# Real-Time Generator Parameter Validation Neeraj Nayak, Krish Narendra, Wenyun Ju, Vikram Chiluka

# Introduction

Models are extensively used for planning and performing system studies. PMU data can be effectively used to validate generator models without taking units offline. NERC reliability standards MOD-26 and MOD-27 require periodic validation of generators, governor and excitation system models. Electric Power Group (EPG) has developed Real-Time Generator Parameter Validation (RT-GPV) application to perform generator model validation using Synchrophasor Data in real-time.

### **Overview**

RT-GPV is a fully automated application that generates a detailed report with results from validating multiple generators whenever a significant event is detected. Results include identification of good and questionable models as well as comparison plots of PMU data and simulated data. Report also provides recommendations for key parameters to be considered for tuning and calibration.



# Benefits

- Synchrophasor Based Application for Real-Time Generator Model Validation
  - Can be Installed in Substation or in Control Centers
- Validate Models without taking units offline
- Automatically Identify Good vs Questionable Models without visual inspection
  - > 4 Criteria used for Quantifying Mismatch
- Efficient Process for Periodically Validate Models
  - Perform validation for each significant event
- Automated Process Save Time, Cost & Effort
- Validate Multiple Units Simultaneously for multiple events
  Verify Model Accuracy for different event conditions
- Recommendation of Key Parameters based on Sensitivity Analysis
  - Narrow down from several parameters to few key parameters for calibration
- Meet NERC MOD-26 and MOD-27 Reliability Standards

Generator Model Validation Report			
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# Key Steps

#### Input Data & Initialization (2 - 6)

- Get Input PMU Data
- Perform System Reduction
- Match Generator Initial Conditions in Simulation and PMU data

#### Validation Process (7 – 11)

- Run Hybrid Dynamic Simulation Using PMU measurements at Generator
- Use Voltage and Angle as Input, Compare P & Q response
- Quantify mismatch in PMU and Simulated data using various criteria accumulated error, first swing peak value and time, settling time etc.
- Automatically Identify Good vs Questionable Models
- Run Sensitivity Analysis and recommend key parameters for Questionable Models



- Automated report generated for each significant event
- Summary Report over long term performance of generator models
- Emailing Capability for Notification for severe mismatches



Time (Seconds)	Time (Seconds)	
—— Simulated Data —— PMU Data	Simulated Data PMU Data	

#### Reporting & Email (12 - 14)

- Generate Automated Report Individual and Summary Report
- Individual Event Report
  - Summary No. of Generators, List of Good & Questionable
  - Validation Results Comparison Plots for Simulated vs PMU
  - Sensitivity Results & Recommendation of Key Parameters
- Summary Report
  - Performance of Generator Models for events over several days, weeks, months
  - Identify Models requiring investigation and tuning
  - Identify events were Simulation did not match reality
- Word and PDF Format, Email

11	Calibration (optimization)	

#### Validation Results for G1 Reactive Power(Q) Validation - Event Active Power(P) Validation - Event 1 0.00 4.00 8.00 12.00 16.00 20.00 24.00 Figure 1. Active power & Reactive Power Comparison Active Power Comparison PMU measurement Simulated data Criteria Difference Accumulated Error 0.098927913 0.098927913 First Swing Peak Value 695.7307436 800.7687378 05.038 First Swing Peak Time 0.3 0.055 0.245 7.4449939 50499399 Reactive Power Comparison PMU Criteria Simulated data Difference measurement Accumulated Error 0.144973111 0.144973111 459.6365356 First Swing Peak Value 399.3055053 60.32 First Swing Peak Time 0.035 0.085 0.05 1.52499399 8.64499399 Settling Time Electric Power Group

# **Automated Reports**

**Real-time Generator Parameter Validation** 

Report

Event 1: March 23<sup>rd</sup>, 2019 3:15:22 PM Number of Generators

Result

Good

Threshold

0.025

0.1

umber of generator models validated Number of good generator models nber of questionable generator model

Generator

G3

G4

G5

**G6** 

G7

G8

G9

G10

G11

G12 G13

G14

Criteria

Accumulated Error Ratio

First Swing Peak Value

First Swing Peak Time(s

ettling Time(s)

Parameter Used for Quantifying Mismatch

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