Power System Resiliency and Technology Role

Vahid Madani and Damir Novosel

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QUANTA TECHNOLOGY

Smart Solutions, Practical Results

Outline

- Reliability Improvement Programs
- Integrating Technology
- Interoperability Considerations
- Technology Example

Smart Grid Reliability Improvement Programs

- Proactive Customer Communications
- Comprehensive Equipment Replacement & Condition-Based Maintenance - transformers, breakers, conductor, switches,...
- Industry Leading Vegetation Management
- Outage Reductions – Wide area monitoring, protection, & control (synchrophasors, SIPS)
- Targeted Circuits and Zones
- Distribution Automation
- Smart Meter Outage Mgmt.
- Safety Improvement

How Do We Integrate Technologies?

Disaster Recovery and Remedial Action Schemes or SIPS

- Integration into existing IT and protection system Infrastructure
- Integration with neighboring utilities and their systems

Synchrophasor Technology

- Integration and data exchange requirements with neighboring systems, or Reliability Coordinators such CAISO or WECC
- Integration into EMS
- Integration into Enterprise Solutions
- Meaningful information / knowledge
- Standards (PG&E Internal, Interoperability amongst neighbors, and Industry)

Distribution Automation and Modularization

- Integration with transmission and customer meter services

Electric Vehicle and Distributed Generation Integration

- Operational constraints, visibility and control flexibility

Others

Integration Issues to Consider

Priority:	Where, what level and how to upgrade
Design:	Complexity, flexibility, redundancy and human interface
Operation:	Integration of DG, SmartMeter, PMUs, etc.: constraints, flexibility, visibility, control & public safety
Workforce:	Availability, capability, knowledge transfer and training
Converging Technology:	Sensing, IT, protection, automation, control, computing, data management
IT Capacity:	Legacy IT systems, architecture and processing limitation
Coordination:	Roles, responsibilities, and communication

Integration Lessons Learned

- Include all stakeholders in development: engineering, protection, operations, maintenance, construction, IT, manufacturers, etc.
- Test, Test, Test – perform several "proof of concept" tests, including how it will integrate with legacy systems, and then pilot the design
- Standardize – "users" develop work procedures (operations, testing, troubleshooting, maintenance, etc.) prior to installation
- Training – Identify new technical skill requirements and establish comprehensive, hands-on training programs
- Make software program revisions and Human interface easy
- Data Management – who, what, when and where?

Interoperability Considerations

- **Standards**
  - Standards required [but not sufficient] for interoperability.
  - Standard conformance is precursor for achieving interoperability
- **Testing**
  - Both standards and implementation agreements are subject to interpretation and may include options, choices, or configurations.
  - Consistent testing and conformance assessment can verify performance and potentially interoperability - key to consistent interpretation of test results
  - Identifies the need for improvements to devices/system, as well as feedback for improving standards and implementation agreements
- **Life-cycle Management**
  - Life-cycle management, asset utilization, and revision control are all considerations affected by interoperability
  - Architecture interoperability needs to support system life-cycle management and asset utilization (long-term system deployment roadmap)

The Role of Conformity Assessment

- Standards are set to ease use of technologies
  - Validating device conforms to the applicable standards
  - Which options within are implemented for conformance purposes?
  - How are the Standards' requirements interpreted?
- Conformance Test
  - Does implementation conform to the standard?
  - What is the behavior in error situations?
  - Data (test results) versus interpretations (assessment)!
- Conformance assessment
  - Key to consistent interpretation of test results
    - Different products tested by same test facility
    - Different tests entities
    - Same product tested by the original test facility or by others
  - Feedback process for improving and maturing standards

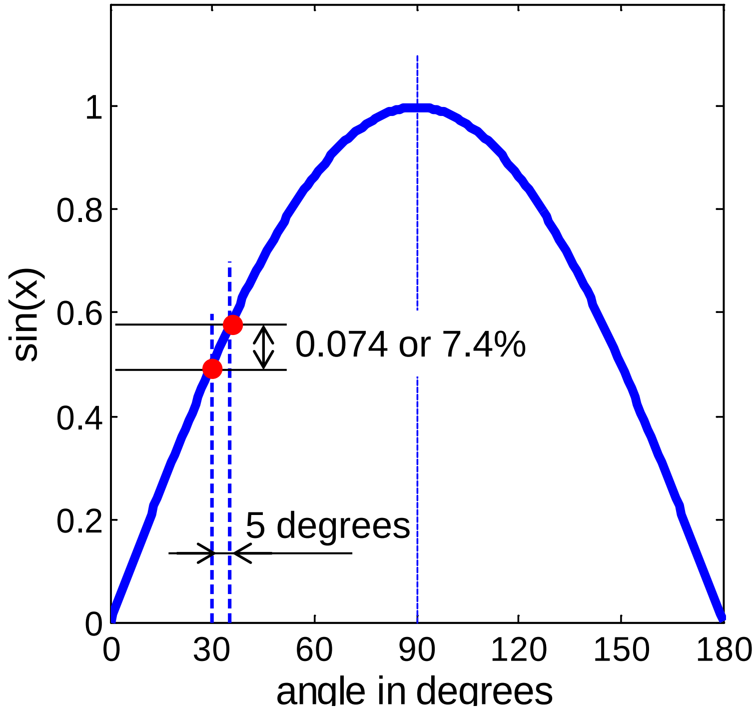
Perspective of Key Stakeholders

- Levels the playing field
  - The end-user / utilities know what to expect
  - The manufacturers know what is expected of them
- Requiring a Certified Product from a vendor
  - Vendor makes the investment as a qualification cost
  - Cost is spread over all sold licenses of the product, with reduced overall cost due to avoiding the need for re-tests for various end-users.
  - Early discovery of problems avoids dealing with unexpected behaviors during installation and over project life cycle
  - Vendor and User save dollars and time in Operation & Maintenance
- In the absence of an industry level Conformance Assessment, end-users to establish internal programs
  - PG&E Proof-of-Concept (POC) Facility for Synchrophasor systems
    - Significant cost
    - Helped identify gaps and mature/develop Guides and Standards

Implications of Phasor Measurement Quality

- Level of accuracy requirements is highly related to applications
- For monitoring, both amplitude and phase errors would result in false alarms.
- For special protection, amplitude and phase errors would result in false arming.
- For state estimation, small phase error may result in large discrepancy in power flow.
- For control, phase error (time delay) leads to unexpected control output, and thus unexpected (usually deteriorated) control performance

→ Characterization and calibration are important to ensure phasor quality.



Source: NASPI – PSTT

Pacific Gas and Electric Company

Why Increased Emphasis for Conformance?

Pacific Gas and Electric Company

What has changed in the recent years?

- Increased emphasis on the reliability and the availability of the electric power
  - Increased deployment of power network monitoring, protection, and control
- Wide-area Advanced Warning Systems
  - Requires consistent measurement over geographically diverse and far away locations
  - PMU conformance test will help ensure measurement consistency
- Baselining and use of historic data for extracting patterns
  - Requires consistent measurements over time
- Fast changing technology increased cost for internal conformance testing
  - Power companies traditionally managed conformance of their requirements using internal standards and internal testing (internal qualifications)
  - Increased demand on "overall" system performance, as opposed to discrete components
  - Many companies don't have internal resources to qualify newer technologies
  - With fast changing and increased rate of technology introduction, the resources (both skillsets and costs) required for internal qualification are increasing
  - Accordingly, pooling resources and use of external conformance assessment programs are attractive (sometimes the only practical solution)

Proof of Concept (POC) Facility

Instrumental in gathering the knowledge to provide the industry with direction and a fast track process for maturing the standards such as the IEEE C37.118.2, C37.238, C37.242, C37.244, and IEC-61850-90-5

- Risk management: Identifies and remedies product and system integration issues
- A conduit to the industry standards
- Tests have resulted in:
  - Identification of standards' gaps
  - Remedied integration issues with potential
    for serious delays during field installation
- Fine tuning applications for functionality and performance
- Transition from development to operation for training future users

Synchrophasor Standards Lessons Learned - PC37.242 and PC37.244

- **Configuration commands from control center**
  - To configure synchrophasor network from control center via synchrophasor protocols.
- **Requesting recent data**
  - Destination PDC to request recent data, if lost during UDP transmission.
- **Using a reliable mechanism for one time messages**
  - One time messages such as commands, status to use TCP vs UDP.
- **Interpolation vs. real data**
  - Data quality flags to indicate real/calculated data.
- **Up- and down-sampling issues**
  - Challenges with interpolation and aligning data with different rates / different filters..
- **Data Diagnostics**
  - Devices to provide statistics / diagnostics for the data, to allow troubleshooting.
- **Configuration sequence**
  - The sequence of configuration files exchange on PMU Power down / up to be clarified.
- **Configuration validation**
  - Configuration files should be stored and compared with newly received to validate changes.
- **Effect of filtering on M class data**
  - Filtered / interpolated data may or may not preserve the M class data quality.
- **Time quality information**
  - Some clocks do not include time quality bits in 1588/C37.238 and/or IRIG-B outputs
- **GPS Antenna**
  - Details on connection, compensation, splitters, power for active antennas

Realizing Benefits from Synchronized Measurement Deployment

- Present deployment is only “tip of the iceberg” for on-going reliability improvements and benefit realization
- Assure Life-cycle Quality of Measurements
- Baselining to Provide Norms: Historical data/Simulations
- Updates of Application and Design Roadmaps
    - System expandability as measurements and applications grow
    - System integration with other enterprise systems
- Deploying New Applications and Installing New PMUs
- Engineering and Operator Guidelines and Training
- Data and Information Exchange Across Interconnections

Finding a killer application!?

Conclusion

GOAL - Use Smart Grid technology to create a more efficient, sustainable and reliable electric system

Approach

- R&D Projects initiatives, e.g. EPIC – utility partnership
- Partnership with vendors, academia, consultants, standard organizations, …

CHALLENGES

- Effectively integrate Smart Grid technologies into the existing electric system
- Simplify the Human Interface and manage revisions
- Ensure an available workforce that can support the fast moving technology
- Industry cooperation on common platforms and standards