Western Electricity Coordinating Council

Western Interconnection Synchrophasor Program (WISP)

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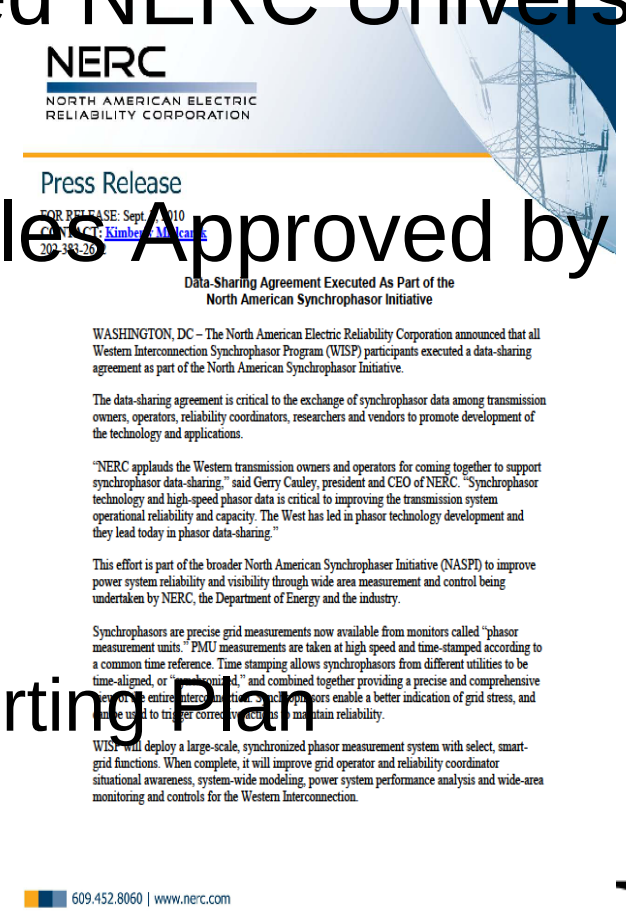
NASPI Work Group Meeting

October 5-6, 2010

Start with Some Good News!

- 9/9 Partner Entities Signed NERC Universal Data Sharing Agreement
- WISP Planning Deliverables Approved by DOE
  - Project Execution Plan
  - Cyber Security Plan
  - Metrics and Benefits Reporting Plan



NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Press Release

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Data-Sharing Agreement Executed As Part of the North American Synchrophasor Initiative

WASHINGTON, DC – The North American Electric Reliability Corporation announced that all Western Interconnection Synchrophasor Program (WISP) participants executed a data-sharing agreement as part of the North American Synchrophasor Initiative.

The data-sharing agreement is critical to the exchange of synchrophasor data among transmission owners, operators, reliability coordinators, researchers and vendors to promote development of the technology and applications.

"NERC applauds the Western transmission owners and operators for coming together to support synchrophasor data-sharing," said Gerry Cauley, president and CEO of NERC. "Synchrophasor technology and high-speed phasor data is critical to improving the transmission system operational reliability and capacity. The West has led in phasor technology development and they lead today in phasor data-sharing."

This effort is part of the broader North American Synchrophaser Initiative (NASPI) to improve power system reliability and visibility through wide area measurement and control being undertaken by NERC, the Department of Energy and the industry.

Synchrophasors are precise grid measurements now available from monitors called "phasor measurement units." PMU measurements are taken at high speed and time-stamped according to a common time reference. Time stamping allows synchrophasors from different utilities to be time-aligned, or "synchronized," and combined together providing a precise and comprehensive [illegible] entire interconnection. Synchrophasors enable a better indication of grid stress, and can be used to trigger corrective actions to maintain reliability.

WISP will deploy a large-scale, synchronized phasor measurement system with select, smart-grid functions. When complete, it will improve grid operator and reliability coordinator situational awareness, system-wide modeling, power system performance analysis and wide-area monitoring and controls for the Western Interconnection.

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Program Participants

- WECC Sponsorship and Delivery Management
  - Mark Maher, WECC COO mmaher@wecc.biz
  - Linda Perez, WECC Managing Director of RC & IT lperez@wecc.biz
  - Vickie VanZandt vrvanzandt@msn.com
  - Mike Bianco mbianco@bridgeenergygroup.com
  - Jim Dow ptmjim@gmail.com
- Partners
  - 9 cost share partners; 11 additional participating entities throughout West
- Academic and Other
  - Montana Tech, the University of Wyoming and Pacific Northwest National Laboratory

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WISP Funding Overview

- 5-Yr Grant (3-yr deployment objective) – WECC awarded $54M
- Total program cost $108M
- $54M in cost share match from nine partner entities including WECC
- Largest of 10 Synchrophasor Projects

Cost Share Partners / PMUs & PDCs

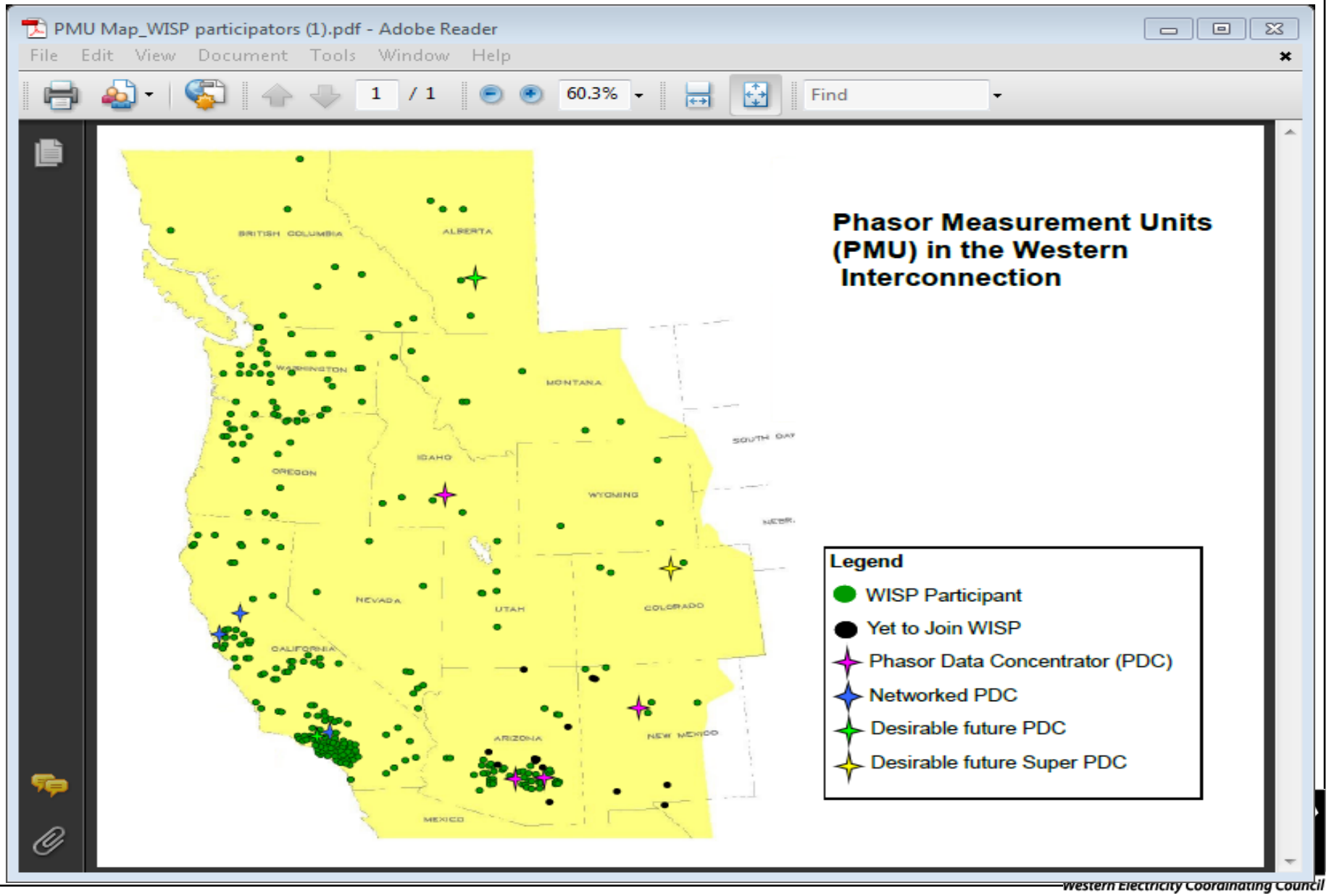
- System initially sized for ~300+ PMUs, 2400 measurements
- Approximate counts below; dependent on final architecture
- Some devices outside WISP Scope

Cost Share Partner Estimates	PMUs	CC PDCs
Bonneville Power Administration	80-90	4
California ISO/California Energy Commission	NA	4
Idaho Power Corporation	8	2
NV Energy	8	1-2
Pacific Gas & Electric (redundant system)	120 - 140	6
PacifiCorp	10	2
Salt River Project	60	2
Southern California Edison	60-70	4
WECC	NA	4

Additional Participants - 8 of 11 Have Accepted

Additional Participant Estimates	PMUs	PDCs
Alberta Electric System Operator	7	1-2
Arizona Public Service	TBD	TBD
British Columbia Hydro	12	1-2
El Paso Electric	TBD	TBD
Los Angeles Department of Water & Power	11	1-2
Northwestern Energy	3	1-2
Public Service of New Mexico	4	1-2
San Diego Gas and Electric	2	1-2
Tri-State G&T	4	1-2
Tucson Electric	TBD	TBD
Western Area Power Admin	8	1-2

PMUs Planned in the West – 300+



Project Infrastructure Scope

- 300+ PMUs, 2400 signals, 50+ PDCs
- New Wide Area Network
  - Managed telecommunications network for synchrophasor data transport throughout the West
  - Aligns with NASPInet specifications
- Field Communications
  - Partners extension of local area and campus networks
- Data Center IT Infrastructure
  - Four new IT environments planned at WECC
- Phasor Gateways
  - More planning and collaboration w/NASPI is required

PDCs

- Redundant configuration planned at each partner and each WECC RC
- Key functionality includes
  - Concentration (aggregation and time alignment) of C37.118-2005 frames
  - Initially able to support approximately 300 PMUs, 2400 synchrophasors, 300 frequency and frequency rate of change values
  - Scalable up to 120 frames/sec
  - Tools to assist in configuration and maintenance and operation

WISP Applications Scope

- Wide Area Situational Awareness
- General and rate-of-change monitoring & alarming
- Phase angle monitoring
- Voltage stability
- Oscillation detection, energy, damping estimate and mode meter
- Wide Area Shared View
- Event location & analysis
- System performance baselining
- System probing test monitoring
- State Estimation/Model Validation

COTS Approach – Minimal Customization Planned

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WISP Cyber Security Guidelines

- WECC and partners will comply with all applicable cyber security standards
  - Minimum standard is NERC CIP
  - Leveraging NIST 7628 Risk Assessment Framework
  - Leveraging Department of Homeland Security: Cyber Security Procurement Language for Control Systems
- WECC and partners collaborating on an end to end synchrophasor system risk assessment
- Partners to determine how their synchrophasor equipment will be deployed and secured within the framework of the risk assessment and mitigating controls
- WECC may refuse data from a source that is deemed to present an unacceptable cyber security risk

Data Communications Approach

- What are you doing to assure interoperability?
  - Leveraging current data transport standards – C37.118-2005
  - Work with NASPI PSTT on naming conventions
  - Define and develop a PMU / PDC Registry
- How will you test the effectiveness and security of your synchrophasor communications system?
  - Coordinated testing with participants
    - Connectivity testing
    - Data validation testing
    - Load and performance testing
    - High-availability testing
    - Validation of end to end security controls

What else should we know about your project?

- What are the most challenging things about your project?
  - End to end cyber security approach
  - Balancing spend and reimbursement curve
  - Interoperability validation
  - Testing and certification
- What are the biggest challenges in resolving architecture for communications and data flow?
  - Concerns about original partner budget commitments not covering high-availability and critical asset implementation
  - Predicting C37.118 and 61850 harmonization timeline and migration strategy

What else should we know about your project?

- Other useful information to share?
  - PG&E Approach for Proof of Concept and Validation
  - Collective Experience
- What can NASPI do to support your project?
  - Facilitate collaboration on phasor gateway development and implementation
  - Further define the implementation strategy for NASPInet – what do we collectively want to achieve next 2.5 years
  - Collaboration on Registry Specifications
  - PDC testing & certification requirements; PDC interoperability testing
  - Data archival requirements

Key Accomplishments

- DOE planning deliverables completed
- PMU placement criteria completed
- Draft business requirements completed
- Draft system architecture specifications completed
- Draft oscillation and detection requirements completed
- WAN specifications completed
- WAN, PDCs and Applications RFI efforts completed
- 8/11 additional entities have accepted WECC's invitation to participate

Key Tasks in Progress

- WISP integrated schedule definition and critical path analysis
- Application and PDC RFP development
- WAN RFP development
- Cyber security requirements
- Oscillation detection design specifications
- WECC IT infrastructure technical requirements and test environment design
- WECC data center expansion design

Procurement Timeline – WAN Services

- Wide Area Network (WAN)
  - Expected to be a Managed Network solution
  - RFI responses from 10 vendors received in April
  - RFP planned for release this month (Oct)
  - Vendor selection scheduled for Dec/Jan

Procurement Timeline – PDCs & Applications

- PDCs & Applications
  - RFI responses from 12 vendors received in May
  - RFP scheduled to be issued in November
  - Vendors to Respond to All or Individual Components
  - WECC to Award to One or Multiple Vendors
  - Vendor(s) selection scheduled for next March

RC Infrastructure Timeline

- Data Center expansion
  - Vancouver, Wash. - February 2011
  - Loveland, Colo. - July 2011
- IT Infrastructure deployment
  - Test environment - April 2011
  - Dispatcher training environment - March 2012
  - Production environment - June 2012

Oscillation Detection, Oscillation Energy, Damping Estimate and Mode Meter Applications

- The West experiences four oscillatory modes, two of which (.25 and .4 Hz) produce significant reliability vulnerabilities
- Will produce better damping estimates as damping levels decrease, and will correlate high oscillation energy with mode identification to inform alarming levels
- Functionality provided by Montana Tech, the University of Wyoming and Pacific Northwest National Laboratory
- Moving from research to production grade by August 2012; prototype is on-line in test environment at BPA today

Voltage Stability

- West has voltage stability vulnerabilities in major load centers; high path loadings also produce voltage stability concerns
- Voltage stability will be addressed by a combination of measurement-based and model-based tools
- Voltage displays
  - Geographical view of voltage contours in the system
  - Voltage trends
  - Display reactive margin at a bus (estimated or calculated by model)
- Reactive Reserve tool
  - Calculate and geographically display dynamic and static reactive reserves

Voltage Stability – PV-Curves

- Determine and display
  - PV nose curves based on current topology
  - Operating point on the nose curve
  - Slope of curve (dV/dP) and margin to collapse point at operating point
  - Rate of change of slope as operating point moves
- Calculate PV curve for current operating state and contingency based on a state estimator model
- Alarm on slope, rate of change of slope and margin to collapse point

Power System Performance Baselining

- Establishing seasonal norms for phase angles
- Baseline system frequency response, distribution of governor response, and impact of wind generation on system frequency performance
- Baseline oscillation damping – mode frequency and damping, mode shapes, oscillation energy, detecting and fixing forced oscillations, benchmark system models
- Deploy engineering tool to detect and study grid disturbances and unusual system conditions – outages, oscillations, power plant control failures

Phase Angle Displays and Alarms

- Phase angles across an interconnection indicate transmission system stress
- Baseline studies will establish seasonal norms for phase angles in the West
- Phase angle displays present phase angle in relation to the limits and historic norms and recent trends (last 10-15 min)
- Alarms notify operators when phase angles exceed safe operating limits; decision support tools to be included

System and Component Model Validation

- Accuracy of system and component models affects the precision of safe operating limits determined by off-line studies
- Better models may allow relaxation or tightening of operating limits where appropriate
- Synchrophasor data is compared against simulated model behavior to make correction in model parameters
- Baselining of system behavior is used to identify areas where models may need to be improved or off-line studies need to be expanded

WASA Shared View

- Common views of west-wide reliability available to all participants
- Facilitates a simultaneous look at the same screens/ information by RCs and System Operators
- Western Interconnection and four regional views planned
- Features planned:
  - Selectable, pre-configured views
  - Mode meter display with the four primary WECC oscillatory modes
  - Reactive reserve display, pre-defined reactive reserve groups
  - Pre-defined trends for key facilities (to capture oscillations)
  - Alarm indicators to draw users attention