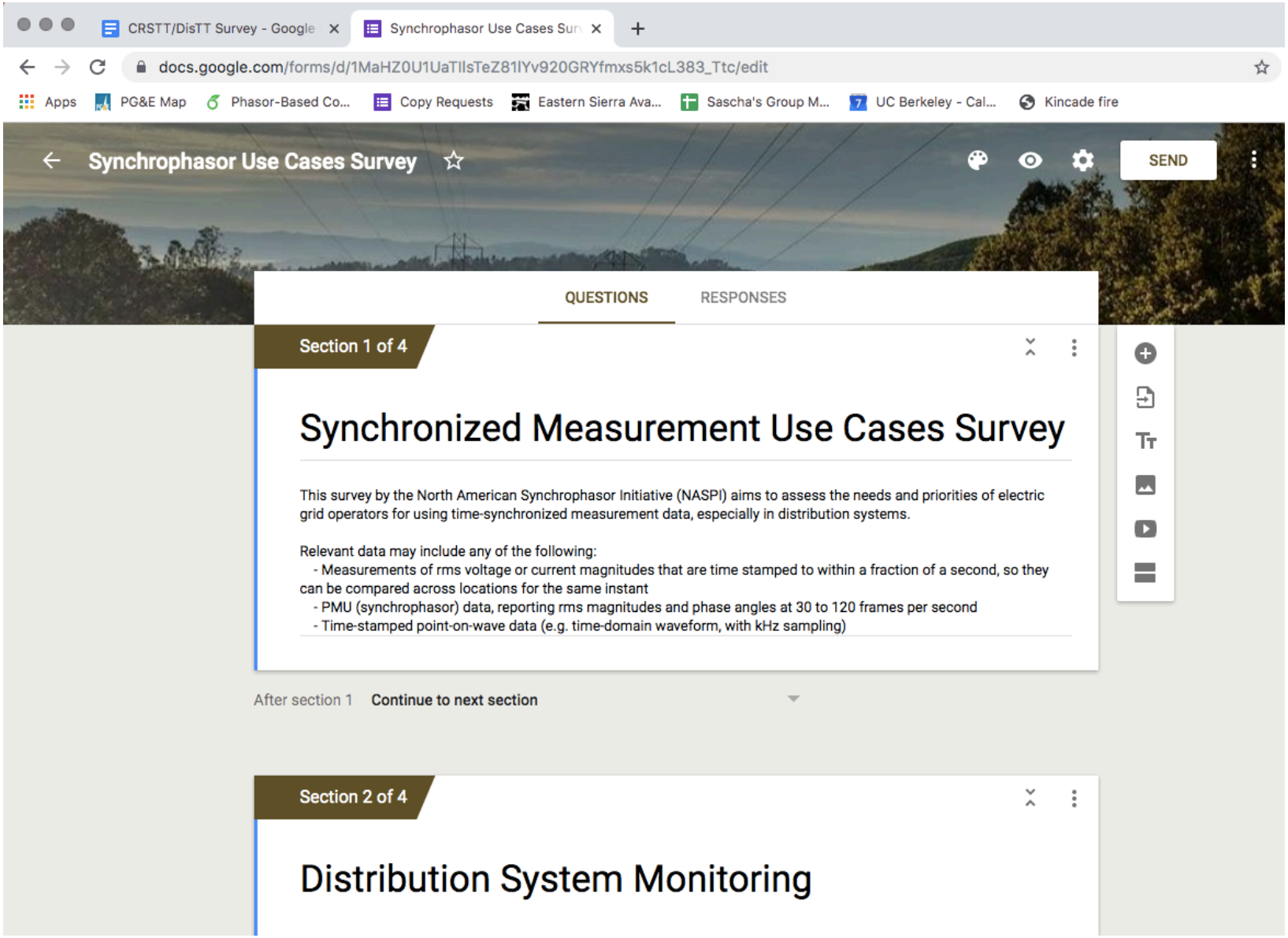
European Distribution Operator Perspectives

Panos Moutis, Omid Alizadeh-Mousavi (DEPsys, Switzerland)

- Conducted a survey of European utilities
- Informed the development of GridEye platform
- Smart meter deployment in Europe: desire to use data for more applications, but running into issues with data quality and ownership. Trend toward wider-area grid monitoring solutions to meet use cases that existing datasets cannot support.
- Applications of interest include power quality, DG, fault detection
- Use cases of interest and prioritization vary significantly depending on the characteristics of the utility

DisTT Use Case Survey



Survey Results
as of early December 2019

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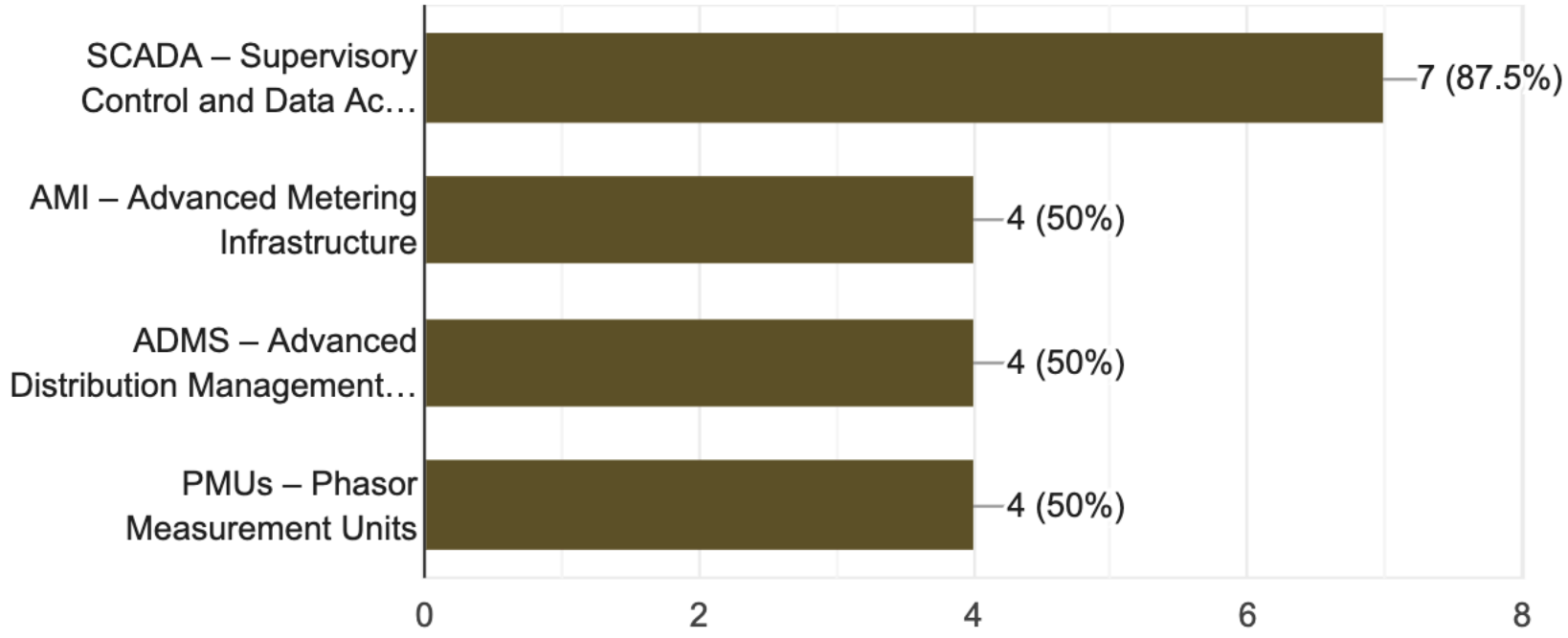
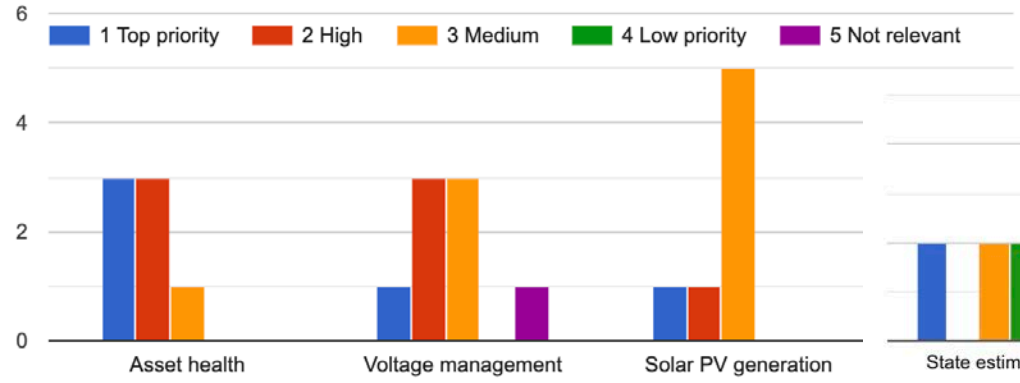
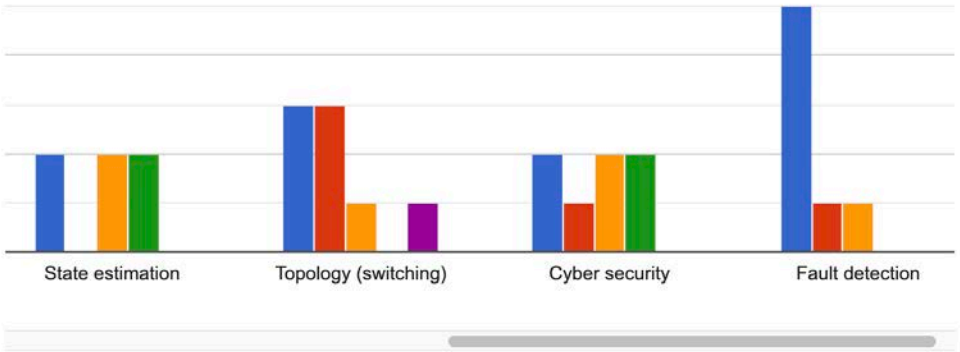
What grid monitoring solutions does your utility currently use at the distribution level? (check all that apply)

8 responses



Please rate the priority of concern for monitoring each of the following aspects of distribution systems





Are there others not listed above?

1 response

Autonomous load shaping that reconciles real time G/T/D availability & constraints, while capitalizing on intermittent low/no carbon generation (whether centralized or distributed).

Briefly describe the relevant distribution system (e.g. dense urban networks, long rural feeders, ...)

5 responses

Highly varied

Urban residential distribution 8 Subs/24 Feeders at 25 kV. 5 subs ~15 feeders at 15 kV. Combination of 115 kV and 69 kV sources to these subs.
25 kV was loop fed, meaning primary was in and out of distribution transformers with load break switches on the primary side of every transformer, few (but some) vaults/junction boxes. 150+ switching orders in 2018 where we moved greater than 500 meters to one (or multiple) different distribution feeds for greater than one hour. This utility doesn't have a standard "non-switched" configuration anymore...they literally move from State A > State B > State C etc.
Prolific SCADA at all subs and many feeder devices, both OH and URD...plus full (and second) AMI deployment.
This was at the cooperative serving the Fargo, ND region. Surprisingly an advanced Distribution System Operator function is in place...one that surpasses those in the Minneapolis/St. Paul region.

nominal voltage of 20 kV, short lines (most of them below 100 m), load demand that varies as function of time and weather condition.

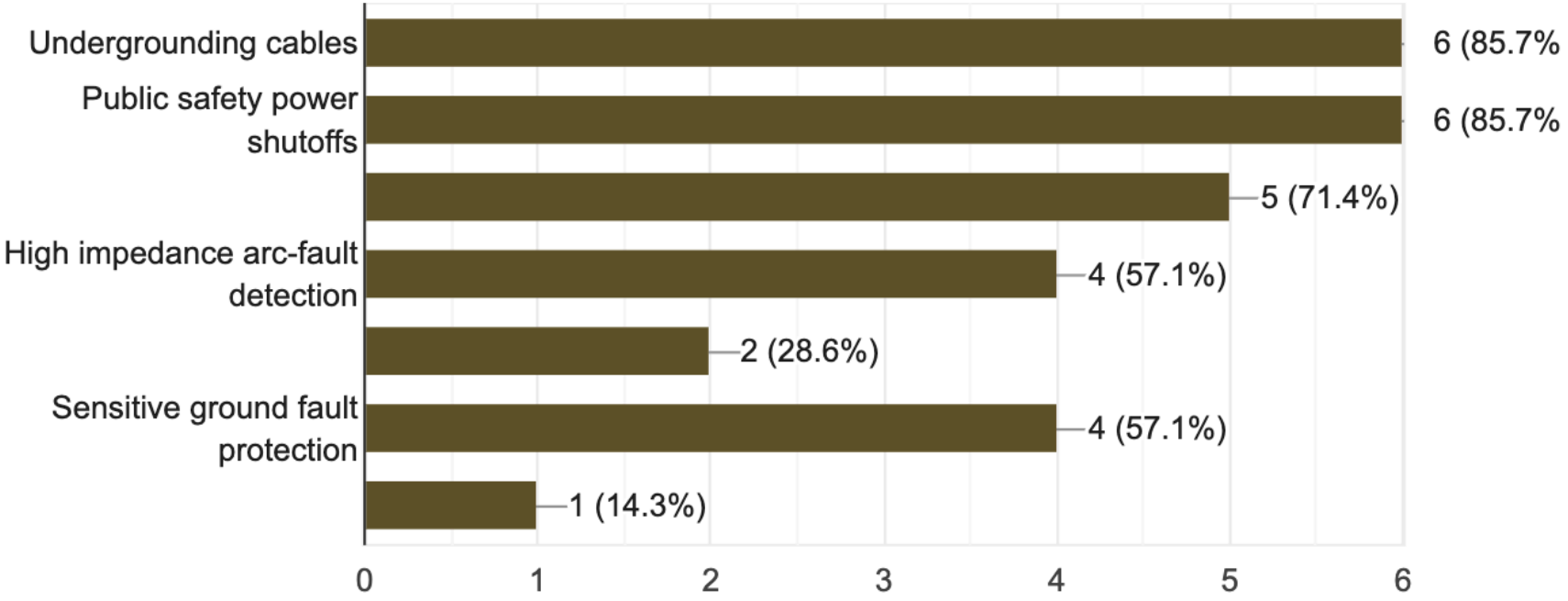
Diverse system topography with mostly radial systems with ties to adjacent circuits

university campus, urban networks, rural feeders

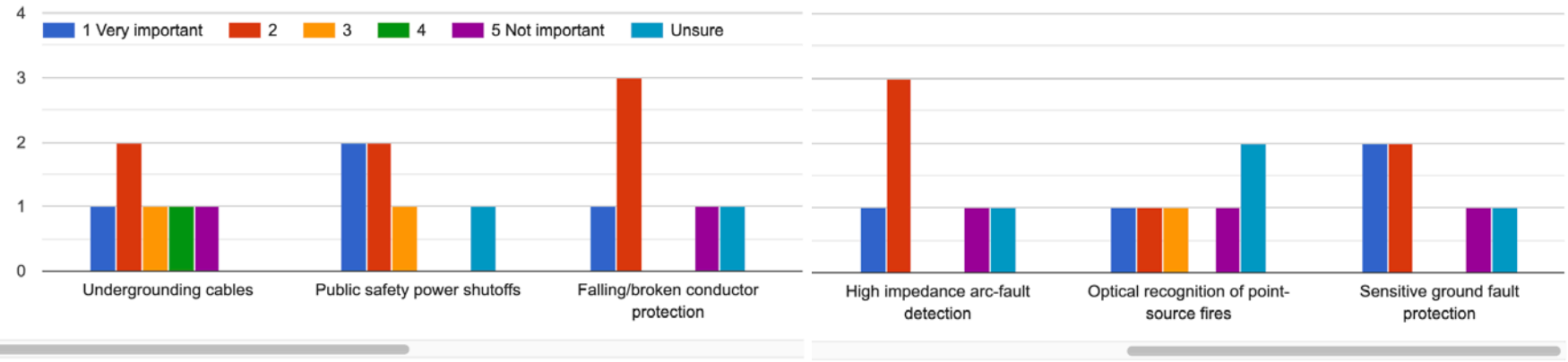
Fire Risk Mitigation

Which wildfire mitigation measures does your utility already employ? (Check all that apply)

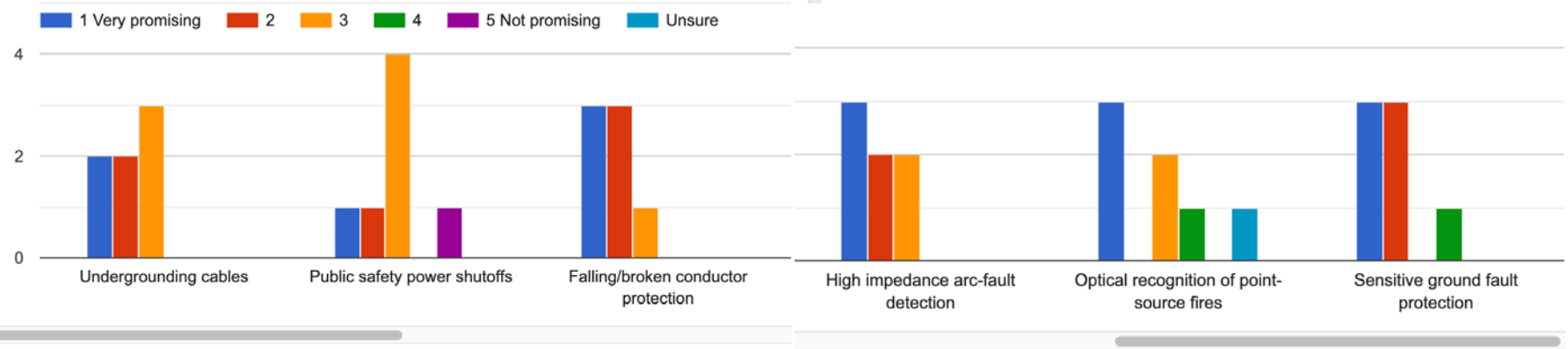
7 responses



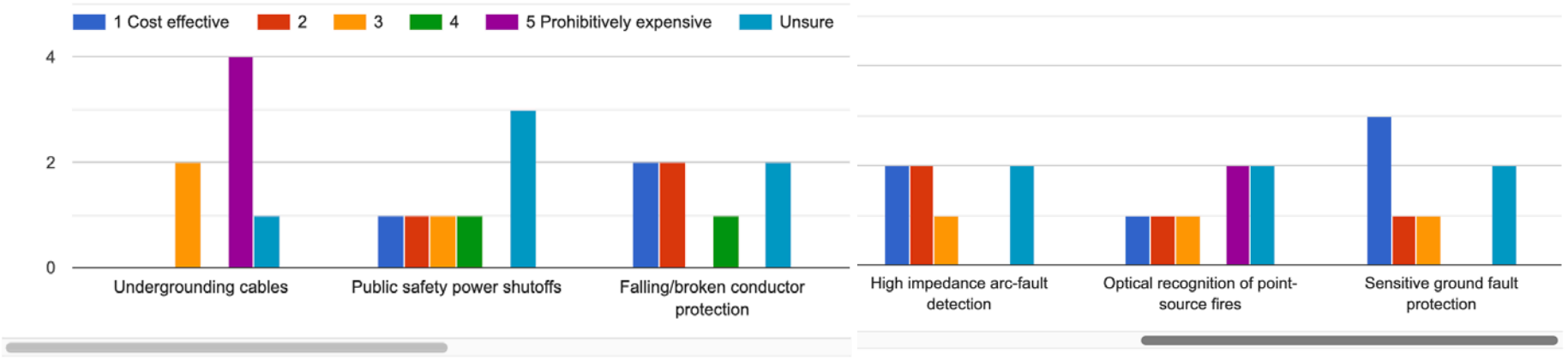
How important is each of the following wildfire mitigation strategies to your utility?



How promising do you consider each of these strategies to be for the future?



Please rate each strategy in terms of cost effectiveness, based on your estimation.



Do you have any further thoughts about how sub-second, time-synchronized measurements can be used to support wildfire mitigation efforts?

4 responses

Power Line signal propagation seems like worthy research in regards to falling conductor protection, as well as the overall operationalization of Synchrophasor data. If every socket based watt hour meter (and preferably every relay too...) either sent or received a time synchronous 8 or 10 digit identifier at the given sample rate (30/60/120) times per second...we could theoretically know Sub/Bus/Feeder/Phase (or "Circuit/Phase", if you prefer) topology to every meter (and hopefully relay...) on the system - again, at the measured sample rate.

This is a big lift, worthy of vendor collaboration. Similarly, the potential benefits are large and include benefits to Falling Conductor Protection, and autonomous load shaping at the far reaches. If we have accurate models representing every physical thing installed on our grid(s), and we know the physical state of said grids, we can shape existing (and new) load into the wind/solar window...without exceeding thermal constraints on any of said physical devices (breakers/fuses/primary wire/secondary wire/transformers/pedestals etc.)

Note on the signal propagation, this doesn't need to be MB/GB/Ethernet over powerline...again only an 8 to 10 digit identifier 120 times per second max. Send the rest of the data back from the meter or relay (or any other microprocessor enabled/grid connected device) over our existing and deployed (RF/Cell etc) communication systems. The AMI meter seems like the logical place to start this effort.

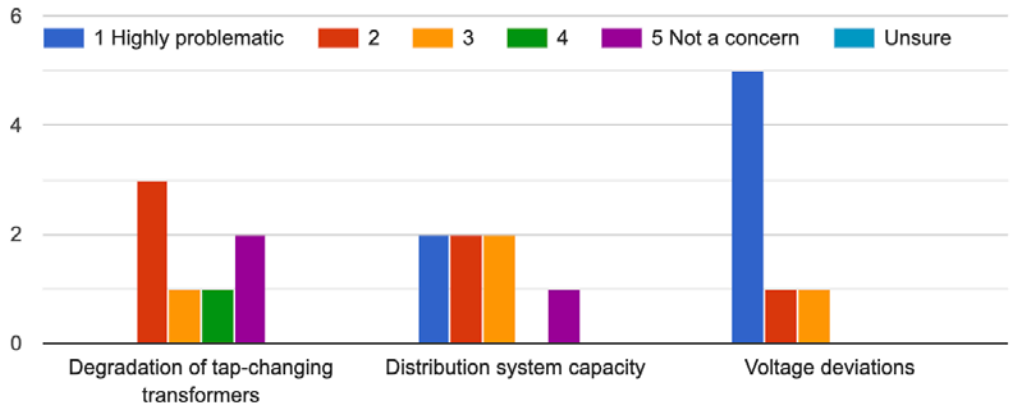
machine learning and waveform capture to identify probable cause

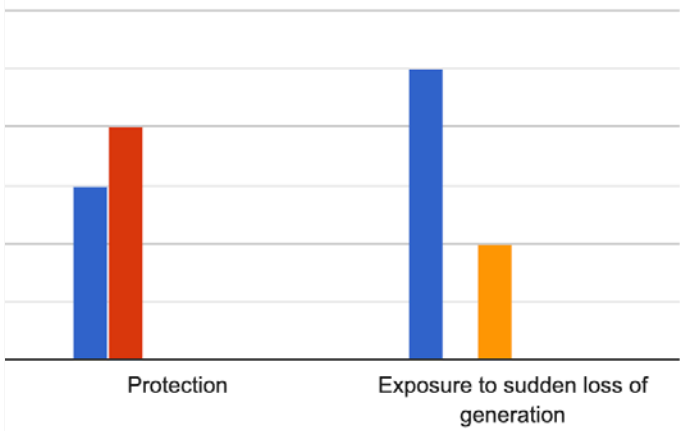
Geo spatial display of wildfire and PMU available nearby can provide a good situational awareness tool for early warning and impact analysis

I haven´t thought about synchronized measurements like a strategy to wildfire mitigation

Distributed Energy Resources

How much do each of the following challenges associated with a higher penetration of DERs (e.g., photovoltaic systems, battery storage, electric vehicles) concern you?





Are there other issues with an increased penetration of DERs that concern you?

4 responses

Islanding Protection

Increased DER's and electrification of end use(s) concern me broadly...if we don't head into the uncharted territory that I just wrote about :)

Low inertia and therefore fast frequency variations. Redefinition of phasors in this evolving scenario.

Power Quality

In your view, how could sub-second, time-synchronized measurement data help address the above issues?

6 responses

Determining Islands

Without redesigning PLC propagation as I'm suggesting, an increase in Phasor Measurement Unit's in distribution systems of course still correlates to a general increase of "Synchrophasor data value" to the given issues above...but I want to remove the guesswork. Let's remove the human communication from distribution topology awareness. With prolific non-microprocessor based switching locations (jumpers/knife blades/elbows/switches etc)...I'm not sure how we completely answer topology awareness without new PLC propagation technology.

Prompt activation of frequency control resources in order to mitigate the reduced inertia of the system

Promptly identify rapid frequency variations and support control actions (like under frequency load shedding)

Power Quality detection (Voltage imbalance), Harmonics

We are developing an automatic voltage controller based on synchrophasors. It aims to optimize tap changing using in order to avoid voltage deviations.

Additional Questions (time permitting)

Has your utility ever done state estimation on your distribution circuits? For example to inform decisions related to renewables integration? If so, what measurement data are used?

8 responses

No

not sure

Yes and No. In my prior role we were using 15/60 minute AMI watt hour data in tandem with the Distribution Engineering Workstation from Engineering Distribution Design. This was better than the amount of watt hours accumulated in 31 (or 365) days, but was only computed on the system in it's "standard configuration"...which as I've mentioned, was virtually nonexistent. We were also running this in tandem with WindMil, and hadn't deviated fully from WindMil at the time...as DEW model cleanup beyond transformer aggregation was necessary.

No, I don't believe so-

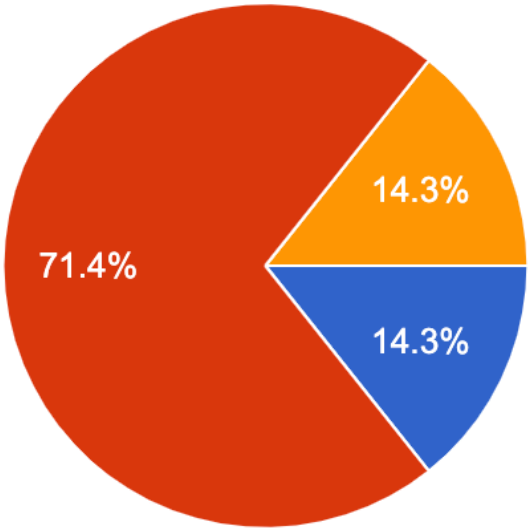
Yes, capacity analysis was done through ICA to determine max integration and specific integration points on every circuit

PMU measurements of current and voltage phasors are currently used to perform real time state estimation and determine the most likelihood voltages in all the system nodes. The estimated state is used to monitor the grids and to perform fault location and faulted line identification.

XM is not a utility, is the Colombian System Operator (transmission level).

Is there value-added in validating distribution network models with high-precision empirical data? If so, what types of circuits would be most useful to explore:

7 responses



- Circuits with lots of industrial load
- Circuits with high penetration of DER
- Yes - Both of the above, and all circuits. This will be ever changing as loads/personal habits change. To that end...residential feeders might be of more interest initially (more dynamic load/generatio…

How is equipment health currently being monitored for condition based maintenance? Would it be useful to have real-time data to detect events that induce unnecessary stress on equipment?

5 responses

We monitored transformer loading with AMI data...not earth shattering, but helpful. We were also aggregating/displaying AMI voltage and blink data/anomalies to monitor non-SCADA equipped breakers and regulators for correct or incorrect operations, or even to include rural services with overloaded triplex/secondary wire (found via combination of hourly AMI voltage and watt hour data)

Yes

Yes, maintenance systems could benefit from PMU data

Few Distribution company have online health monitoring centralized system in place. Yes, real-time event detection help in early resolution of issue and mobilizing of manpower.

As system operator, we do not monitor equipment health

Does your utility employ microgrid solutions? Could synchrophasor data assist in the deployment and enabling/disabling of such resources on the distribution network?

7 responses

I would love to look at any microgrid solution available, as I question how they're doing what I've wrote about in these responses...effectively.

For the monitoring of the microgrid

Yes

Yes and yes. Identifies system behaviors that microgrid may be more sensitive to.

Yes. We have a microgrid on campus that uses PMU measurements collected by a local PDC to make decisions. Of course PMUs can be adopted for microgrid monitoring and control.

Few, Microgrid at university level are there. Yes, the Synchrophasor can help.

We also have a microgrid project on the way. That microgrid will have synchrophasor measurements to monitoring and control.

Any other thoughts on this subject? Thank you so much for taking the survey!

3 responses

Looking forward to hearing feedback from others :)

In my opinion, the problem of PMU synchronisation should be addressed as GPS is not always available at the distribution level

Cost of PMU at Distribution level and their robustness and easy deployment will have a great impact. PMU at distribution should be with RTU capability to take action along with data.

NASPI Control Room Solutions Task Team Monthly Meeting

December 10, 2019

Agenda

I. Introductions

II. Recap of Fall 2019 NASPI Working Group Mtg.

III. Review CRSTT Mission, Goals and Objectives

IV. Discuss status of CRSTT work products

- Focus Area Documents
- Video Event Files
- Use Case Documents

V. Adjourn

Oct. 2019 NASPI WG Mtg. Recap

Highlights of the most recent NASPI WG Mtg. include:

- Time-Synchronized Measurements Training Workshop
- Increased focus on Point-On-Wave Measurements
- Consideration for how NASPI can promote business value and engage stakeholders (including expansion of NASPI LT)
- CRSTT & DisTT continued commitment to coordinating monthly calls and work products

CRSTT, DisTT & PRSVTT Joint Agenda

I. Introductions
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III. CRSTT: Work Products Review
IV. PRSVTT: Revised PMU Standard
V. DisTT: European Distribution Operators' Perspective
VI. Distribution PMU Use Case Survey
VII. Train the Trainer Recap/Summary
VIII. Discussion: Synchrophasors for wildfire mitigation
IX. Operations Use Case Effort
X. Discuss distribution-specific use cases (DisTT and PRSVTT)
XI. Next Steps & Round Table

CRSTT Mission

CRSTT will work collectively with other NASPI task teams to advance the use of real-time synchrophasor apps for the purpose of improving control room operations and grid reliability.

CRSTT will utilize its experience and regional diversity to provide advice, direction, support and guidance to NASPI stakeholders and other organizations involved in the development and implementation of real-time synchrophasor apps.

CRSTT Goals

1. Develop a series of use case summary docs that define how entities are using synchrophasor data to provide operational value.
2. Create additional video event files for use cases and simulated events.
3. Gather operator feedback on synchrophasor-based apps.
4. Support the design, development and delivery of synchrophasor-related training for ops staff.
5. Develop a series of Lessons Learned docs related to the use of synchrophasor technology in the operations environment.
6. Draft new and update existing focus area documents as the need arises.

CRSTT Objectives

1. Identify and help to address issues that are impeding the implementation of synchrophasor-based applications in the Operations Horizon.
2. Develop documentation that defines the safety, reliability and economic benefits that synchrophasor technology provides.
3. Recognize and share industry best practices.
4. Support the design, development and delivery of synchrophasor-based application training for end users.
5. Promote operational event analysis to demonstrate the value of synchrophasor technology.

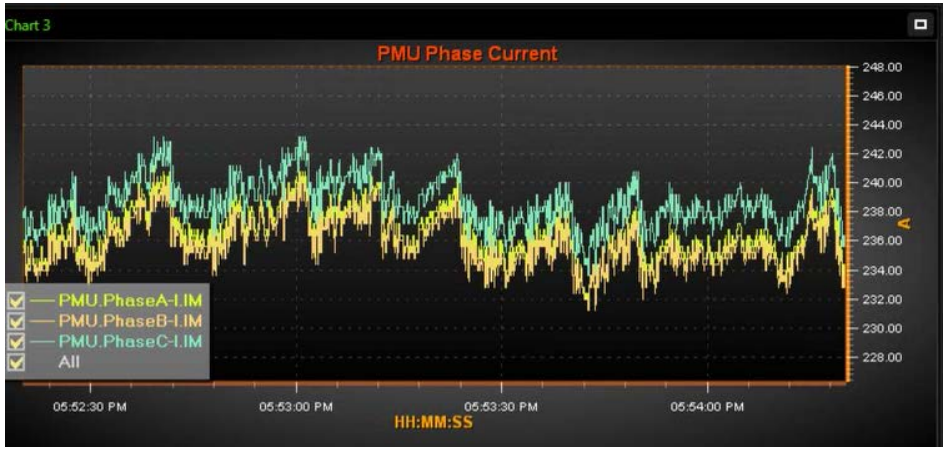
Focus Area Documents

1. **System Islanding Detection and Blackstart Restoration – June 2015.**
   - (Kleitsch – ATC, Cassiadoro – TRS)
2. **Using Synchrophasor Data for Voltage Stability Assessment – Nov. 2015.**
   - **(**Farantatos – EPRI, Vaiman – V&R Energy)
3. **Using Synchrophasor Data for Phase Angle Monitoring – May 2016.**
   - (Cassiadoro – TRS, Nuthalapati – LCRA)
   - **Requests for updates sent on 8/20/2019 with response date of 9/27/2019.**
4. **Enhanced State Estimation Survey –Preliminary responses received; more analysis needed.**
   - (Vaiman – V&R Energy, Kleitsch – ATC)
5. **Using Synchrophasor Data for Oscillation Detection – Feb. 2018.**
   - (Nuthalapati –LCRA, Dyer –EPG, Blevins and Rjagopalan –ERCOT, Patel -EPRI)
6. **Using Synchrophasor Data to Determine Disturbance Location – Feb. 2019.**

   (Nuthalapati – LCRA, Zweigle –SEL Inc., Cassiadoro –TRS)
7. **Using Synchrophasor Data to Monitor Reactive Power Balancing – FUTURE**
   - (Cassiadoro -TRS, Peak –Zhang, Vaiman –V&R Energy)

Video Event Files

Objective – Continue building library of events to demonstrate value PMU data provides when analyzing abnormal events and disturbances.



Video
PMU versus SCADA Video Events Summary. Please refer to EPG's template and the Synchrophasor Data File Format .CSV when creating a video event.
Video 1 - Current and voltage oscillations observed on the 138 kV system during testing of new generator controls (65 MW gas turbine). RTDMS PMU vs. SCADA Video 1
Video 2 - Voltage oscillations observed on the 230 kV system when a water pump was taken offline. RTDMS PMU vs. SCADA Video 2
Video 3 - Voltage oscillations observed following the loss of a 345 kV line during a period of high wind generation. RTDMS PMU vs. SCADA Video 3
Video 4 - Real and Reactive Power oscillations observed on the 69 kV system during a period of high wind generation with the plant radially connected (i.e. one of two normal source lines out of service). RTDMS PMU vs. SCADA Video 4
Video 5 - Real and Reactive Power oscillations observed during a period of high wind generation. RTDMS PMU vs. SCADA Video 5
Video 6 - Real Power and voltage oscillations observed following the loss of a large generator. RTDMS PMU vs. SCADA Video 6
Video 7 - Wind farm Oscillation Detection and Mitigation using Synchrophasor Technology Wind Farm Oscillation Detection and Mitigation
Video 8 - A 230kV fault followed by a loss of a large generation plant caused system frequency to drop approximately 72mHz momentarily, while having an impact on nearby system voltages and online generators (Clip 1, Clip 2 , Clip 3)
Video 9 - Please be patient with the download, the video is very large. This video captures the actual synchronization of a large generator to the electric grid. The windows in the visualization tool capture frequency, output power, voltage angle, and voltage magnitude of the generator and at a reference point on the electric grid.

Use Case Documents

Objective – Develop docs that demonstrate ways that grid operators and electric utilities are using synchrophasor data to provide operational value.

Event ID	Event	Event Category	Entities Involved	Event Description	Extended Description in Related NASPI Technical Paper	Safety Impact	Reliability Impact	Budgetary Impact
TE02	Failing potential transformer	Transmission Equipment	ATC	Abnormal voltage signature found while reviewing PMU data led to discovery of a failing potential transformer which was subsequently isolated and replaced.	p.38	The utility avoided safety risk to personnel that might have been in close proximity to the PT during its failure.		Utility avoided costs associated with customer minutes of interruption that would have resulted from the potential transformer's failure had the condition not been identified and a mobile transformer placed in service to facilitate the outages necessary for its replacement.
TE03	Loose connections in potential circuits	Transmission Equipment	OG&E	Fluctuations observed in positive sequence voltage data collected from PMUs led to discovery of a loose fuse connection in a CCVT safety switch. PMU data has been used in a similar fashion to reveal faulty terminations, animal-damaged conductor and contact corrosion.	p.40			Utility avoided costs associated with equipment damage and customer minutes of interruption that might have resulted had the issues not been addressed.

Reference: **Using Synchrophasor Data to Diagnose Equipment Health and Misoperations Event Summary Table**

CRSTT – Primary Contacts

Name: Michael Cassiadoro

Email: mcassiadoro@totalreliabilitysolutions.com, Phone: 360-836-9008

Name: Jim Kleitsch

Email: jkleitsch@atcllc.com, Phone: 608-877-8102

Name: Sarma Nuthalapati (NDR)

Email: ndrsarma@ieee.org; Phone: 512 801 3191

Next NASPI CRSTT Conference Call: Jan.28, 2020.
Next NASPI WG Meeting: April 2020 in Minneapolis, NM.