PMU Enhanced Power System Operations

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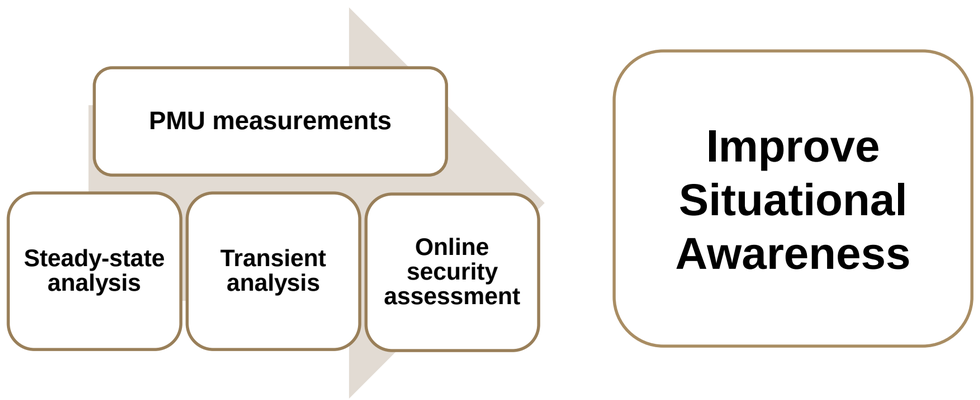
GOALS

- Develop a power flow algorithm for solving part of a power network using the standard ac model, and other parts using the more approximate, but less computationally intensive, dc model.
- Develop a framework to get useful information from PMU data in order to improve situational awareness.
- Develop a reduced model approach to decrease computational complexity in power system transient simulation.

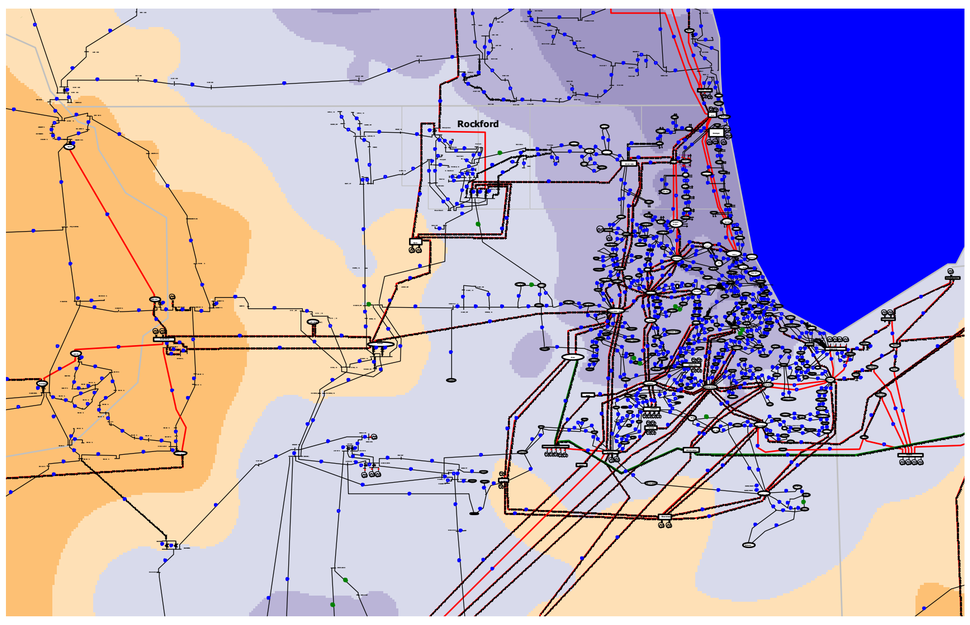


FUNDAMENTAL QUESTIONS/CHALLENGES

- A key question is whether the PMU data help operators and engineers make better and more timely decisions.
- PMU data can be utilized to improve understanding of complex system behaviors.
- How can the data be used for enhancing power system operations?
  - Real-time event detection and security assessment.
  - Dynamic reduction and system model validation.
- How can we include PMU measurements in power system analysis tools?
- How can we increase computational efficiency of power system analysis tools?

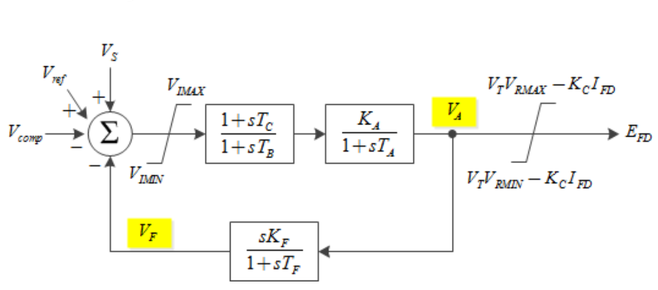
RESEARCH PLAN

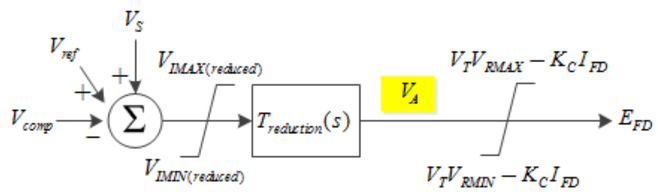
- Fast steady-state power flow analysis.
  - A new power flow algorithm combines ac and dc power flow models depending on the area of interest for study.
- Approach that uses PMU data to derive a simple equivalent system.
  - Develop an approach to derive model parameters of the equivalent system.
  - Develop an algorithm to detect system events.
  - Develop a method to decrease system complexity.
- Fast analysis of transients in power systems.
  - Identify modes in the original system where fast dynamics do not appear.
  - Develop a practical way to determine when fast modes can be removed.
  - Develop a method to eliminate the modes from system equations.

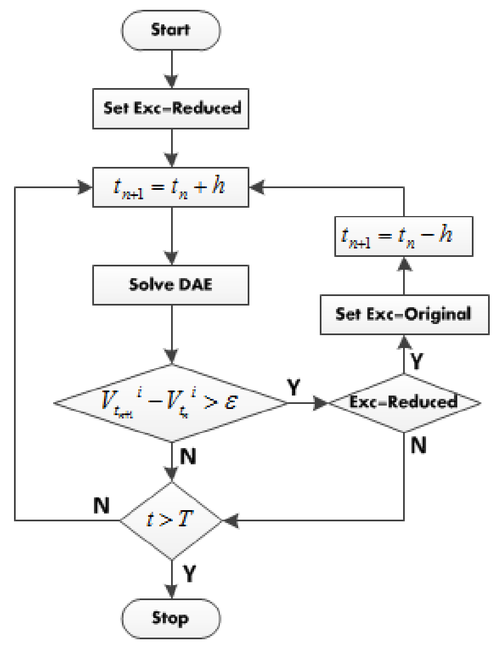


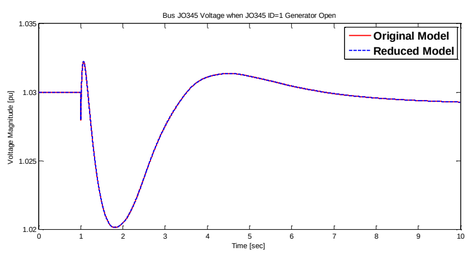
RESEARCH RESULTS

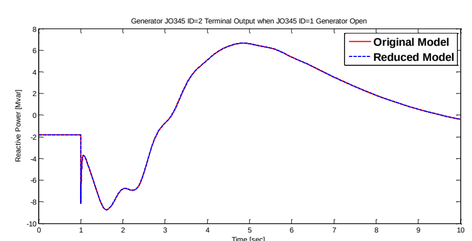
- Completed mixed power flow analysis using ac and dc models.
  - Published in *IET Generation, Transmission and Distribution.*
- As a step towards development of an equivalent system that uses PMU data, parameter estimations of the equivalent model have been implemented.
- For faster transient simulation, the EXST1 exciter model, a common exciter model used in the WECC case, has been reduced. The approach provides a fast solution without sacrificing simulation accuracy.
  - A paper has been submitted to *IEEE Transactions on Power Systems* and is now under review.

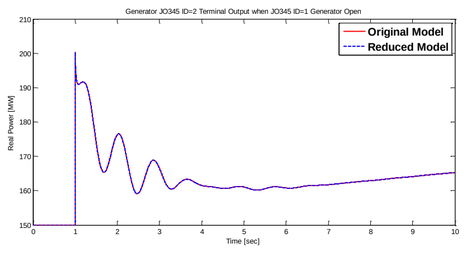












BROADER IMPACT

- Online security assessment.
  - This project could help operators run fast system security assessments.
- Fast dynamic simulation with reduced models:
  - By preserving most of the system modes in the area of interest for study.
  - Coherency testing.
  - Machine aggregation.
  - Network reduction.
- Power system model validation.
  - Identify model inaccuracies between simulations and actual responses.

INTERACTION WITH OTHER PROJECTS

- None for this project.

FUTURE EFFORTS

- Acquire actual power system PMU data and associated power system models.
- Test the developed method and algorithm with real or simulated data for verification.
- Improve the accuracy of the mixed power flow analysis in external systems.
- Apply the mixed analysis concept for transient simulation.
- Identify technology transfer opportunities through industry interactions.

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