Distribution PMU Scoping Study

NASPI

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Distribution PMU?

- About 1600 PMUs installed in transmission/generation
- Have improved situational awareness
- Have improved system models
- and started people thinking . . .

- What about doing the same for distribution?

Distribution Scoping Study

Led by Lawrence Berkeley National Laboratory, a group of national labs

- Oak Ridge National Laboratory
- Pacific Northwest National Laboratory
- Sandia National Laboratories

came together to perform a “scoping study”

The group studied applications and feasibility.

Here’s some of what was found

Method

- How (and for what purposes) does **monitoring** presently take place in distribution systems?
- Are present approaches to distribution system monitoring **adequate**?
- If not, why not, and what **role(s)** might **PMUs** play in addressing present inadequacies?
- Do PMUs represent a **superior approach** compared to other alternatives?

And finally

- **What**, if anything, should the U.S. **Department of Energy** (DOE) do to change the present state of affairs?

Challenges in distribution

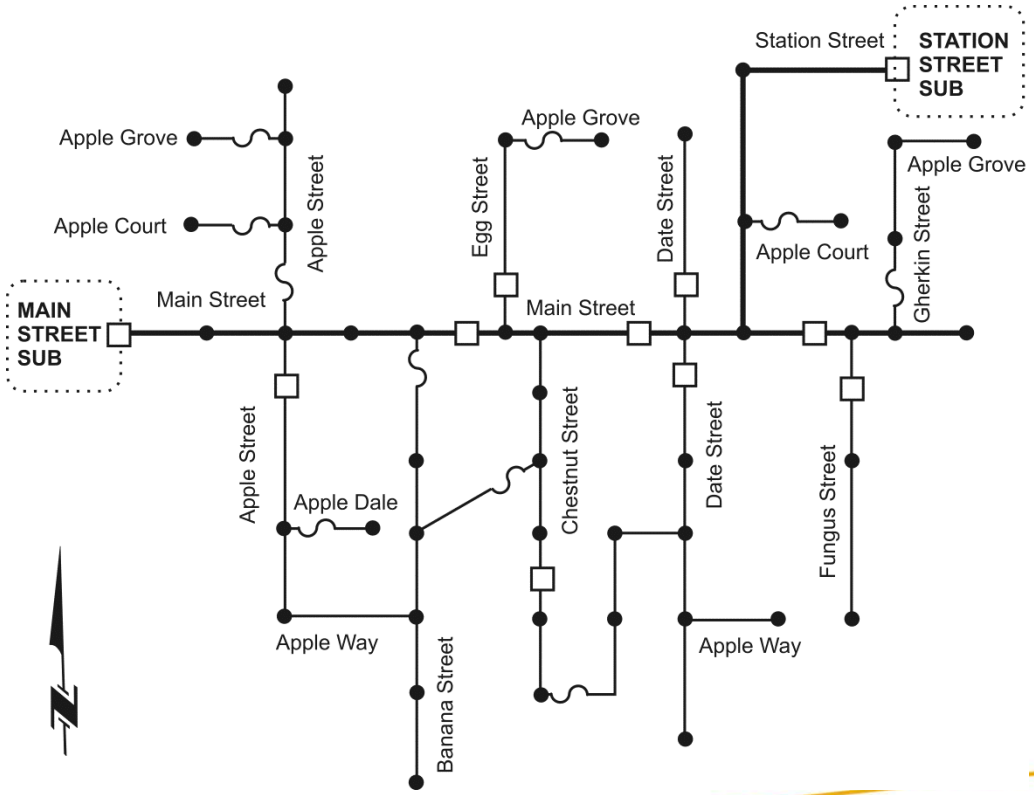
- Customer expectations getting tougher
- More DER[1]
  - Power flow tidal
  - Can trip off, causing frequency or voltage problems
  - Unanticipated loading
- Load character changing

To address how PMUs might “play into” the situation, we looked at several Case Studies

[1] Distributed Energy Resources

Use Case 1

- System Reconfiguration to Manage Power Restoration



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Use Case 2

- Planning and Modeling Requirements Associated with High DER Penetration
  - Model validation/calibration
  - Observe grid evolution
  - SCE – pilot scheme
  - SMUD and HEC – solar irradiance
  - Lack of standardized models and data formats
  - CIM?

Use Case 3

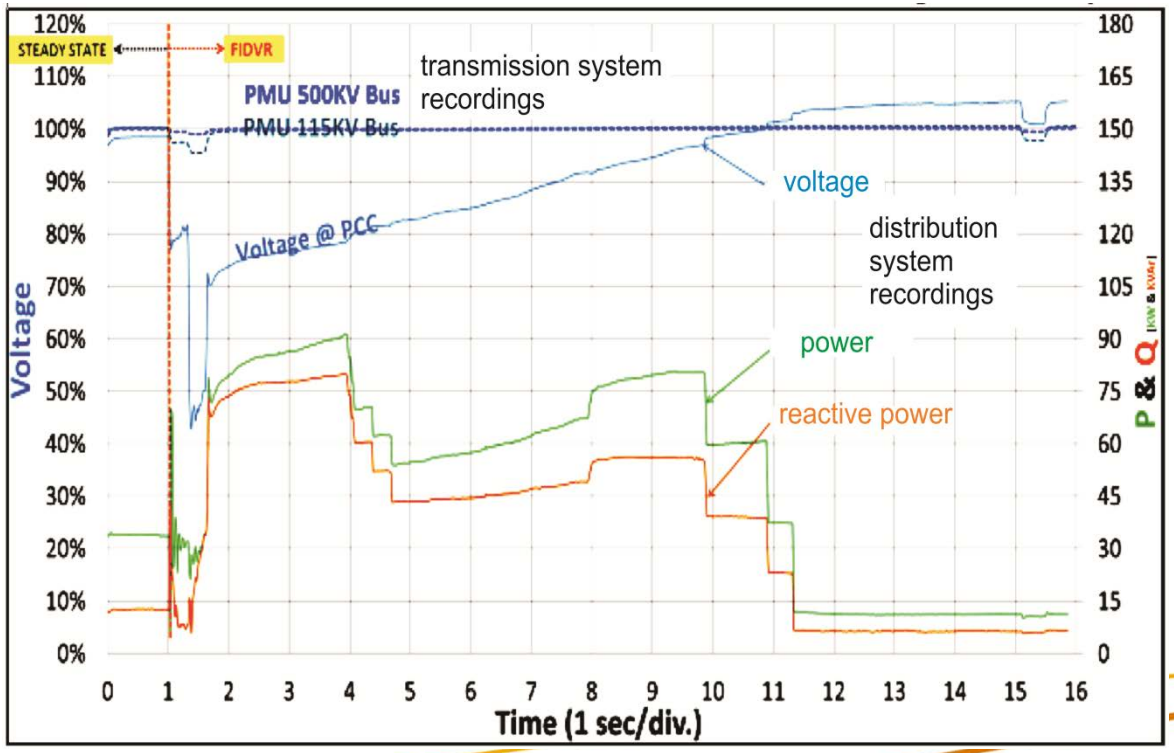
- Voltage Fluctuations and Low- and High-Voltage Ride-Through Associated with DER
  - Validate physical network
  - Voltage profiles
  - DER behavior
  - During faults

Use Case 4

- Operation of Islanded Distribution Systems
  - On large scale, New Orleans and Gustav
  - On smaller scale, take advantage of PV, small hydro etc
  - Lack of inertia suggests PMU speed-based role

Use Case 5

- Detection and Measurement of Fault-Induced Delayed Voltage Recovery (FIDVR)



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Toward future distribution PMU use cases (1)

- System Operation (normal)
  - 1. Active management of distributed energy resources
  - 2. Monitoring of the performance of the power system itself
  - 3. Control of voltage in the power system
  - 4. State estimation/power flow
  - 5. Reconfiguration of the system for loss reduction or system management
  - 6. Thermal and health monitoring of devices
- System Operation (faulted)
  - 7. Coordination with relaying (especially reverse power flow)
  - 8. Detection of outages and location of faults (including high impedance)
  - 9. Reconfiguration of the system following a fault
  - 10. Islanding (microgrid) detection and operation
  - 11. FIDVR detection and remediation
  - 12. Oscillation (forced or resonant) detection

Toward future distribution PMU use cases (2)

- Diagnostics and Modeling, (non-real-time functions)
  - 13. Power quality monitoring
  - 14. Model parameter validation
  - 15. Forensic analysis of events or abnormal system conditions
- Planning (also off-line, but has a specific and narrow purpose)
  - 16. balancing of loads for optimal system operation
  - 17. collecting load data for system planning
  - 18. analysis of dynamics (including state estimation)

Challenges in distribution

- Communication reliability
  - Customer telephone
  - Power line carrier/ripple
  - HF/VHF/UHF radio
  - Fiber optics
- Capital cost justification
  - Outage mitigation/reconfiguration
  - System monitoring
  - Voltage control
  - Meter reading
  - Loss optimization

Perspectives

- How Many PMUs?
  - One at each substation
  - One at each large DER
  - to get started . . .
- Communication Data Rates
  - Not large by Web or cell-phone standards
  - Yet large gaps exist in capability
  - Recommend a Traffic Study
- Communication Architectures
  - Unlikely similar to transmission
  - Open Source?
  - Need study
- PMU data Management Handling
  - Need to support multiple user roles
  - Be prepared for complexity!

Why and How DOE should be involved

National interests served by deployment of distribution PMUs

Appropriate roles for DOE R&D on distribution PMUs

- Not R&D: relatively mature technology
- Standards, Calibration
- Support Demonstrations
- Information sharing

Concluding comment

PMU produced some unexpected results in transmission

Expect the unexpected in distribution!