DOE/OE Transmission Reliability June 2017 Program Peer Review

Reviewer Comments and Ratings

Real Time Applications Using Linear State Estimation Technology
Ken Martin, Electric Power Group, LLC

Low Value (1)	Somewhat Valuable (2)	Valuable (3)	Very Valuable (4)	Highest Value (5)	Average Score
		xx	x	x	3.75

Bertagnolli: **Valuable**

Q1: Similar to BIR project by RPI/GPA but adds RTCS; provides possibility of using breaker status from PMU instead of RTU; well organized and supported project.

Q2: Investigate other new state estimation techniques (least square vs LAV); be open to using breaker status from PMU instead of SCADA

Cummings: **Valuable**

Q1: Incorporation of angle separation is important next step for RTCA. Direct use of PMU measurements on angle separation great next use.

Q2: Always use existing data sources – translate automatically. Angle separation on lines – need to alarm against actual angle reclose settings. Update $\not{Z}$ from RT models. Predetermine which element loss significantly changes $\not{Z}$ matrix. Lean on power of MHO diagram.

Dagle: **Very Valuable**

Q1: Very central to the goals/objectives of the program, well organized and executed with strong partners. Also a great set of advisors. This work is poised to provide long-term benefit to the nation's electric power system. The performance enhancement of the eLSE is impressive. The methodology for evaluating accuracy, albeit somewhat ad-hoc, seemed reasonable.

Q2: Would like to see more publications and project outputs that would be more broadly applicable to other vendors' solutions. One suggestion for improvement would be more focus on the eLSE itself, getting into performance tradeoffs applicable to various applications. I felt that some of the security assessment work was a bit off topic and diluted the focus and impact of this work. I think the timeline for online demonstration is too short to provide meaningful results. Going live in December, wrapping up in February.

Goldstein: **Highest Value**

Q1: RTCA is an important application and is at a relatively high TRC. The RTAP will help with other RT applications to come to market more quickly.

Q2: Contact NIST concerning using the PMU Applications Test Framework to help understand application response to PMU data impairment.

Matthews: **(Recused)**

Q1: Note: BPA is a project partner. New project, so some leeway in deliverables justified, but will look to see specific results in the near future.

Q1: How important is this research for DOE'S R&D Program?
Q2: What, if anything, should be done to improve this research activity?

Q2: Project parallels other initiatives/projects such as those with PNNL. Would be very interesting to see comparative analysis of performance and accuracy on annual basis. Redundant projects a good play early in technology cycle. However, it is important to set stage gates pick superior projects earlier as opposed to funding multiple projects 'forever'." In other words, 'spread plays', or authorizing multiple, seemingly redundant Projects can be smart to see which approach or Project Team performs the best. But, you need a mechanism to kill off all but the best asap to keep from spending too much.

Substation Secondary Asset Health Monitoring and Management System
Kevin Chen, Electric Power Group, LLC

Low Value (1)	Somewhat Valuable (2)	Valuable (3)	Very Valuable (4)	Highest Value (5)	Average Score
		xxx	xxxx		3.6

Bertagnolli: **Valuable**

Q1: Similar to work at GA Tech by Sakis Meliopolis; needs all three phases of data

Q2: Keep in mind that this depends on a MODEL of the substation which needs configuration, switch status, etc. Check out work done by Sakis Meliopolis at GA Tech. This type of failure detection is better done using the raw data (point on wave sample) but that technology has not been developed yet, so you are using the next best thing (i.e., higher sampled data)

Cummings: **Very Valuable**

Q1: Detection of Ø imbalance important – identify potential failures; use of substation PMU/PDC important maturity – not everything needs to be streamed.

Q2: Keep architecture in sub-transmit "info" not data to operations. Auto monitoring – manual interaction on exception basis. Pattern recognition important to incorporate. 621850 protocol in stations? Higher sample rate would be good. Add inputs from manufacturers equip.

Dagle: **Valuable**

Q1: This project is meeting an important need that is currently lagging behind commercially available tools using prevalent data that is now available. Partnering with AEP is very valuable. The project plan seems to include all of the necessary elements to ensure success, and is organized into a project plan that looks reasonable and comprehensive. Nice leveraging of the NASPI white paper.

Q2: I would have liked to see a more clear delineation between this project and the previous one. This should be a consumer of eLSE output, not a contributing developer of that technology. If these different elements were more rigorously modularlized, with standard interface specifications, would be a better approach. It would be better, in my opinion, to better link theory with implementation concepts. Some of the future signature analysis seems like it was taken as examples of things that have occurred, but not a rigorous analysis of exactly what to look for and why. This theory, for example, could define ideal measurements, and what you trade off with actual measurements (vs taking actual measurements as the given).

Gardner: **Very Valuable**

Q1: We may find that 'so called secondary' uses of PMU data may prove more important than primary uses. It is very important to continue to champion safety-related applications.

Q1: How important is this research for DOE'S R&D Program?
Q2: What, if anything, should be done to improve this research activity?

Q2: Expand beyond transducers: Switch adjustment; cap banks; transformers (partial discharge?); reactor banks; arrestors. Correlate with relay alarms.

Goldstein: **Valuable**

Q1: What is the cost/benefit of this work? Is equipment failure a real concern at substations? Is there enough failure data available to do needed analysis? Can an untested system determine the difference between a localized issue and a remote issue?

Q2: Contact NIST concerning using PARTF. Consider using the high-speed point-on-wave data before converting to phasor data. With phasors you lose harmonic information. Involve manufacturers to participate.

Matthews: **Very Valuable**

Q1: Distributed intelligence (moving processing to substation) is the new opportunity that we should be exploring.

Q2: Another new project, so little accomplished yet. Keep focus on two areas: PMU signatures of failing devices (as PMUs come online, encourage other utilities to submit datasets preceding equipment failures). (1) build up a 'dictionary' of precursors to failures; (2) really emphasize the Distributed Processing of PMU data – standalone data analysis at substations, only information goes to control center/operators.

Sobajic: **Very Valuable**

Q1: Important work area; mixing phasor and point-on-wave data; recognition of failure modes.

Q2: Close collaboration with AEP strongly recommended. Expand on use of PR in potential applications. Engage manufacturers.

Operationalizing Synchrophasors for Enhanced Electric Grid Reliability and Asset Utilization

Chaitanya Baone, General Electric Company (GE)

Low Value (1)	Somewhat Valuable (2)	Valuable (3)	Very Valuable (4)	Highest Value (5)	Average Score
x	xx	xx	xx	x	3.0

Bertagnolli: **Low Value**

Q1: The products from this project will help utilities meet NERC standards (MOD 24, 25, 33). The industry would likely develop these tools without DOE support.

Q2: Get generator owners involved in this approach and refocus this effort to gen asset owners.

Budhraja: **Highest Value**

Q1: Validating models is critical for reliability improvement.

Q2: Coordination with other initiatives of BPA, PNNL, NERC-SMS.

Cummings: **Valuable**

Q1: More validation/calibration tools the better; may be duplicative of ongoing work.

Q1: How important is this research for DOE'S R&D Program?
Q2: What, if anything, should be done to improve this research activity?

Q2: Coordinate with NERC SMS, PNNL, and BPA. Do NOT mischaracterize validation work that has been done in West since 1996.

Dagle: **Somewhat Valuable**

Q1: This is a needed technology evolution to commercialize a series of technologies that have been previously developed by academia and National Labs. The partners will provide a solid basis for providing something of value to the industry. An important conduit for implementing things that have been going on.

Q2: It's not entirely clear what new capabilities are being enabled by this project vs what this vendor should be doing on their own in response to various market forces. It's not clear that they are fully leveraging prior work, e.g., EPRI, etc. The presentation itself was a little baffling to me. I am not sure I understood the concept of the P or Q spiral methodology. There should be more laser-focus on developing commercial-grade products vs playing around with other concepts that may or may not materialize, otherwise this project deviates from its core proposition. At the end of this, I thought about the incremental value of this project and what this project will provide that isn't already available without this project, and it seems that industry might be just as well off without this project. (This perspective materialized during the talk.) Note: the presentation itself might be more bleak that the project itself. A lot of good points came out during the Q&A.

Gardner: **Somewhat Valuable**

Q1: Offline event capability on multiple events. Can screen and identify disturbances that are good for identification.

Q2: Define particular differentiating features of this work. What is the value of this work? Good models? → better intentional testing. Lower cost testing? → how does this help?

Goldstein: **Very Valuable**

Q1: NERC has identified that, historically, model validation has been lacking. We need this.

Q2: Collaborate with PNNL/BPA to leverage past work. This is not new work.

Matthews: **Very Valuable**

Q1: This work is <u>really</u> important, with huge implications for enhancing the reliability of the BES – starting with alleviating introductions of forced oscillations by badly tuned generators. Also opens rationale for requiring RT PMUs on each generator work.

Q2: Very concerned that this is highly related to work financed by DOE-OE and BPA (TIP352), which is a PNNL-led project in partnership with GE (PSLF Team), old Alstrom team, and PeakRC. Investment could be better leveraged by convening GE-PNNL meetings to better coordinate and to avoid replicating work already performed under DOE grants.

Sobajic: **Valuable**

Q1: Development and improvement of a commercial products. Valuable for power industry. Early Stage.

Q2: Load modeling and its use needs further attention. Utility involvement is essential. System identification requirements need to be clearly stated.

Q1: How important is this research for DOE'S R&D Program?
Q2: What, if anything, should be done to improve this research activity?

Advanced Synchrophasor Protocol (ASP) Development and Demonstration Project
Ritchie Carroll, Grid Protection Alliance (GPA)

Low Value (1)	Somewhat Valuable (2)	Valuable (3)	Very Valuable (4)	Highest Value (5)	Average Score
		x	xx	xxxxx	4.5

Bertagnolli: **Highest Value**
Q1: This will eliminate many of the issues that make the current technology difficult to live with and make it easier for utilities to adopt PMU technology

Q2: Include in the project scope and schedule some effort to move this toward a standard (IEEE PRC meetings etc). Consider how EIDSN would be impacted. Investigate and document network details.

Budhraja: **Highest Value**
Q1: Addressing protocols for scalability and efficient data transmission is very important.

Q2: Manage expectations – don't try to solve "all" problems. Practical usability. Focus on creating good use cases for protocol demonstrations. Document applications and use cases for which protocol will be critical.

Cummings: **Very Valuable**
Q1: Great project – sorely needed.

Q2: Beware compression – it is not your friend. Just because the data is not transmitted, doesn't it mean it is not needed for Event Analysis.

Dagle: **Highest Value**
Q1: Pick up and move forward on NASPI concepts is necessary. The large number of participants is excellent. The project is well founded and is poised for success. This will be very important to the future. STTP building on GEP is a good approach. Open source approach is good. Building some functionality, e.g., security, is a good requirement. Meta data exchange is great.

Q2: It is not clear how much of this work is being coordinated with the NASPI DNMTT, and how it will keep going after the project has been completed. It will take time to implement this as an international standard, and we need a process/mechanism to make this happen. (Vague passing reference to this task team, we need close coordination.) Clarify how this will be codified as a standard: IEEE vs IEC approach.

Gardner: **Highest Value**
Q1: Promising step change in control-center level data exchange. Good support from vendors (SEL, EPG)

Q2: Relationship with IEC 61850. Important to pursue with standards bodies. Interoperability is important.

Goldstein: **Highest Value**
Q1: Existing protocols (C37-118-2/IEC 61850) are <u>not</u> sufficient for large volume streaming data.

Q1: How important is this research for DOE'S R&D Program?
Q2: What, if anything, should be done to improve this research activity?

Q2: Collaborate with IEEE PSCC to create a standard or trial use standard. Mapping: C37-118-2 + 61850.

Matthews: **Valuable**

Q1: Seems to have more limited applicability, particularly for ISOs/RTOs. That will change as PMUs propagate to the Distribution network.

Q2: Coordination/comparison to the work to 'distribute intelligence' to nodes (e.g. substations). The big problem with more and more big data complicating funding actionable information. Should be considered in concert with the projects to manage data at the nodes.

Sobajic: **Very Valuable**

Q1: Wide impact on future applications and system architecture.

Q2: Not started yet; ensure that GPA team and utility sponsors have adequate means to tackle this issues. Any inspiration from IT industry?

Eastern Interconnection Situational Awareness Monitoring System (ESAMS) Prototype Demonstration
Joe Eto, Lawrence Berkeley National Laboratory

Low Value (1)	Somewhat Valuable (2)	Valuable (3)	Very Valuable (4)	Highest Value (5)	Average Score
			xxx	xxx	4.5

Bertagnolli: **Very Valuable**

Q1: This project may be the only use of PMU data for very wide area monitoring and provides a foundation for wide area control. Common View will be important for system operators.

Q2: Consider involving Canadian utilities (IESO, NBSO, etc). Consider engaging the ISO/RTO council (IRC), specifically the emerging technologies task force, which is under the IRS operating committee. Consider engaging the Regional Reliability Council, specifically NPOC.

Budhraja: **Highest Value**

Q1: Applications and processes that provide useable intelligence to grid managers for reliability management is important for realizing value from synchrophasor investments.

Q2: Continuing to ensure user engagement and commitment for demonstration and validation.

Cummings: **Very Valuable**

Q1: Very important to understand behavior of EI.

Q2: Don't limit to pairs. Holistic view from cohesive zones. Pairs not of specific interfaces. Identify commonality of generators participating in multiple modes.

Garner: **Highest Value**

Q1: Executive buy-in at PJM is key. Good mention of that effort. Appears to be appropriately sized. Add Dominion sites: Surry, Lexington, Valley, Yorktown. Good coordination with EIDSN.

Q2: Add more Dominion points. Add focus on HVDC infrastructure. Add focus on PV (Southeast) and Wind (SPP) dashboard.

Q1: How important is this research for DOE'S R&D Program?
Q2: What, if anything, should be done to improve this research activity?

Goldstein: **Highest Value**

Q1: Continuation of ongoing very important work. Important to keep learning about wide-area measurement.

Q2: Need to expand coverage.

Matthews: **Very Valuable**

Q1: Transitional project: now that PMUs are coming in service with appropriate maintenance & calibration, how do we leverage technology to grasp large areas. This is really important for operators: something is going is… is it in my system or outside of it?

Q2: Need to proceed in parallel with establishing a broader group of stakeholders that grows to large region/national visibility. (Role for NERC/FERC?) need an over-arching entity that can transcend the current operating coordinators.

Discovery Through Situational Awareness (DTSA)

Brett Amidan, Pacific Northwest National Laboratory

Low Value (1)	Somewhat Valuable (2)	Valuable (3)	Very Valuable (4)	Highest Value (5)	Average Score
		xxxx	xx	x	3.6

Bertagnolli: **Valuable**

Q1: This project brings modern "big data" techniques to PMU data (machine learning, pattern recognition, etc)

Q2: Should keep power system experts informed of results. Some of the correlation may be causal and obvious to anyone with power system background. Explore social media, especially twitter feeds. Develop online ways to handle the big data.

Budhraja: **Highest Value**

Q1: PMU data will continue to increase. Data analytics is important to find the 'nuggets' from the haystack that are useable in reliability management.

Q2: Important to distinguish between "after the fact analysis" to learn versus being able to use it for precursor identification for preemptive actions.

Cummings: **Valuable**

Q1: Pattern recognition for future.

Q2: Coordinate with NERC SMS. Consider focusing on learning from local company about switching, etc. signatures for later application to wider area analysis.

Gardner: **Very Valuable**

Q1: Deeply appreciate the application of machine learning to help us find events.

Q2: Try to identify switching events and see what they imply. Embed talent at utility.

Goldstein: **Valuable**

Q1: How important is this research for DOE'S R&D Program?
Q2: What, if anything, should be done to improve this research activity?

Q1: Big Data analysis is an important tool to help us understand power system baseline, events, situational analysis. Using machine learning may help lead to predictive analysis.

Q2: Bring in System info (switching events, other planned events) to help with analysis. Bring in more big data expertise (competing with this project). Get a full-time power system expert to help guide results.

Matthews: **Very Valuable**

Q1: Really promising—and essential. Reaching the PMU maturity level where we have lots of PMUs installed and maintained and generating reams of data. Now—how do we get what we need: INFORMATION. This is a good approach, with the right folks to make progress.

Q2: More, similar projects: reaching critical mass on PMU installs (and quality). Now we need to extract information. Brett's work is great, but more researchers from more labs means we might get solutions sooner.

Sobajic: **Valuable**

Q1: Important area of research; great potential.

Q2: Provide sufficient funding and industry participation.

Suite of Open-Source Applications & Models for Advanced Synchrophasor Analysis

Pavel Etingov, Pacific Northwest National Laboratory

Low Value (1)	Somewhat Valuable (2)	Valuable (3)	Very Valuable (4)	Highest Value (5)	Average Score
	xx	x	xx	x	3.3

Bertagnolli: **Somewhat Valuable**

Q1: This project develops tools for PMU data handling, analysis, and visualization

Q2: Focus on developing tools that might be used to meet NERC requirements, like FRAT. Work towards moving these tools to vendors like Siemens/PTI, MEPPI, which will provide support in the long term. Maybe develop tools that use distribution PMU data. Promote usage among Eastern Interconnection utilities.

Budhraja: **Valuable**

Q1: Good activity. Value questionable. Is it sustainable?

Q2: (no comments given)

Cummings: **Very Valuable**

Q1: Incredibly responsive to improving tools; operations engineering/situational awareness eng.

Q2: Add automated detection and data capture; incorporate several data sources.

Gardner: **Somewhat Valuable**

Q1: A good effort that should be continued. Glad to hear PPMV supports PSS/E.

Q2: Looks like LMVD tool needs more development.

Q1: How important is this research for DOE'S R&D Program?
Q2: What, if anything, should be done to improve this research activity?

Goldstein: **Highest Value**

Q1: These tools are important. They have been available while still in development. Question: who is using these tools so far? Have they yet had an impact?

Q2: Consider if real-time is needed – is 'near real time' good enough? Is Windows good enough or is an RTOS needed? Also consider using graphics processing unit (GPU) to speed up calculations. What is the DOE exit strategy? Proprietary vendor? Or Open Source Community?

Matthews: **(Recused)**

Q1: Recuse – BPA TI Project (TIP349); this is an impressive platform which facilitates "rapid prototyping" and development of tools for planners and analysts to leverage PMU data.

Q2: Continued support for the platform. Yes, certain elements like PPMU may "spin off" to commercial companies (i.e. PSLF) but other potential applications will emerge. The beauty of this investment is that it facilitates quick development of tools for immediate use with a common data architecture and "look and feel" and provides a pipeline for COTS companies to incorporate functionality.

Sobajic: **Very Valuable**

Q1: Valuable set of tools.

Q2: Accelerate transfer of these tools to industry. Provide training classes. Look for commercializers.

Advanced Machine Learning for Synchrophasor Technology

Michael Chertkov, Los Alamos National Laboratory

Low Value (1)	Somewhat Valuable (2)	Valuable (3)	Very Valuable (4)	Highest Value (5)	Average Score
	xxx	xx	x		2.7

Bertagnolli: **Valuable**

Q1: This project applies machine learning (ML) and other advanced technologies to PMU data.

Q2: Do a better job at explaining the advanced mathematics being applied to power system problems.

Budhraja: **Somewhat Valuable**

Q1: Abstract; use cases not clear. Long-term focus – don't expect near-term useful results. Topic is good – linkage to real life value not there.

Q2: Define real use cases.

Cummings: **Somewhat Valuable**

Q1: Very good exploratory work on network sensing – longer term.

Q2: Tie topology estimation to SE knowledge of lines out. Be careful not to over-simplify network reductions (capture dynamics contribution to load). Electro-spatial context – mileage is not everything.

Q1: How important is this research for DOE'S R&D Program?
Q2: What, if anything, should be done to improve this research activity?

Gardner: **Very Valuable**

Q1: Important to the future of real-time operations and closed loop control.

Q2: Continue to push deep into the TOs and TOPs the use case.

Goldstein: **Somewhat Valuable**

Q1: Difficult to determine from the presentation what the actual deliverable is. Scope seems to be very broad – can all this be done in the project timeframe? What are the use cases?

Q2: Next presentation be more clear on what the project deliverables are. Needs the use cases (as Vikram stated).

Sobajic: **Valuable**

Q1: This is difficult. Appears to be fundamental, basic research. However, objectives and concept are not well thought through. This could be a home-run, but requires discipline. Impressive roster, but not well scoped.

Q2: Close scrutiny and strong project management. Very immature project, with an impressive roster, but could wander in the wilderness without a strong hand. May be a luxury in a highly constrained budget environment.

HVDC & Load Modulation for Improved Dynamic Response Using Phasor Measurements

Jianming Lian, Pacific Northwest National Laboratory

Low Value (1)	Somewhat Valuable (2)	Valuable (3)	Very Valuable (4)	Highest Value (5)	Average Score
	x	xx	xxx	x	3.6

Bertagnolli: **Somewhat Valuable**

Q1: This project uses HVDC and loads to damp oscillations. There has been a lot of work done in this area and it would help to understand how this is different.

Q2: Compare proposed methods with other methods. There are several other wide-area control strategies that have been explored (RPI, UTK, etc) and it would be helpful to understand how this compares, advantages, etc.

Budhraja: **Very Valuable**

Q1: Important area for real time wide area controls.

Q2: Goal should be automated modulation. Applicability is central control not distributed.

Cummings: **Very Valuable**

Q1: Very important for forward-looking system stability.

Q2: Controllable loads may be too costly due to communication and susceptibility to hacking. Careful with frequency measurements during faults. Try to stay autonomous with load control.

Gardner: **Valuable**

Q1: (no comments given)

Q2: Could be improved upon by comparing and contrasting with existing body of research.

Goldstein: **Highest Value**

Q1: when it comes to real-time control, this is the most important project to come out of this DOE program!

Q2: Contact NIST about using the PMU Applications Requirements Test Framework (PARTF). Consider that PMUs have significant errors during oscillations. Consider using batteries-distributed.

Matthews: **Very Valuable**

Q1: Question on how this project is unique to the current project? If it is focused on controllable load, then it will require batteries, as it is hard to imagine other commercial/residential load that can be cycled with the type of precision required for this to work.

Q2: Consider this as a 'gamble' on the installation of batteries, particularly for utility scale solar. Or if distributed (small, strategic) flywheels. This is an important concept, but the utility, esp a transmission utility, will want dependable, directly controlled (dispatchable) resources if required for operations.

Sojajic: **Valuable**

Q1: Valuable control application.

Q2: Various controller types could be used and simulated. Evaluate impact on stability

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Powerline Conductor Accelerated Testing

Terry Jones, Oak Ridge National Laboratory

Low Value (1)	Somewhat Valuable (2)	Valuable (3)	Very Valuable (4)	Highest Value (5)	Average Score
	x	xxxx	xxx		3.25

Bertagnolli: **Very Valuable**

Q1: This facility tests overhead conductors, recent developments in materials and coatings, etc. May increase the need for this unique facility.

Q2: Try to understand if there are other facilities of this kind in the world and if so, establish a relationship. Explore other uses for the facility (testing insulators, splices, etc)

Budhraja: **Very Valuable**

Q1: Unique facility; provides good value to industry.

Q2: Could this become a "pay as you go" facility where users pay? Consider developing a business plan to maximize value.

Cummings: **Valuable**

Q1: Great service for advancement of conductor service.

Q1: How important is this research for DOE'S R&D Program?
Q2: What, if anything, should be done to improve this research activity?

Q2: (no comments given)

Dagle: **Somewhat Valuable**

Q1: A well-equipped outdoor test facility for conductor testing. Enables testing of advanced technologies, that is providing good value. Keeping the capability intact is important, and should be maintained. Also—there is value in having a credible, unbiased party doing the testing.

Q2: The linkage to transmission reliability is somewhat tenuous. The use of exotic materials is a cost/benefit tradeoff that should be between the vendor and their customers. I don't see a compelling case for the US Government should be involved. If there is value associated with this capability, it should be provided by the marketplace. There is no incremental reliability benefit associated with doing this testing. Recommend a different sponsor, e.g., EPRI or NATF to be able to provide this capability for the utility industry. Transition funding from taxpayers to rate payers. Note: when he said that results are proprietary to the vendor, that bolstered my conclusion. During the Q&A session, the other reviewers piled on to these concerns. This seems like an area to cut without a clear pathway forward or a business plan.

Gardner: **Very Valuable**

Q1: (no comments given)

Q2: Please consider expanding the facility to test sabotage attempts and power flow control devices (smart wires type technology)

Goldstein: **Valuable**

Q1: What is the exit strategy for this project? Can it be self supporting? This has been a good investment for the US taxpayer.

Q2: Study the DOE exit strategy.

Matthews: **Valuable**

Q1: Important work, but… What is the policy/responsibility of DOE to help US companies commercialize products?

Q2: What is the breakdown of the costs? How much do the commercial companies underwrite the cost? It seems to be a subsidy of DOE to for-profit companies. This might make better sense for EPRI?

Sobajic: **Valuable**

Q1: PCAT – impressive facility

Q2: Funding to be continued

Application of VARPRO Ambient Mode Estimation
Bernie Lesieutre, University of Wisconsin

Low Value (1)	Somewhat Valuable (2)	Valuable (3)	Very Valuable (4)	Highest Value (5)	Average Score
	xx		xxxx	xx	3.75

Bertagnolli: **Somewhat Valuable**

Q1: This project analyzes ambient data looking for osc. and provides several indicators that are continuously updated.

Q2: Introduce noise (errors) into the original signal and investigate performance of the algorithm. Explain how this approach is different than others. Identify and engage partners.

Budhraja: **Highest Value**

Q1: Good innovative approach. Has potential to link to operating guidelines in control centers.

Q2: Document BPA experience and value realized by BPA – use cases.

Cummings: **Very Valuable**

Q1: Great way to identify and measure modes and calculating damping.

Q2: Error detection from known bad data feeds. Consider analysis of multiple mode shapes with common participating generators.

Dagle: **Very Valuable**

Q1: This is a solid project that has a good foundation. Good rigor and providing good value. I also like the technology transfer aspects of this where they brought in something used in a different application to power system applications. This is very similar to the self-coherency function pioneered by Ning Zhou.

Q2: It would be good if the research community could modularize their tools so they can share and re-use modules for things like data conditioning, etc. (He said he used a lot of effort when migrating to real data in the BPA lab). There also needs to be more rigor to have standardized test cases to compare different tools doing similar things. As it is today, we see researchers presenting results without clear context or performance metrics. Idea—deliberately feed in bad data based on typical measurement errors to test susceptibility of the algorithm.

Gardner: **Highest Value**

Q1: Excellent new single metric for measuring persistence. Better for real time environment.

Q2: (no comments given)

Goldstein: **Very Valuable**

Q1: This has the potential for useful precursor information. Quantitatively, this may be susceptible to errors in the PMU estimate, but qualitatively it may not matter if all one is looking for is change in Υ.

Q2: Contact NIST about using the PARTF test framework.

Matthews: **Very Valuable**

Q1: How important is this research for DOE'S R&D Program?
Q2: What, if anything, should be done to improve this research activity?

Q1: Bernie's work underwrites a lot of the progress in characterizing and analyzing oscillatory behavior observed with PMUs. Continued support of his work is an excellent DOE investment to providing operators a definitive number indicating level of risk.

Q2: Continue supporting Bernie's research and opportunities to test (such as at the BPA PMU lab).

Sobajic: **Somewhat Valuable**

Q1: Encouraging initial results (first pass)

Q2: Analysis of multiple signals. Work with utility data

Wide-Area Damping Control Proof-of-Concept Demonstration

David Schoenwald, Sandia National Laboratories

Low Value (1)	Somewhat Valuable (2)	Valuable (3)	Very Valuable (4)	Highest Value (5)	Average Score
	x		Xxx	xxxx	4.25

Bertagnolli: **Somewhat Valuable**

Q1: This project is developing a damping controller for PDCI. This a very specialized control system, not clear why DOE is funding this. BPA & WECC companies should pursue this independently.

Q2: Describe the potential increase in transfers (COI?) as a result of this control feature.

Budhraja: **Highest Value**

Q1: Very important to establish confidence in use of PMUs for control.

Q2: Could this approach be used for real time dynamic ratings?

Cummings: **Very Valuable**

Q1: Great practical testing of long-standing theory

Q2: (no comments given)

Dagle: **Very Valuable**

Q1: This is a solid project that has been around for a while. Good team, good plan, good project objectives. A very deliberate schedule with rigorous testing. This is a very important project to pave the way toward more wide area control projects. Gaining confidence in doing this will pay dividends.

Q2: Look more closely at measurement artifacts (beyond the time delay question) to ensure that bad data can't compromise the controller robustness. The project schedule has slipped significantly over the years. The DOE cost share might impact the BPA ability to keep this going. The value proposition of doing this, and the impact if it doesn't proceed needs to be documented.

Gardner: **Very Valuable**

Q1: Great implementation of a demo and long time coming. Excellent chart on time delays based on testing.

Q1: How important is this research for DOE'S R&D Program?
Q2: What, if anything, should be done to improve this research activity?

Q2: Can a major vendor (ABB, et al?) swoop in here and move forward?

Goldstein: **Highest Value**
Q1: Most important CERTS project to date! Good work!

Q2: KEEP THIS PROGRAM ALIVE!!!

Matthews: **Highest Value**
Q1: High profile, high potential return; enhanced reliability potential is undamped oscillatory behavior can be cancelled.

Q2: Continue support (please). Crucial and pivotal period that within 24 months may lead to commercialization.

Sobajic: **Highest Value**
Q1: Excellent work; very informative presentation!

Q2: Keep it funded—keep it going!

NERC-DOE Special Reliability Assessment: Oscillation Analysis
Mani Venkatasubramanian, Washington State University

Low Value (1)	Somewhat Valuable (2)	Valuable (3)	Very Valuable (4)	Highest Value (5)	Average Score
	xxx	x	xx	xx	3.4

Bertagnolli: **Somewhat Valuable**
Q1: This project investigates an oscillation on the EI and other potential oscillation modes on the EI, ERCOT, WECC. This type of analysis should be done by NERC as a part of normal business activity and not DOE funded. FERC could authorize rate increases to cover the cost of this analysis.

Q2: Present results to as broad an audience as possible, hopefully including the nuclear industry. Consider NERC OC, NATF, NASPI, IEEE, INPO, NRC, FERC.

Budhraja: **Valuable**
Q1: Learning exercise.

Q2: Analysis results need to be linked to how results will be used in planning and operations.

Cummings: **Very Valuable**
Q1: Sorely needed to develop understanding of EI Oscillatory behavior.

Q2: Need to use eigenvalue analysis to determine participating operators. Need to obtain Canadian data—get NEB involved.

Dagle: **Valuable**
Q1: Supporting the NERC SMS is important. Raising awareness of oscillatory behavior among industry stakeholders is good. Understanding the limitations of data availability/formatting is

good to know about. Having rigor on the mathematics and eigenvalues/eigenvectors is important. I'm somewhat unhappy with the application of the 'resonance' term.

Q2: Concern that other subject matter experts e.g., Dan Trudnowski, has not been involved. The work seems a bit ad hoc and unfocused. There should be a more clear work plan with a schedule and deliverables. This feels like a hobby project for Mani. Good analysis but not directly connected to a programmatic activity/outcome. We need to fundamentally ask the question why utility engineers are not doing this analysis. Why is Mani doing this? Why not others? Note: the presentation itself was difficult to understand the scope of the project. This was extracted by the reviewers during the Q&A session.

Gardner: **Somewhat Valuable**

Q1: A good ad hoc analysis provided to the industry—still waiting for actionable take-aways on what to do. What actions can I take home?

Q2: We need an 'easy button' for operators to flag times where we want Mani to take a look at what's going on.

Goldstein: **Somewhat Valuable**

Q1: This looks like DOE is funding WSU to do NERC/Peak's job. No problem with NERC using contractors but is this ongoing or does it have a deliverable?

Q2: Get utilities to communicate when there is an alarm. Need to be more clear of what the project is in the presentation.

Matthews: **Highest Value**

Q1: This project already demonstrating significant ROI. While we used to believe Eastern Grid was quiescent—now we know better. Still much to be done to understand the Eastern Grid at the peril of a significant event.

Q2: Continue funding this excellent work.

Sobajic: **Highest Value**

Q1: Exceptional work! Very informative.

Q2: Continue perfecting data processing systems.

Measurement-Based Stability Assessment
Dan Trudnowski, Montana Tech

Low Value (1)	Somewhat Valuable (2)	Valuable (3)	Very Valuable (4)	Highest Value (5)	Average Score
		x	xxxxx	xx	4.1

Bertagnolli: **Very Valuable**

Q1: This project performs fundamental research into processing PMU data and identifying oscillations. Very thorough analysis of various techniques. Monte Carlo approach is very powerful.

Q2: Would like to see these algorithms applied to data from EI. Would like to see data presented in a better format that the waterfall or multicolored plots (too many colors).

Budhraja: **Highest Value**

Q1: Good project.

Q2: Link to use in real time operations is very important – needs to be addressed.

Cummings: **Very Valuable**

Q1: Moving the ball forward on understanding forced plus known oscillation behavior.

Q2: Pair with mode participant info, mode shapes, and flow information near major mode participants to enhance forced osc location.

Dagle: **Very Valuable**

Q1: A very qualified team—world class experts. Solving and important problem that is necessary to rely on accurate mode meter algorithms. Because of the importance of mode meters to oscillations (a key synchrophasor application area), this is an important area.

Q2: Things are a little fuzzy between Montana Tech research and the commercial interest of Dan and Matt selling mode meter software. I'm not sure how robust the Monte Carlo approach is. It will help explore known variations, but may not be robust for testing systemic issues and/or un-envisioned problems (the unknown unknowns problem). I didn't see much value accomplished doing these cases.

Gardner: **Valuable**

Q1: Good hard work that I'm glad I don't have to do myself. Locating FO in Eastern Interconnection would be important.

Q2: (no comments given)

Goldstein: **Highest Value**

Q1: Continuing research is needed in the area of forced oscillations and localization.

Q2: Produce a product/article that will be used by the utilities.

Matthews: **Very Valuable**

Q1: Mode meter is in the BPA Control, and gaining credibility w/operators. This is already an almost viable product and with modest continued support will be ready for prime time.

Q2: In concert with Mani's project – is mode meter a candidate for application to the Eastern Interconnection

Sobajic: **Very Valuable**

Q1: Exceptional research work. Expanded tool set

Q2: Continue funding this research work.