IBR Model Verification Using Measurement Playback Method

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Outline

• EMT model verification using point-on-wave data playback
• EMT model verification case study
• Transient stability (positive sequence phasor) model verification using PMU data playback
• Conclusion and future work
EMT MODEL VERIFICATION (NEW IN 2023)

Using Point-on-Wave (POW) Data Playback

-- Developed by our intern Haoyuan “Harry” Sun from UTK
ISO-NE Business Needs

• ISO-NE has well documented EMT model requirements, defined in Planning Procedure No. 5-6
  – Model accuracy, usability, and efficiency

• ISO-NE is also in the process to adopt IEEE P2800-2022 for IBR performance requirements

• The accuracy of the EMT models is key to our Planning and Operations studies

• However, we lacked an automated tool and process to validate EMT models against field measurements following a grid disturbance
Problem Formulation

- IBR – (Radial Network) – System.
  - Similar to transient stability model power plant model verification.

*Assuming all internal controls are known and are properly modeled.
Software Platform and Data Source

- **Software**: PSCAD
  - Available playback modules:
    - File read, ideal voltage source

- **Data Source**: DFR or Equivalent
  - Point-on-wave data
  - High sampling rate preferred
Benchmark with Simulation Data

• Playback PSCAD simulation data

• Exact match shows that the EMT playback is a valid approach.
Technical Innovation

• Ramp-up methods
  – Challenges:
    • IBR may need a few seconds to ramp up
    • DFR data usually have a short time window leading to the disturbance
  – Solutions:
    • Option 1: Use a sync check relay
      – Ramp up against an “ideal voltage source”
      – Switch to the “DFR-data voltage source” after steady-state
    • Option 2: Append the POW data file
      – Add seconds of ideal POW data in the beginning
      – Final implementation uses an automated version of this method
Software Development

- Pro-version playback module
  - Packaged all playback functions into a module
    - Defined parameters
    - Wrote the script
  - Automatically assists the ramp-up
    - Outputs ideal voltage waveform during ramp-up period
    - Outputs DFR data from file after steady-state
Software Development (Con’t)

• Auto-version Playback GUI
  – Python GUI
  – Requires a one-time manual PSCAD case setup
    • Copy the pro-version module to the case
  – Calls PSSE to solve gen output
  – Calls PSCAD to setup and run playback
  – Plots results
EMT MODEL VERIFICATION
– Case Study
Case Info

• Subject IBR:
  – ~80 MW solar power plant

• Event:
  – Fault on a bus and tripped a station
    • A few buses away from the IBR
    – Several 115 kV lines were tripped

• IBR Performance:
  – Failed to ride-through the event
  – Output dropped to 20 MW (DFR)
  – Recovery took ~50 seconds (SCADA)
EMT Playback Results

Vanilla Playback w/ Original Model (Routine)

Chocolate Playback w/ Hypothetic Controls (Explore)
TS MODEL VERIFICATION (SINCE 2018)

Using PMU Data Playback

-- Developed by our interns “Marie” Meng Wu (ASU), Weihong Huang (NYPA)
APPMV – Online Service

- Automatic Power Plant Model Verification
  - Transient model
  - Playback PMU data during grid disturbances
  - Multiple model versions for each plant

- Automation
  - Runs 24*7 as a service
  - Runs PPMV for (real) grid disturbances
  - Sends out results through email
BPPMV – Offline GUI Tool

- Batch Power Plant Model Verification
  - One-click verifies multiple models for the same grid event
  - Enables detailed offline studies
Future Work

• Plan to add more IBRs into the TS model verification process
• Plan to compare/validate IBRs’ TS models with EMT models using field measurements following a grid disturbance
• Working with Compliance group to integrate both tools into the business process of model verification
Questions