# North American SynchroPhasor Initiative
# Working Group Meeting
# March 23-24, 2015

## San Mateo Marriott
## 1770 South Amphlett Blvd.
## San Mateo, California 94402
## 650-653-6000

This NASPI work group meeting will focus on research advances in synchrophasor technology. There will be many presentations from industry and academic researchers, along with an extensive poster session. There will be reports on the research being conducted under Department of Energy grants and a focused technical panel on advances in synchrophasor data networking and communications. We will also introduce the new NASPI software exchange.

There will be a $300 registration fee to cover meeting costs, refreshments and lunch on the two meeting days; **the fee will rise to $400** starting March 9. The meeting registration link is here. The NASPI Work Group meeting and the Technical Workshop will be held at the San Mateo Marriott, which is close to the San Francisco International Airport.

NASPI will also offer a technical workshop on Wednesday morning, March 25, on the use of synchrophasor data for state estimation. You can register for that workshop here.

## *Final Agenda*

| **Monday, March 23, 2015** | | |
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| Noon to 1:00 pm | **Registration, refreshments, and networking -- Convene meeting room (mezzanine)** | |
| 1:00 - 1:15 pm | Welcome, introductions, and logistics review | Jeff Dagle (PNNL)<br>Alison Silverstein (NASPI) |
| 1:15 - 1:30 pm | DOE update | David Ortiz (DOE) |
| 1:30 - 3:15 pm | **Research session 1**<br>• Oscillation source location and long term dynamic performance baselining study using ISO-NE's synchrophasor data -- Qiang Zhang, Xiaochuan Luo, Slava Maslennikov, Feng Ma & Dave Bertagnolli (ISO- New England) and Jiawei-Alex Ning, Natheer Al-Ashwal & Karine Hay (Alstom Grid)<br>• Turbo ambient oscillation monitoring for large-scale synchrophasor data -- Hamed Khalilinia, Lu Zhang & V. Mani Venkatasubramanian (Washington State University)<br>• Automated event analysis tool for synchrophasor data in the Indian grid -- | |

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| | Chandan Kumar, Prithwish Mukhopadhyay, Abhimanyu Gartia, Rajkumar Anumasula, Srinivas Chitturi, Sunil Patil & P.K. Agarwal (POSOCO India)<br>• Synchrophasor-based voltage stability assessment of load centers at Entergy -- Adam Wigington & Evangelos Farantatos (Electric Power Research Institute) and Floyd Galvan, Jay Ramamurthy, Rubal KC, Adrian Lazo, Sze (Cat) Wong, Maryclaire Peterson & Venkat (Sharma) Kolluri (Entergy)<br>• PMU-based application for frequency response analysis and baselining -- Dmitry Kosterev (Bonneville Power Administration) & Pavel Etingov (Pacific Northwest National Lab) |
| 3:15 - 3:30 pm | **Break (refreshments and networking)** |
| 3:30 - 6:00 pm | **Task Team break-out sessions** |
| | **Control Room Solutions Task Team -- Collaborate 3 meeting room (3d floor)**<br>• Ramon Leon (XM South America) & Yi Hu (Quanta Technology) -- iSAAC -- Roadmap for a synchrophasor-based Intelligent Supervision And Advanced Control system<br>• V. Mani Venkatasubramanian & Xun Zhang (Washington State University), Javier Guerrero (Universidad del Norte), Jingdong Su (ABB), Hong Chun (Varentec) and Farrokh Habibi-Ashrafi, Armando Salazar & Backer Abu-Jaradeh (Southern California Edison) – Hierarchical two-level voltage controller using synchrophasors for Southern California Edison<br>• Alex Wang, Hsiu-Khuern Tang, Bo Yang, Yutaka Kokai, Nao Saito & Umeshwar Dayal (Hitachi America) -- Detecting and classifying disturbances in power grid using multiple PMUs<br>• Automated event analysis tool for synchrophasor data in the Indian grid -- additional discussion -- Chandan Kumar, Prithwish Mukhopadhyay, Abhimanyu Gartia, Rajkumar A, Srinivas Chitturi, Sunil Patil & P.K. Agarwal (POSOCO India) |
| | **Data & Network Management Task Team -- Synergy 4 meeting room (mezzanine)**<br>• Matthias Strobbe & Chris Develder (Ghent University), Mario Paolone, Paolo Romano, Marco Pignati & Stela Sarri (Ecole Polytechnique Fédérale de Lausanne), Wei Koong Chai & Konstantinos Katsaros (University College London), Ning Wang (University of Surrey), Michael Hoefling & Michael Menth (University of Tübingen), Herman Bontius (Alliander), Erik Poll (Radboud University Nijmegen) & Jimmie Adolph (National Instruments) -- Information-centric communication infrastructure for real-time state estimation of active distribution networks using synchrophasor measurements<br>• Jianhua Zhang & Aranya Chakrabortty (North Carolina State University) and Yufeng Xin (University of North Carolina Chapel Hill) -- ExoGENI-WAMS: A U.S.-wide cloud communication network for wide-area monitoring and control of power systems<br>Xiaoyuan Fan, Dongliang Duan & Liang Du (University of Wyoming) -- GPS-spoofed synchrophasor data correction for state estimation |

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| | **Engineering Analysis Task Team -- Synergy 1 meeting room (mezzanine)**<br>• Dmitry Kosterev & Steve Yang (Bonneville Power Administration) & Pavel Etingov (Pacific Northwest National Lab) -- PMU-based application for power plant model validation (PPMV)<br>• Neeraj Nayak & Wayne Schmus (Electric Power Group) and Ryan Quint (Dominion Virginia Power) -- Generator model verification using recorded synchrophasor data -- process and requirements<br>• Gang Zheng, Frederic Howell & Lei Wang (Powertech Labs) -- A software-based real-time synchrophasor system emulator (ePMU)<br>• Zhenyu (Henry) Huang, Ning Zhou, Ruisheng Diao, Shaobu Wang, Steve Elbert, Da Mang & Shuai Lu (Pacific Northwest National Lab) -- Capturing real-time power system dynamics: opportunities and challenges<br>• Yang Chen, Le Xie & P.R. Kumar (Texas A&M) -- Synchrophasor data-driven early anomaly detection via dimensionality reduction<br>• V. Mani Venkatasubramanian, Anjan Bose, Carl Hauser, Dave Bakken, David Anderson, Chuanlin Zhao, Dong Liu & Ming Meng (Washington State University), Tao Yang (American Electric Power), Lin Zhang (Electric Power Group), Jiawei Ning (Alstom Grid) and Zaid Tashman (Space Time Insight) -- Real-time grid simulator *GridSim* for large-scale power systems<br>• Maryam Kazerooni, Trevor Hutchins, Tom Overbye & Hao Zhu (University of Illinois at Urbana-Champaign) -- Use of PMU data for geomagnetic disturbance model validation<br>• Phuc Huynh & Hao Zhu (University of Illinois at Urbana-Champaign) -- Complexity analysis for PMU measurement-based load modeling |
| | **Performance Requirements, Standards & Verification Task Team -- Convene meeting room (mezzanine)**<br>• Vedran S. Perić & Luigi Vanfretti (KTH Royal Institute of Technology) and Xavier Bombois (Delft Technical University) -- Least costly probing signal design for power system mode estimation<br>• Naresh Acharya, Chaitanya Baone and Santosh Veda (GE Global Research) -- Modeling and assessment of synchrophasor data quality<br>• Ryan Nice (PJM Interconnection) -- Phase angle unwrapping and handling<br>• Joe Gracia & Paul Ewing (Oak Ridge National Lab), and Jeff Zhao, Lingwei Zhan & Yilu Liu (University of Tennessee Knoxville) -- PMU error impact on measurement-based applications<br>• Jeff Zhao, Lingwei Zhan & Yilu Liu (University of Tennessee Knoxville) and Joe Gracia & Paul Ewing (Oak Ridge National Lab) -- Distribution level phasor measurement accuracy limits<br>• Lingwei Zhan & Yilu Liu (University of Tennessee Knoxville) -- Research on the measurement errors of synchrophasors in a real power grid environment |
| 6:00 - 8:00 pm | **Reception and poster session -- Inspire meeting room (mezzanine)**<br>**Poster presentations:**<br>• Paranietharan Arunagirinathan & Ganesh Kumar Venayagamoorthy (Clemson University) -- Power system stabilizer tuning using PMUs<br>• Tamara Becdjac, Mladen Kezunovic & Tomo Popovic (Texas A&M University) -- Field end-to-end calibration for synchrophasor system<br>• Govind Chavan, Matthew Weiss, Aranya Chakrabortty & Subasish Bhattacharya (North Carolina State University) and Armando Salazar & Farrokh Habibi-Ashrafi (Southern California Edison) -- Real-time identification and predictive analysis of a multi-area WECC power system model using synchrophasors<br>• Raymond de Callafon (University of California San Diego) & Chuck Wells (OSIsoft) -- Automatic detection of the source of forced oscillations in wide area power grids |

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| | • Geneviève de Mijolla, Yu Xia & Joe Chow (Rensselaer Polytechnic University) -- Cascading failure detection using phasor angles<br>• R. Jalilzadeh Hamidi, H. Khodabandehlou, H. Livani & M. Sami-Fadali (University of Nevada - Reno) -- PMU-based transmission state estimation using compressive sensing method<br>• Tatsuki Inuzuka, Osamu Tomobe, Norifumi Nishikawa, Mika Takata, Taichiro Kawahara & Shinji Fujiwara (Hitachi) -- Decision making support system for power system operation using PMU historical data<br>• Prashant Kansal (American Electric Power) -- AEP's experience with synchrophasor system and data quality improvements<br>• Hyojong Lee, Ren Liu, & Anurag K. Srivastava (Washington State University) -- Cyber-physical co-simulation for real time validation of synchrophasor applications<br>• Yong Liu, Gefei Kou & Yilu Liu (University of Tennessee-Knoxville) and Joe Gracia & Tom King (Oak Ridge National Lab) -- Design of a large-scale virtual power grid for research community<br>• Richard Macwan, Ti Xu & Tom Overbye (University of Illinois at Urbana Champaign) -- Development of interactive, transient stability level power system simulation cases for PMU research and education<br>• Saurav Mohapatra & Tom Overbye (University of Illinois at Urbana Champaign) -- Real-time modal identification for large-scale power systems using PMU data<br>• Vedran S. Perić & Luigi Vanfretti (KTH Royal Institute of Technology) and Xavier Bombois (Delft University of Technology) -- Optimal signal selection for power system ambient mode estimation using a prediction error criterion<br>• Cheng Qian, Mladen Kezunovic & Tomo Popovic (Texas A&M) – Open source PMU calibration system<br>• Ashfaqur Rahman and Ganesh Kumar Venayagamoorthy (Clemson University) -- A new approach to state estimation<br>• Karl Reinhard, Kenta Kirihara, & Yang Liu (University of Illinois at Urbana Champaign) -- Synchrophasor data quality assessment<br>• Karl Reinhard, Michael Quinlan & Bogdan Pinte (University of Illinois at Urbana Champaign) -- Open-box PMU<br>• Karl Reinhard, Daniel Long, Brianna Drennan, & John Lee (University of Illinois at Urbana Champaign) -- NISTIR 7628 Visualization<br>• Mustafa Saad, Ahmed Eltom, Gary Kobet & Raga Ahmed (University of Tennessee at Chattanooga) -- Performance comparison between dual-blinder and phasor-based out-of-step detection functions using hardware-in-the-loop simulation<br>• James Schrock, Christian Garcia, Richard Gudgel, Jessica Hart, Jon Key & Stephen Bayne (Texas Tech University) -- Undergraduate education and development of low cost synchrophasors<br>• Jerry Schuman & Sean Murphy (PingThings) -- A use case: transforming PMU data with big data technologies<br>• Komal Shetye & Tom Overbye (University of Illinois at Urbana-Champaign) -- Using PMU data for validating transient stability models<br>• Mika Takata, Norifumi Nishiwaka, Shinji Fujiwara, Satoshi Iesaka, Hiroyasu Kiba, Pulung Waskito, Taichiro Kawahara & Yutaka Kokai (Hitachi) -- The integration of high performance relational database and archived files for big PMU data analytics<br>• Philip Top (Lawrence Livermore National Lab) -- Long term evolution of low amplitude resonances in PMU data<br>• Kai E. Van Horn, Alejandro D. Dominguez-Garcia & Peter W. Sauer (University of Illinois at Urbana Champaign) -- Measurement-based real-time security-constrained economic dispatch<br>• Tianying Wu, S. Arash Nezam Sarmadi, V. Mani Venkatasubramanian & |

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| | Ananth Kalyanaraman (Washington State University) and Alex Pothen (Purdue University) -- Fast SVD computations for synchrophasor applications<br>• Guanqun Wang & Chen-Ching Liu (Washington State University) and Mahendra Patel & Evangelos Farantatos (Electric Power Research Institute) -- PMU-based monitoring of power system dynamics<br>• Meng Wang, Joe Chow, Pengzhi Gao, Xinyu Tony Jiang, & Yu Xia (Rensselaer Polytechnic), Scott Ghiocel (Exponent), Bruce Fardanesh & George Stefopolous (New York Power Authority), Yutaka Kokai & Nao Saito (Hitachi) and Michael Razanousky (New York State Energy Research & Development Authority) -- A low-rank matrix approach for the analysis of large amounts of power system synchrophasor data<br>• Ruichao Xie & Dan Trudnowski (Montana Tech) -- Propagation properties of forced oscillations<br>• Ruichao Xie & Dan Trudnowski (Montana Tech) -- Distinguishing features of natural and forced oscillations<br>• Lingwei Zhan & Yilu Liu (University of Tennessee Knoxville) -- Universal grid analyzer development<br>• Lin Zhu, Hesen Liu, Zhuohong Pan, Feifei Bai & Yilu Liu (University of Tennessee Knoxville) and Evangelos Farantatos, Mahendra Patel & Navin Bhatt (Electric Power Research Institute) -- Oscillation damping control design using measurement-based transfer function model |

| **Tuesday, March 24, 2015** | |
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| 7:30 - 8:00 am | **Refreshments and networking** |
| 8:00 - 8:40 am | Task Team updates |
| 8:40 - 10:30 am | **Research presentations session 2 -- DOE-sponsored research**<br>• Development of a comprehensive software suite for stability monitoring and analysis based on synchrophasor measurement -- Jian Ma & Scott Feuerborn (Burns & McDonnell)<br>• Delivering near real-time phase angle deltas using Inter-Control Center Communication Protocol (ICCP) -- Dan Brancaccio (Bridge Energy Group for Peak RC)<br>• Direct non-iterative state estimator (DNSE) demonstration project -- Dino Lelic (Quanta Technology)<br>• PG&E synchrophasor applications demonstration and deployment -- Vahid Madani (PG&E)<br>• Phasor simulator for operator training (PSOT) -- Bill Blevins (ERCOT) and Frank Ashrafi & Jim Dyer (Electric Power Group) |
| 10:30 - 10:45 am | **Break (refreshments and networking) -- sponsored by PingThings** |
| 10:45 - 12:00 pm | **Research presentations session 3 -- IT and Networking Advances**<br>• Eastern Interconnection Data-Sharing Network update -- Jim McNierney (EIDSN) (10)<br>• DNMTT Networking Systems Survey results -- Bob Braden (University of Southern California-ISI) (20)<br>• Energy DMZ as a model for NASPInet -- Dick Willson (Allied Partners) (15)<br>• GOSS: A middleware solution for flexible, interoperable and secure power grid applications – Sharma Poorva, Bora Akyol, Tara Gibson, Mark Rice & Craig Allwardt (Pacific Northwest National Lab), Selim Ciraci (Microsoft) and Ian Gorton (Carnegie Mellon University) (10)<br>• Towards more effective & resilient power apps exploiting better |

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| | communications and computation -- Dave Bakken (Washington State University) (10) |
| 12:00 - 1:00 pm | **Lunch (provided)** |
| 1:00 - 1:30 pm | **NASPI Software exchange**<br>• Meet the NASPI Software Exchange -- Alison Silverstein (NASPI)<br>• NASPI software contributor elevator pitches:<br>o Ritchie Carroll – Project Alpha<br>o Ren Liu – PMU Animation Software<br>o Kevin Jones – Synchrophasor Analytics<br>o Pavel Etingov – Frequency Response Analytics Tool<br>o Greg Zweigle – SEL SynchroWAVE Event 2015 |
| 1:30 - 3:10 pm | **Research presentations 4 -- Renewables plus**<br>• Making sense of synchrophasor data for utilities (SynchroVIEEU Project) -- Dora Nakafuji (Hawaiian Electric), Greg Zweigle (Schweitzer Engineering Laboratory), Matthew Shawver (Referentia Systems) and Ronald Davis (DNV GL)<br>• Oscillations monitoring and tie-line bias control with high penetration of PV systems using PMUs – Ganesh K. Venayagamoorthy, Iroshani Jayawardene & Paranietharan Arunagirinathan (Clemson University)<br>• Data mining for oscillations from wind generators in ERCOT Interconnection using archived synchrophasor data -- Rajagopalan Sidharth, Sarma Nuthalapati & Bill Blevins (ERCOT) and Prashant Chandrasekar (Electric Power Group)<br>• Oscillatory dynamics and corridor stress in the Alberta electric system – Landon Worsfold, Geoffry Case, Murray Mueller (Alberta Electric System Operator) and Gurudatha Pai & Manu Parashar (Alstom Grid)<br>• An application of wide area synchrophasor-based transient stability status prediction -- Dinesh Rangana Gurusinghe (University of Manitoba & RTDS), Athula Rajapakse (University of Manitoba) and Dean Oullette & Rick Kuffel (RTDS Technologies) |
| 3:10 - 3:25 pm | **Break & refreshments** |
| 3:25 - 5:00 pm | **Research presentations 5 -- Distribution-level applications & cascades**<br>• Micro-synchrophasor measurements in distribution systems -- Alexandra von Meier (California Institute for Energy & Environment & University of California Berkeley), Emma Stewart (Lawrence Berkeley National Lab, Alex McEachern (Power Standards Laboratory), Reza Argandeh (CIEE) & Michael Andersen (UC Berkeley)<br>• The Distribution PMU: a scoping activity -- Mark Buckner & Travis Smith (Oak Ridge National Lab), Jeff Dagle, Harold Kirkham & Frank Tuffner (Pacific Northwest National Lab), Joe Eto & Emma Stewart (Lawrence Berkeley National Lab) and David Schoenwald (Sandia National Lab)<br>• New distribution µPMU technology for low cost (fully non-intrusive) installations -- Greg Wolfe & Margaret Paietta (Fischer Block)<br>• Wide-area distribution synchrophasor system -- Greg Zweigle (Schweitzer Engineering Labs)<br>• Advancements in the real-time simulation of large active distribution systems for PMU testing -- Christian Dufour (Opal-RT)<br>• Update from the IEEE PES CAMS Task Force for the Understanding, Prediction, Mitigation and Restoration of Cascading Failures – Milorad Papic (Idaho Power) & Marianna Vaiman (V&R Energy) |
| 5:00 pm | Adjourn |