

# Using Synchrophasor Measurements to Detect Cyber Attacks on Distribution Grids

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Alex McEachern, Power Standards Lab

Alex@PowerStandards.com

Sean Peisert, Lawrence Berkeley National Lab

C.P. McParland, Lawrence Berkeley National Lab

**All errors attributed to Alex, all good ideas attributed to Sean and Chuck, due to Alex's scheduling problems making it impossible for Sean and Chuck to review.**

# Background on grid cyberattacks (1)

- Policy / political background
  - Hackers
  - State-sponsored adversaries
    - Avoiding acts of war
    - Requirements for “Proportional Response”
    - Detection / monitoring is critical element

This slide: Alex McEachern, not co-authors...

# Background on grid cyberattacks (2)

- Technical background
  - Self-destructive nature of the grid
    - It's a closer match with explosives factory than with internet
  - Types of attacks
    - Change the state of a switch, and lie about its state
    - Change the control algorithm in an intelligent grid device
  - Nature of engineers
    - Risk averse
    - Tests and rehearsals (aligns with policy)
    - Rehearsals must
      - have no functional effect (policy)
      - Be confirmable (technical)

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# Background on grid cyberattacks (3)

- Nature of cyber defense at utilities
  - "t present, focused on attacks against digital relays and specific commands, not necessarily the effects of those commands
  - Opportunity to add physics-based detection
    - Volts, amps, impedance, synchrophasors...
    - Physics detection informs & narrows bit/packet detection targets
  - Still in organization silos – how do we overcome?
  - Still focused on generation/transmission – how do we include distribution and end-use?

# Microsynchrophasors to detect distribution grid cyber attacks

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# Microsynchrophasors to detect distribution grid cyber attacks <sup>(1)</sup>

- Use dispersed microPMUs to report actual grid configuration
- Compare actual grid configuration to intended grid configuration
- Difference indicates possible attack
- Example: Source impedance of a distribution feeder, and substation bus-tie switch attack (patent issued)

# Microsynchrophasors to detect distribution grid cyber attacks (2)

- Use microPMUs to reverse-engineer the control algorithm parameters in intelligent grid devices
  - Continuous, automated reverse-engineering
  - Example: Tap changing regulators (upstream)
  - Example: Capacitor switches (downstream)
- If control parameters change abruptly, possible attack...

# A couple of notes (1)

- Algorithms rely on secure and reliable data communication
  - PMU data is always vulnerable to replay-type attacks
  - Secure microPMU communication is being actively investigated
  - Does not necessarily use the utility comms systems
- May not require synchrophasor measurements...
  - Very high resolution magnitudes, combined with precision time stamps, may be enough in some cases



# A couple of notes (2)

- The most useful information is seen during non-steady-state grid conditions.
- New technique to use ordinary, in-use distribution transformers for ultra-precise measurements of distribution-level microsynchronphasors (patent pending)

# A couple of notes (3)

- Practical availability of the concept, and the underlying technology
  - PSL has developed the sensor
  - LBNL & partners (ASU, PSL, etc...) have developed the methodology to detect capacitor bank switches + transformer tap changes
  - Ready to test at utilities – tests planned over next few months.

# Conclusions

- Distribution grid cyber attacks are happening.
- Detecting rehearsals of these attacks aligns with policy and technical goals, especially for attacks originated by state adversaries.
- Microsynchronphasor measurements show promise for detecting distribution grid cyber attack rehearsals.

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