NASPI Novel Applications for Synchronized Power Instrumentation

A DOE-EPRI Joint Initiative

IBR Performance Response and Analytics Monitoring (IPRAM) Task Force

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IBR Plant Performance Monitoring and Analysis White Paper

Purpose of the Task Force:

- Bring together industry experts and stakeholders to address the evolving challenges and opportunities in monitoring and analytics for inverter-based resources (IBRs).
- Develop best practices, share experiences, and foster collaboration to enhance the reliability and performance of IBR-rich grids.

Importance of the Whitepaper:

- Provides a comprehensive review of current IBR monitoring practices, recent events, and emerging technologies.
- Identifies critical gaps, lessons learned, and practical recommendations to guide industry standards and regulatory evolution.
- Serves as a reference for operators, policymakers, developers, and researchers navigating the transition to modern, IBR-rich power systems.

Broader Impact:

- Advances industry understanding and adoption of effective IBR monitoring strategies.
- Supports more reliable, flexible, and sustainable grid operations.
- Informs future standards, drives innovation, and shapes policy decisions that benefit the entire power sector and wider community.

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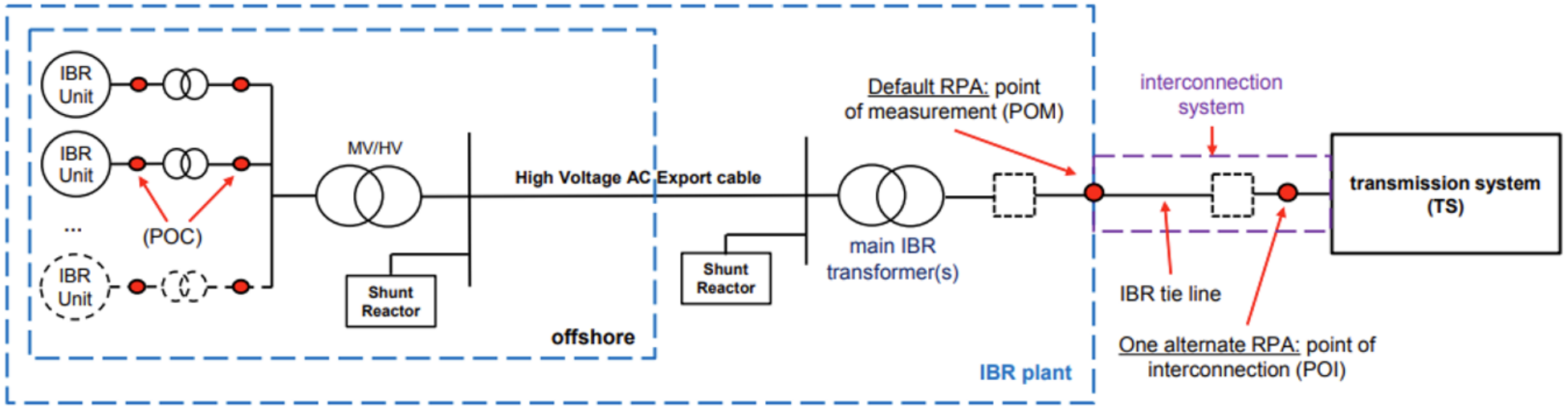
Outline

1. **Introduction**
   - Motivation for IBR monitoring
   - Monitoring considerations for IBR-rich grid
   - Standards for IBR performance monitoring
   - Present Limitations
2. **Existing and Demonstrated IBR Performance Monitoring and Analytic Method**
   - PMU-based monitoring
   - Synchro-waveform based monitoring
3. **IBR monitoring considerations**
4. **IBR monitoring and Analysis – Case Studies**
5. **IBR Performance Monitoring and Analytics Proposed Advanced Methods**
   - Interharmonics based analysis
   - Generator Scorecard
6. **Conclusions**
   - Topics of discussion for future

Monitoring Locations and Sampling considerations

- Distinctions between the point of measurement (POM), point of interconnection (POI), and reference point of applicability (RPA) for IBR performance requirements.
- Measurement Types and Sensors – effective monitoring requires multiple measurement types - namely phasor, waveform, and status signals
- Measurement Resolution – PMUs 30/60 frames per second, waveform measurement (in variations of kHz)
- Continuous vs triggered Data acquisition – setting of triggers to monitor waveform data. Only well-known signature of faults may not suffice for setting triggers.

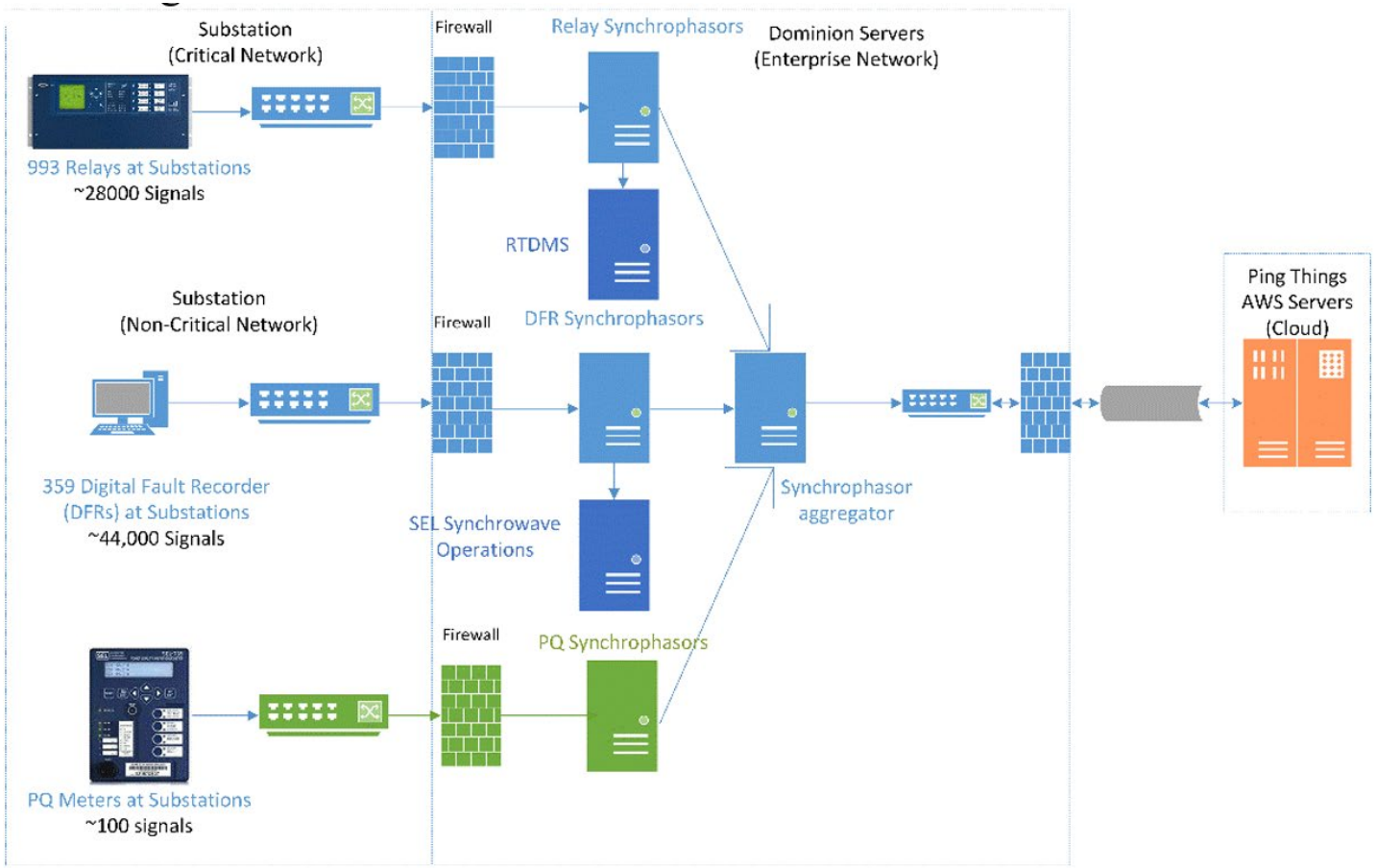


Monitoring considerations for IBRs – data channels

IBR channels to record beyond V and I in IBRs

1. **Fault ride-through and post-fault recovery**
    - LVRT/HVRT settings, momentary cessation flag (active/ cleared) with reason code if applicable
    - Current Limiter indicators, saturation flag.
    - Reactive injection command and limiter status (e.g., Q priority engaged, Q cap reached)
2. **Voltage control interactions/ oscillatory behavior**
    - PPC voltage control mode (V control / PF / Q setpoint), droop settings, deadbands
    - AVR/Volt-VAR function enabled and state
    - Inverter control mode (grid-following vs grid-forming; voltage regulation enabled/disabled)
    - Limiter state (Q limit reached; current limit reached; voltage loop saturation)
    - Device health flags that can affect control (communications loss to PPC)
3. **Frequency response events (FFR/PFR) and curtailment behavior**
    - Frequency-watt / droop mode enable and active state
    - Inverter control mode (grid-following vs grid-forming)
    - For grid following inverters - PLL lock status

Utility Use-cases for IBR monitoring



Simplified architecture of Synchrophasor Analysis Environment in Dominion Energy as of March 2025

Thank you

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Questionnaire

What are some of the current **applications that need IBR-monitoring** in your organization?

Examples:

- Oscillation detection.
- Monitor grid strength/ short circuit ratio.
- Others

What **IBR-performance related** challenges are you currently facing?

Examples:

- Baselining normal operations. Differentiating between normal and abnormal operations.
- Baselining performance standards for different types of inverters (GFM, GFL).
- IBR response to topological changes.

How are you tackling the challenge?

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Questionnaire

Can you share a successful **IBR-monitoring case study**?

Examples:

- Oscillation detection.
- Monitor grid strength/ shirt circuit ratio.
- Others

Seeking contributions on IBR-monitoring related case study

What **IBR-data related** challenges are you currently facing?

Examples:

- Visibility into DER behavior. General visibility of IBR behavior.
- Proprietary information
- Time-synchronization

How are you tackling the challenge?

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Questionnaire

What **methods and tools** are you using to process and analyze monitoring data?

- Potential use of AI for IBR monitoring? Anomaly detection?
- Other advanced methods in research or deployment?

Seeking contributions on state-of-the-art monitoring solutions

Other thoughts and suggestions?

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Timeline

Draft completed: September 2025

Ready for Publication: December 2025