Paving the Way for Smart Grids through Measurements and Standards

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Energy and Climate Partnership of the Americas Ministerial Meeting

September 7, 2017

Energy Independence and Security Act

NIST has *"primary responsibility to* ***coordinate*** *development of a* ***framework*** *that includes protocols and model standards for information management to achieve* ***interoperability*** *of smart grid devices and systems…"*

External Coordination: Frameworks

NIST Special Publication 1108

NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0

Office of the National Coordinator for Smart Grid Interoperability

National Institute of Standards and Technology • U.S. Department of Commerce

2010

NIST Special Publication 1108R2

NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 2.0

Office of the National Coordinator for Smart Grid Interoperability,
Engineering Laboratory
in collaboration with
Physical Measurement Laboratory
and
Information Technology Laboratory

National Institute of Standards and Technology • U.S. Department of Commerce

2012

This publication is available free of charge from http://dx.doi.org/10.6028/NIST.SP.1108r3

NIST Special Publication 1108r3

NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 3.0

Smart Grid and Cyber-Physical Systems Program Office
and Energy and Environment Division,
Engineering Laboratory

in collaboration with
Quantum Measurement Division,
Semiconductor and Dimensional Metrology Division,
and Electromagnetics Division,
Physical Measurement Laboratory
and
Advanced Network Technologies Division
and Computer Security Division,
Information Technology Laboratory

http://dx.doi.org/10.6028/NIST.SP.1108r3

National Institute of Standards and Technology
U.S. Department of Commerce

2014

An integrated Approach to Smart Grid Testing

- Performance + interoperability
- Multidisciplinary – combines expertise of different NIST projects and laboratories to work together on multiple aspects of Smart Grid R&D
  - high-power inverters and power conditioning systems
  - microgrid operational interfaces
  - PMUs, smart sensors
  - cybersecurity
  - advanced networks
  - smart meters

NIST Smart Grid Testbed

SGIP Smart Grid Interoperability

NIST Measurement Science

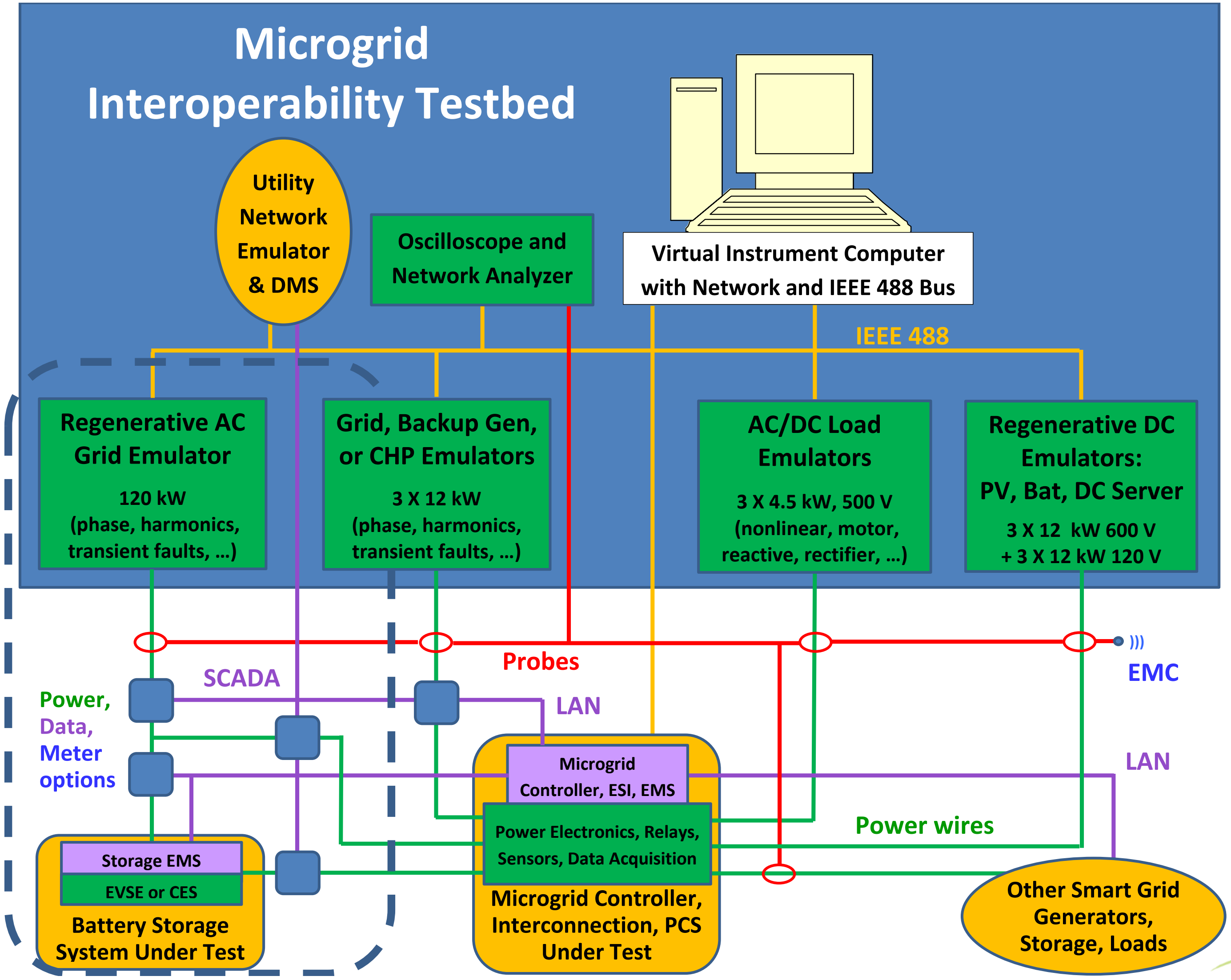
DOE/DOD Labs, Test & Certification

ESI, EMS, Microgrid & Storage functions

IT Networks, Cyber Security, EMC, Sensors & Smart Meters

Power Electronic Interconnection Equipment

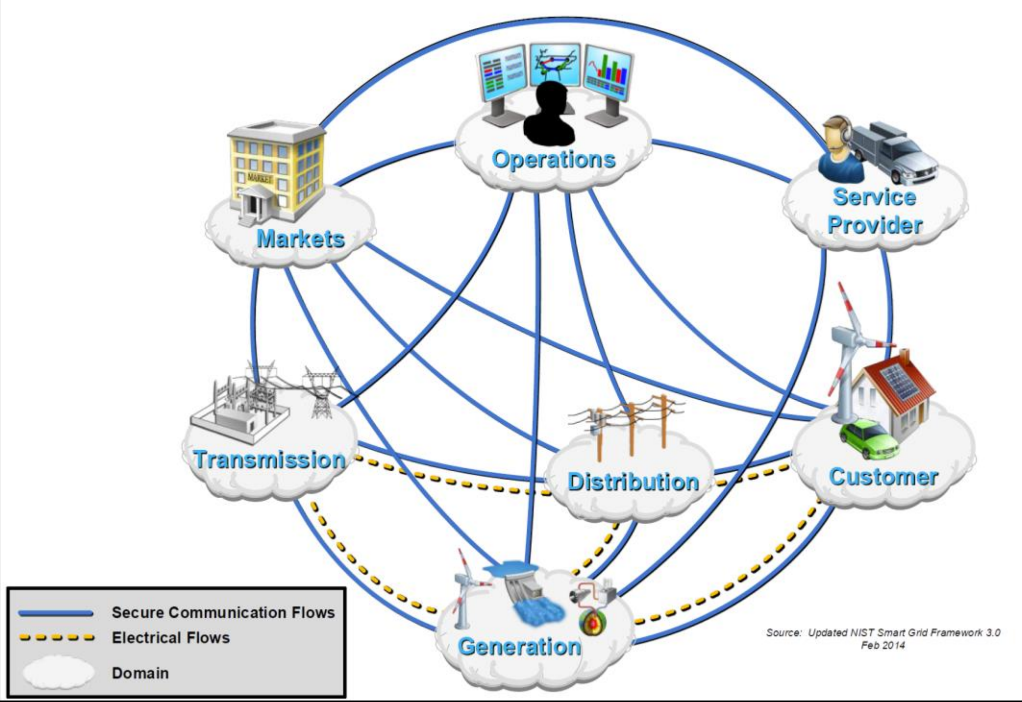
Grid-Interactive Microgrid, DER & Smart Appliances

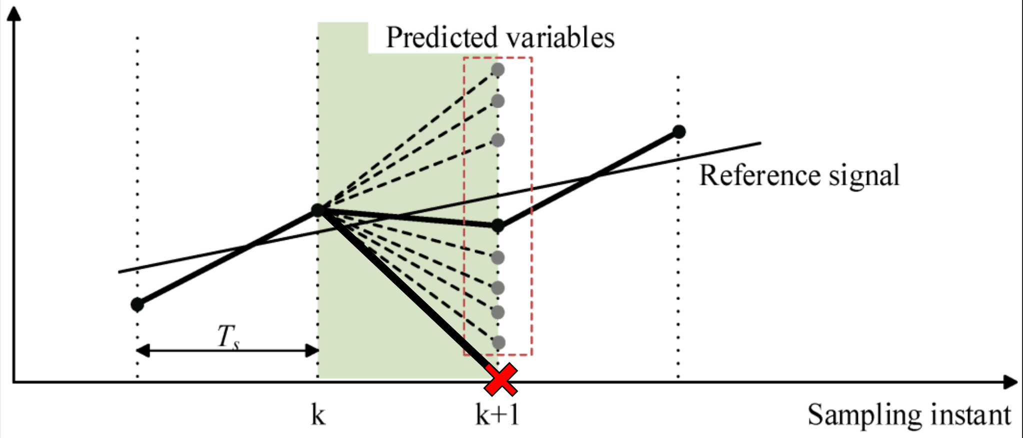


Allen Hefner (NIST)

Uncertainty is a dominant challenge

- **Grid is highly distributed and complex**
  - —Increasing diversity of device, resource, and control
- **Uncertainty is growing**
  - —Growing numbers and increasing dynamics of variables lessen the likelihood of well-behaved, predictable system
  - —Legacy models and tools incapable of addressing the growing uncertainty
- **Progress needed across multiple dimensions**
  - —New grid models
  - —Networked measurements
  - —Diversified applications
  - —Expanding customer base



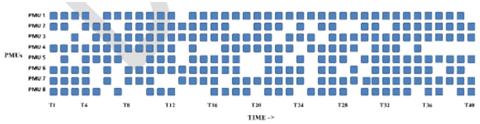


Synchrometrology for the electric power system

- Synchrometrology is the scientific study of time-synchronized measurement.
- The NIST Synchrometrology Lab supports U.S. competitiveness and economic security through research and standards development in the field of time synchronized measurements in electric power generation, transmission, and distribution.
  - —Co-funded by Departments of Commerce and Energy.
- Ongoing Projects:
  - —Reducing measurement uncertainty in preparation for future requirements.
  - —Collaborate in the assessment of the impact of errors in synchronized measurement on power system applications.
  - —Collaborate in development of voluntary consensus standards and guides:
    - IEEE Standards Association
    - International Electrotechnical Commission.
  - —Collaborate in the development of conformity assessment methods.

PMU Application Requirements

- Two years ago, NASPI formed the PMU Applications Requirements Task Force
  - —NASPI-wide, about 40 members




NASPI North American SynchroPhasor Initiative

NASPI-2016-TR-002
PNNL-25262

DRAFT

PMU Data Quality:

A Framework for the Attributes of PMU Data Quality and a Methodology for Examining Data Quality Impacts to Synchrophasor Applications

NASPI PMU Applications Requirements Task Force

November 2016
Draft 2

- NASPI, NIST, and PNNL collaborated on a white paper which is published by NASPI today. Provides guidelines and terminology for assessing application needs

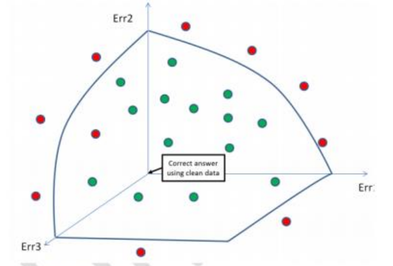
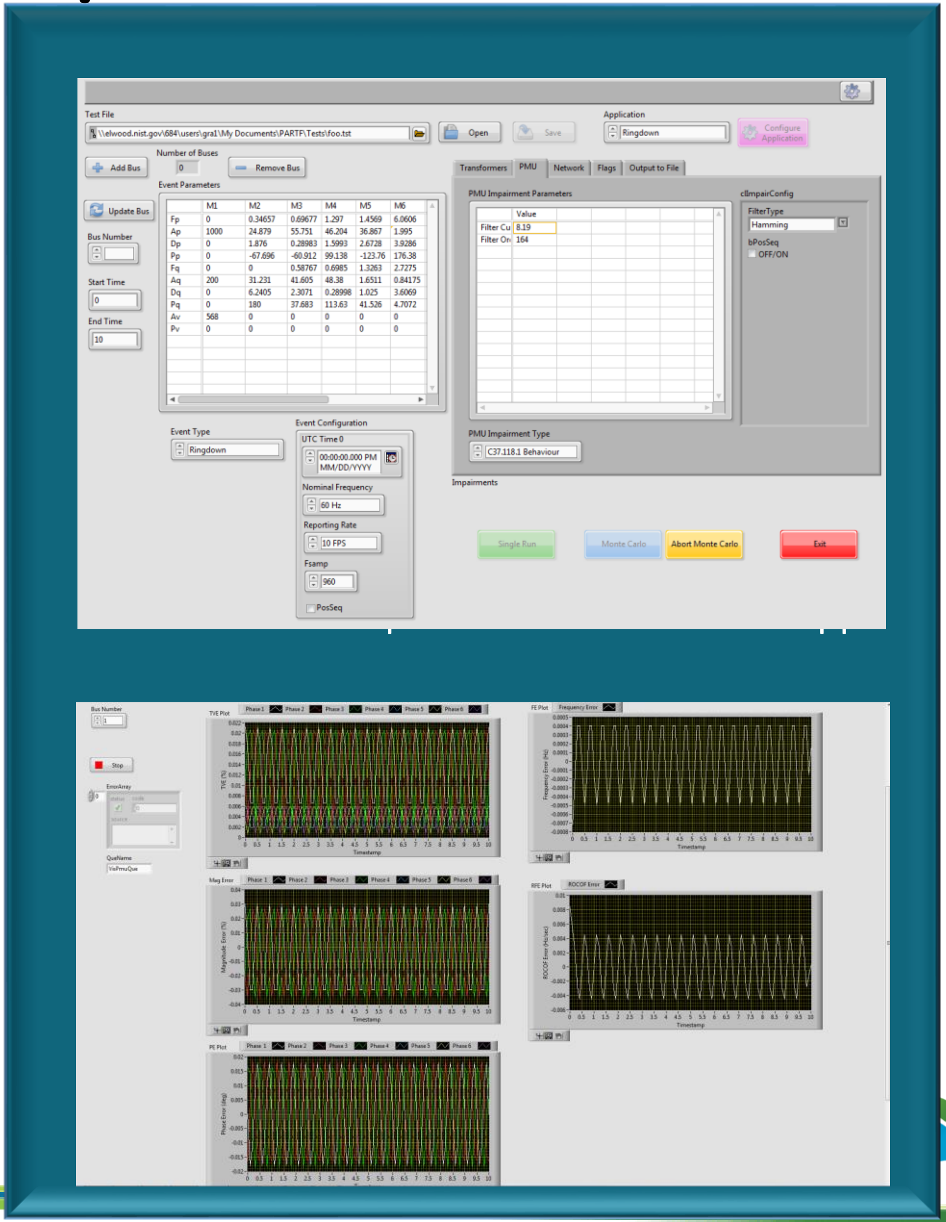


Figure 4-2: Application Performance Envelope for varying data errors relative to clean data

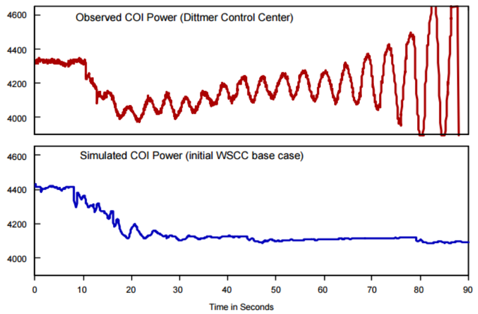
Colllaboration on PARTF development with:

INTI – Pablo Marchi

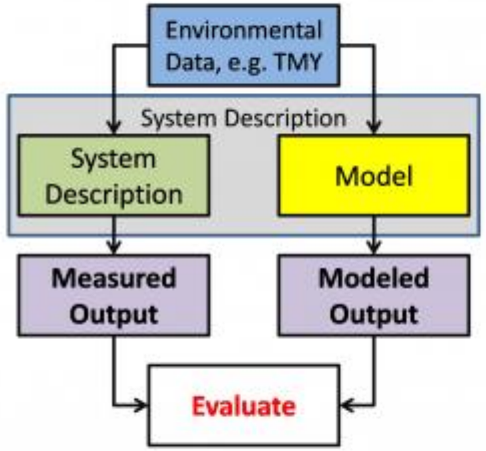
INMETRO – Marcelo Britto Martins.



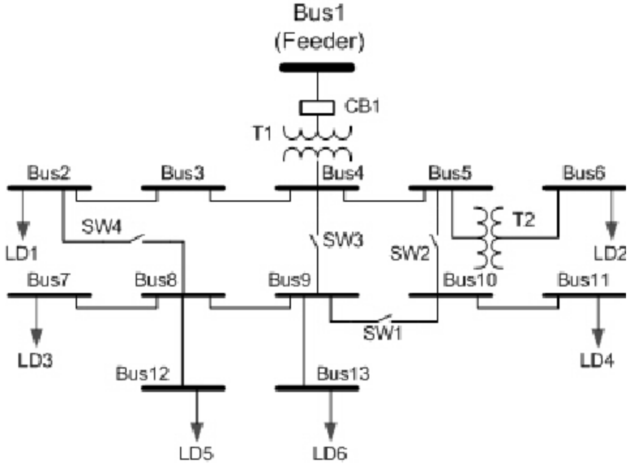
Model Validation



- Models are relied upon throughout the power system.
- We compare measurements of "actual values" against model predictions to help validate the model
  - —But how *actual* are the "actual values?"
    - *And how bad can they be before there is a problem?*
- NERC requires models to be validated
  - Many policies, reports and papers have been published on the topic.
- What is the impact of synchronized measurement error on model validation?



Credit: Sandia National Laboratory



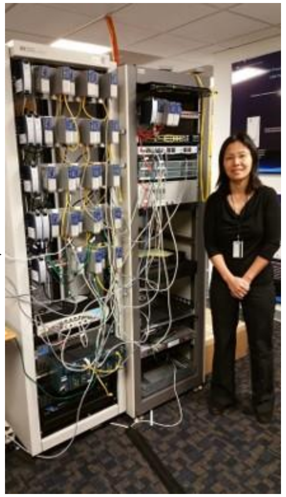
Conformity Assessment & Traceability

- NIST supports PMU conformity assessment by establishing traceability for IEEE ICAP Conformity Assessment Program

Yi-hua Tang, Josephson Array and Zener Diode

Richard Steiner, Multimeter Calibration System

Steve Jefferts and Tom Heavener, NIST-F2 Cesium fountain atomic clock



Ya-Shian Li-Baboud, Timing Source Calibration

Jerry Stenbakken calibrating The PMU Calibrator Calibration System

Allen Goldstein, taking a break from calibrating calibrators

THE VALUE PROPOSITION FOR SYNCHROPHASOR TECHNOLOGY

- methodology for identifying and estimating the benefits of using synchrophasor technology to enhance grid operations and planning
- calculate and sum the value of these monetary and non-monetary benefits over time
- Cost savings are derived from:
  - congestion reduction,
  - reduced labor costs associated with reduced forensic analysis
  - model validation
  - deferred or avoided capital acquisition
  - Reduced outages through oscillation detection and actions to restore grid stability
  - identifying potential equipment failures and fixing them before they occur
  - congestion reduction, reduced labor costs associated with reduced forensic analysis, and model validation
- Environmental benefits due to increased amount of intermittent renewable energy that can be accommodated by the grid

Thank you!