NASPI North American SynchroPhasor Initiative

DisTT Conference Call November 10, 2016

1. Roll Call
2. Breakout Session Report from Oct 19 Seattle Meeting
3. Applications, use cases and associated requirements
4. White Paper next steps
5. Updates about ongoing distribution PMU projects
6. Other topics / new business

Report Out: Distribution Task Team Session

Wednesday, October 19, 2016

Presentation Synopses
(please see slide decks online)

Harold Kirkham (PNNL)

Phasor Measurement: A Short History of the Technology and the Standards

Pause to think before you try to write standards; learn from PMU history. Devices compliant with standard can produce very different results.

Sean Murphy & Jerry Schuman (PingThings)

Using micro-PMU data for a data-driven solution to geomagnetic disturbances

We can find cool correlations in huge datasets quickly and easily;
Moore’s Law still applies in data science.

Tariq Rahman (SDG&E) & Kamal Garg (SEL)

SDG&E Experience with Distribution Synchrophasors and Catching Falling Conductors

We can get actionable operational intelligence; have identified 60 use cases for distribution PMUs.

Report Out: Distribution Task Team Session

Wednesday, October 19, 2016

Field Experience with Distribution PMUs

Distribution synchrophasor research projects and use cases explored to date: a preliminary inventory

Many distribution use cases have been identified and are in different stages of development

DisTT will compile ongoing projects and references so that we can learn from each other

Report Out: Distribution Task Team Session

Wednesday, October 19, 2016

Discussion: Technical Specs for Distribution PMUs

- We must consider what we want distribution PMUs (incl. attendant communication and data systems) to actually do, in the context of different applications, well before anyone writes standards.
- We already see very different needs (e.g. latency, data continuity, precision and accuracy, streaming rate) for distribution PMU data in different situations.
- M-class vs. P-class illustrates a tradeoff between latency and data quality, imposed by filtering. Applications dictate the need for filtering.
- Filtering data onboard PMU device or at application level is an important decision
- Perhaps frequency should be computed on the PMU device itself?
- Should particular devices pertain to certain applications or will it be a one size fits all approach?

NASPI North American SynchroPhasor Initiative

Discussion: Technical Specs for Distribution PMUs, cont’d

- Noise and residuals are an important part of understanding performance; DisTT will try to ask the right questions of experts.
- May need both phasor and waveform analysis.
- Sources of error: PTs and CTs, temperature drift… how can we calibrate?

Report Out: Distribution Task Team Session

Wednesday, October 19, 2016

White Paper

DisTT is collaborating on a ~~white paper~~ set of white papers about

- Distribution PMU experience, challenges and lessons learned to date
- What’s different in distribution vs. transmission
- Technical requirements associated with different applications
- Data quality assessment
- Making the business case for distribution PMUs
- Research road map and problem statements

NASPI North American SynchroPhasor Initiative

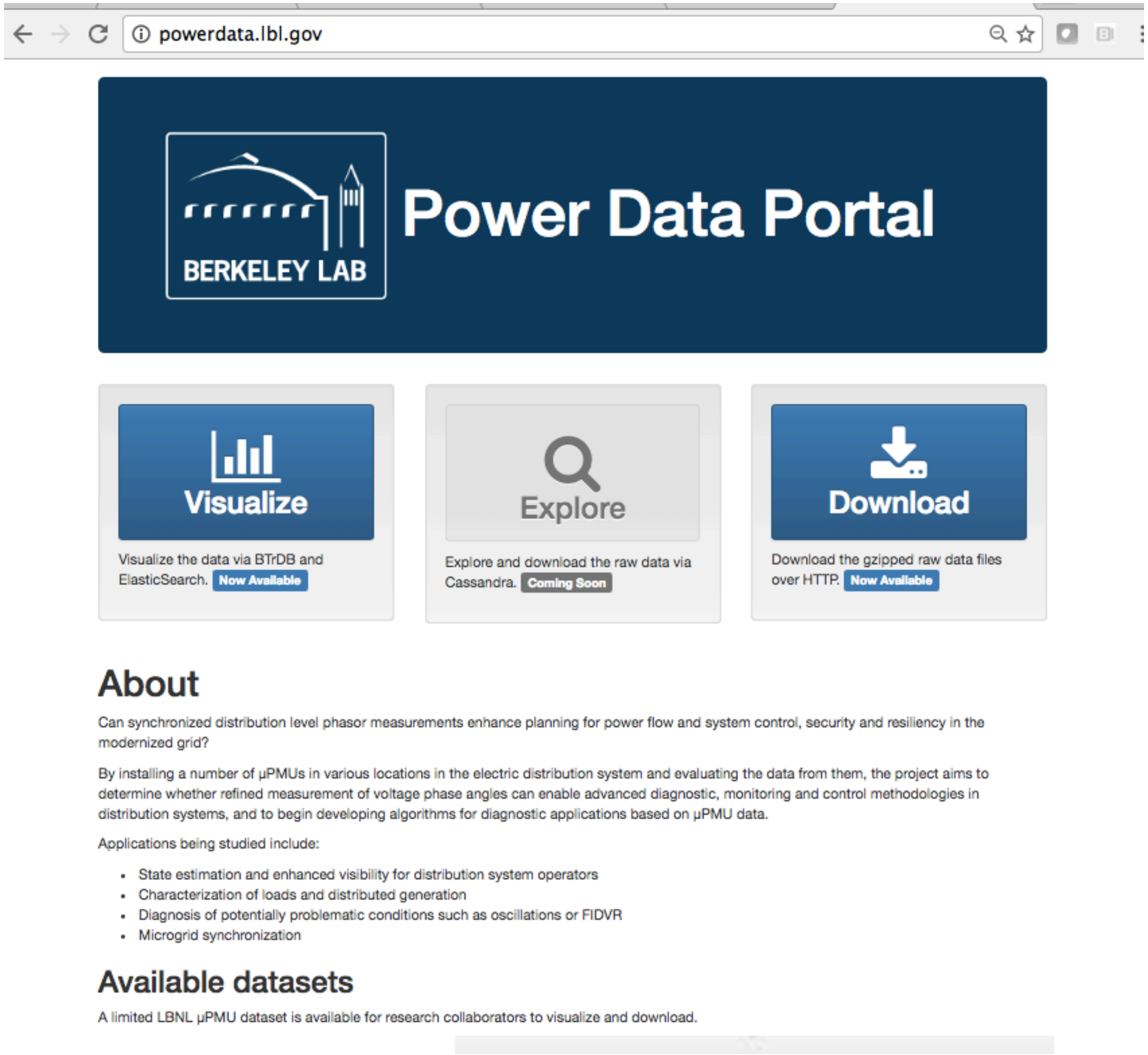
Report Out: Distribution Task Team Session

Wednesday, October 19, 2016

Reference Dataset

LBNL is making a 3-month reference dataset from three micro-PMUs on a 12-kV system available for researchers

see powerdata.lbl.gov



Visualize the data via BTrDB and ElasticSearch. **Now Available**

Explore and download the raw data via Cassandra. **Coming Soon**

Download the gzipped raw data files over HTTP. **Now Available**

About

Can synchronized distribution level phasor measurements enhance planning for power flow and system control, security and resiliency in the modernized grid?

By installing a number of μPMUs in various locations in the electric distribution system and evaluating the data from them, the project aims to determine whether refined measurement of voltage phase angles can enable advanced diagnostic, monitoring and control methodologies in distribution systems, and to begin developing algorithms for diagnostic applications based on μPMU data.

Applications being studied include:

- State estimation and enhanced visibility for distribution system operators
- Characterization of loads and distributed generation
- Diagnosis of potentially problematic conditions such as oscillations or FIDVR
- Microgrid synchronization

Available datasets

A limited LBNL μPMU dataset is available for research collaborators to visualize and download.

Applications, Use Cases and Associated Requirements

from Alison:
One thing I hope to see the DisTT do is create a set of use cases for ways that we could use pmu-like devices at distribution level (distributed resource monitoring and integration, distribution to transmission integration incl FIDVR, voltage monitoring/mgmt, etc). This should call out the specific measurement, speed, time synch or filtering characteristics needed to perform effectively for each use (case), plus whether the data need to be streamed in real time (and to where) for the use to be most valuable.

Discussion: What do we know already about what will be needed from distribution PMU data to support different applications?

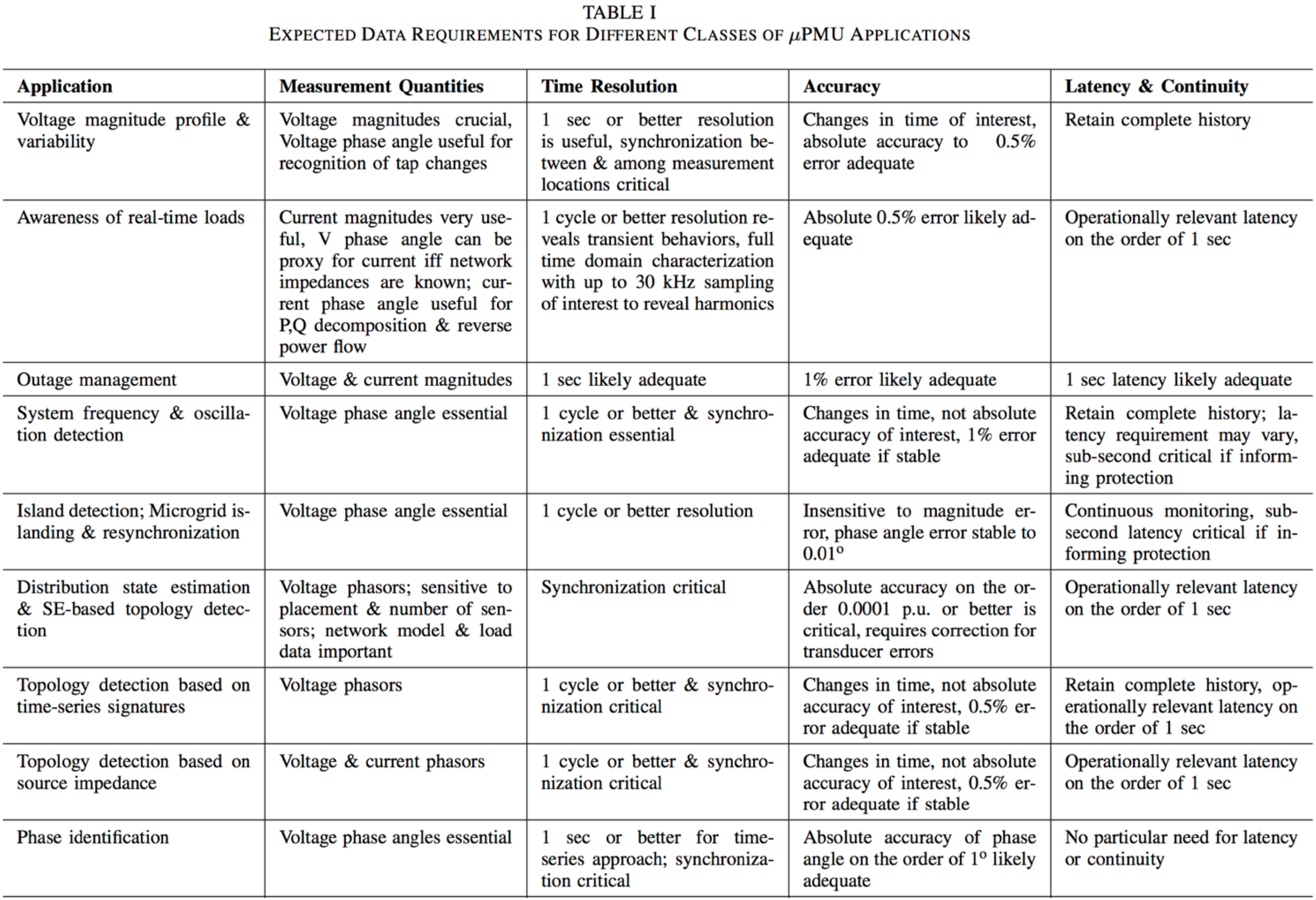


TABLE I

EXPECTED DATA REQUIREMENTS FOR DIFFERENT CLASSES OF μPMU APPLICATIONS

Application	**Measurement Quantities**	**Time Resolution**	**Accuracy**	**Latency & Continuity**
Voltage magnitude profile & variability	Voltage magnitudes crucial, Voltage phase angle useful for recognition of tap changes	1 sec or better resolution is useful, synchronization between & among measurement locations critical	Changes in time of interest, absolute accuracy to 0.5% error adequate	Retain complete history
Awareness of real-time loads	Current magnitudes very useful, V phase angle can be proxy for current iff network impedances are known; current phase angle useful for P,Q decomposition & reverse power flow	1 cycle or better resolution reveals transient behaviors, full time domain characterization with up to 30 kHz sampling of interest to reveal harmonics	Absolute 0.5% error likely adequate	Operationally relevant latency on the order of 1 sec
Outage management	Voltage & current magnitudes	1 sec likely adequate	1% error likely adequate	1 sec latency likely adequate
System frequency & oscillation detection	Voltage phase angle essential	1 cycle or better & synchronization essential	Changes in time, not absolute accuracy of interest, 1% error adequate if stable	Retain complete history; latency requirement may vary, sub-second critical if informing protection
Island detection; Microgrid islanding & resynchronization	Voltage phase angle essential	1 cycle or better resolution	Insensitive to magnitude error, phase angle error stable to 0.01°	Continuous monitoring, subsecond latency critical if informing protection
Distribution state estimation & SE-based topology detection	Voltage phasors; sensitive to placement & number of sensors; network model & load data important	Synchronization critical	Absolute accuracy on the order 0.0001 p.u. or better is critical, requires correction for transducer errors	Operationally relevant latency on the order of 1 sec
Topology detection based on time-series signatures	Voltage phasors	1 cycle or better & synchronization critical	Changes in time, not absolute accuracy of interest, 0.5% error adequate if stable	Retain complete history, operationally relevant latency on the order of 1 sec
Topology detection based on source impedance	Voltage & current phasors	1 cycle or better & synchronization critical	Changes in time, not absolute accuracy of interest, 0.5% error adequate if stable	Operationally relevant latency on the order of 1 sec
Phase identification	Voltage phase angles essential	1 sec or better for time-series approach; synchronization critical	Absolute accuracy of phase angle on the order of 1° likely adequate	No particular need for latency or continuity

excerpt from von Meier, Stewart, McEachern, Andersen & Mehrmanesh,
Precision Synchrophasors for Distribution Systems: A Summary of Applications (submitted)

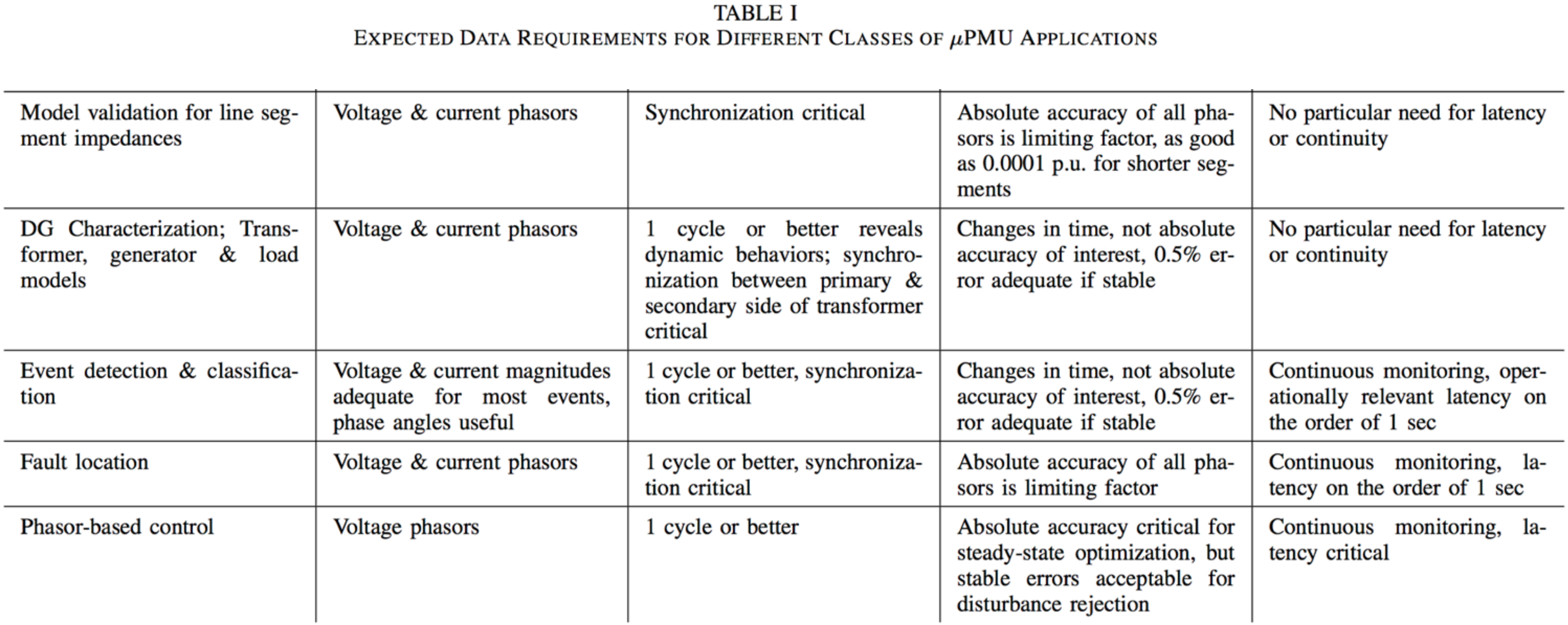


TABLE I

EXPECTED DATA REQUIREMENTS FOR DIFFERENT CLASSES OF μPMU APPLICATIONS

Model validation for line segment impedances	Voltage & current phasors	Synchronization critical	Absolute accuracy of all phasors is limiting factor, as good as 0.0001 p.u. for shorter segments	No particular need for latency or continuity
DG Characterization; Transformer, generator & load models	Voltage & current phasors	1 cycle or better reveals dynamic behaviors; synchronization between primary & secondary side of transformer critical	Changes in time, not absolute accuracy of interest, 0.5% error adequate if stable	No particular need for latency or continuity
Event detection & classification	Voltage & current magnitudes adequate for most events, phase angles useful	1 cycle or better, synchronization critical	Changes in time, not absolute accuracy of interest, 0.5% error adequate if stable	Continuous monitoring, operationally relevant latency on the order of 1 sec
Fault location	Voltage & current phasors	1 cycle or better, synchronization critical	Absolute accuracy of all phasors is limiting factor	Continuous monitoring, latency on the order of 1 sec
Phasor-based control	Voltage phasors	1 cycle or better	Absolute accuracy critical for steady-state optimization, but stable errors acceptable for disturbance rejection	Continuous monitoring, latency critical

excerpt from von Meier, Stewart, McEachern, Andersen & Mehrmanesh,
Precision Synchrophasors for Distribution Systems: A Summary of Applications (submitted)

Applications, Use Cases and Associated Requirements

Elaborate on this table?

- *Filtering*
- *…*

Consider using same format as CRSTT?
1-2 page summary document about each specific use case

White Paper – Next Steps

https://drive.google.com/open?id=1udcZXXU3QPduBM8S1RGcOWb_axmbfwatEz_xztJvloE

Divide into multiple papers

Assign leads

Ongoing Distribution PMU Projects

Updates?

Other Topics, New Business

?

DisTT Logistics

Lead: Sascha von Meier (UC Berkeley) vonmeier@berkeley.edu

Co-Lead: Emma Stewart (LBNL) estewart@lbl.gov

Coordinator: Teresa Carlon (PNNL) teresa.carlon@pnnl.gov

Next call Thursday, Dec 1, 10am PST/1pm EST *okay?*