Situational Awareness in Generation/System Control Centers of Synchronous Generators’ Damping Performance

P. Arunagirinathan, I. Jayawardene and G. K. Venayagamoorthy

Real-Time Power and Intelligent Systems Lab.
Clemson University, SC 29634, USA
http://rtpis.org

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gkumar@ieee.org
Outline

• Challenges
• Synchro-Visualization
• Modal Analysis
• Results
• Conclusion
Challenges

- Increasing risk of blackouts due to poorly damped low frequency rotor oscillations
- Increasing penetration level of renewable energy sources changes the power system operating conditions dynamically
- Power system stabilizer (PSS) performances are not monitored
- Lack of situational awareness (SA) at generation and system control centers
- No synchronized SA developed to assist generation and system control center operators
Synchro-Visualization

Phasor Measurement Unit (PMU)
- Synchronized wide area measurements
- Faster reporting rate

High Performance Computing (HPC)
- Fast computing and reliable data processing

System Control Center

Generation Control Center 1
Generation Control Center n

Phasor Data Concentrator (PDC)
Synchro-Visualization of Modal Analysis

Phasor Measurement Unit (PMU)

- Synchronized wide area measurements
- Faster reporting rate

High Performance Computing (HPC)

- Fast computing and reliable data processing

At System Control Center

At Generation Control Center 1

At Generation Control Center n
Synchro-Visualization of Modal Analysis

- Situational awareness in control centers on damping performance of the synchronous generators in the power system
- Continuous of PSSs for oscillation damping
- Improved power system operational reliability even with high levels of renewable penetration
Note: Real-time weather data collected on 22nd September 2013 from Clemson SC has been used for this study.
Visualization at System Control Center

Frequency and Damping

Play mode
Play speed
Mode separation
Synchro-Visualization

Generation Control Center 1

System Control Center
Synchro-Visualization Results
PV output 0 MW, without PSSs

Generation Control Center 1
P₁ = 700 MW

Generation Control Center 2
P₂ = 700 MW

System Control Center

Generation Control Center 3
P₃ = 721 MW

Generation Control Center 4
P₄ = 700 MW
Synchro-Visualization Results
PV output 0 MW, PSSs with Standard Parameters

Generation Control Center 1
$P_1 = 700$ MW

Generation Control Center 2
$P_2 = 700$ MW

System Control Center

Generation Control Center 3
$P_3 = 721$ MW

Generation Control Center 4
$P_4 = 700$ MW
System Control Center

Generation Control Center 1
P₁ = 700 MW

Generation Control Center 2
P₂ = 700 MW

Generation Control Center 3
P₃ = 721 MW

Generation Control Center 4
P₄ = 700 MW

Synchro-Visualization Results
PV output 0 MW, PSSs with Tuned Parameters
As per the weather data collected on 22nd September 2013 from Clemson SC.
As per the weather data collected on 22nd September 2013 from Clemson SC.
Conclusion

Synchro-Visualization of Modal Analysis:

• Draws attention of control center operators on system damping
• Draws attention of generator operators on the oscillation modes and available damping
• Aids in decision-making on generation outputs with respect to generator and system stability
• Provides wide-situational awareness and aids in system stability constrained energy dispatch
• System and generator damping performance can be improved to accommodate variable generation.
Thank You!

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