Fusing Models and Data for a Dynamic Paradigm of Power Grid Operations

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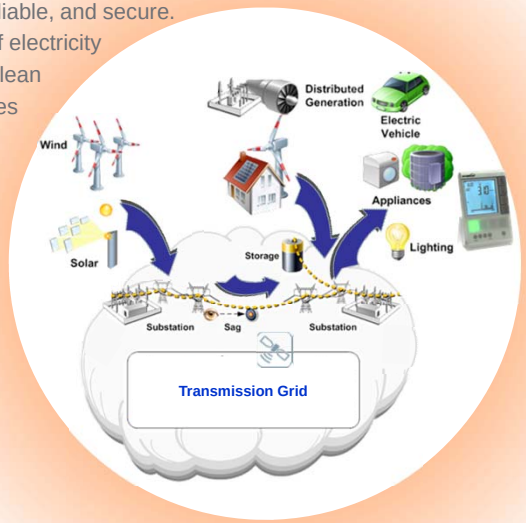
Driver: Clean and Efficient Power Grid

Grid Evolution Meeting Information Revolution

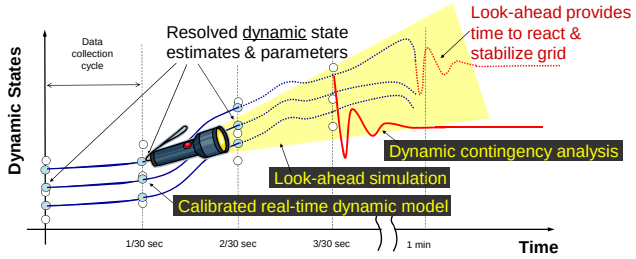
The nation's power grid faces new challenges driven by the expectation for a clean and efficient grid, in addition to being affordable, reliable, and secure.

"80 percent of electricity comes from clean energy sources by 2035" – President Obama, State of the Union speech.



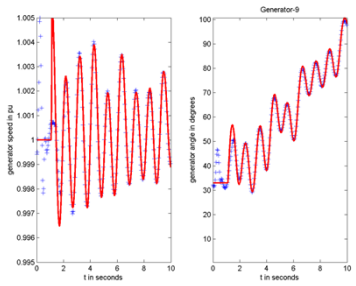
Vision: Dynamic Paradigm of Power Grid Operations

Fuse theoretically-based grid model with measurement data for real-time estimation of dynamic states that drives look-ahead simulation and dynamic contingency analysis.



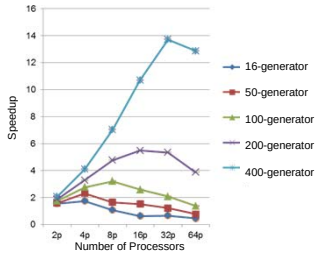
Real-time Estimation of Dynamic States – Know where we are

- Advanced the Kalman Filter technology for estimating dynamic states through fusion of models and data , enabling analysis of non-linearity and discontinuity.
- Developed methods for measurement selection, sensor placement, and uncertainty quantification.
- Developed software codes that scale to 1000s of cores, moving towards to 100,000 cores.



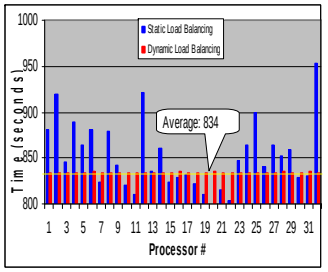
Look-ahead Dynamic Simulation – Know where we are going

- Achieved 14x speed-up for a 400 machine system. Speed-up performance is expected to be better with larger system sizes (e.g., the western US power system has 3000 generators).



Dynamic Contingency Analysis – Know where we might be

- Developed a platform for massive N-x contingency analysis
- Implemented dynamic load balancing schemes for maximum processor utilization
- Achieved close-to-linear scalability with large-scale power grid models



Impact

High-fidelity real-time grid analysis that enables a real-time dynamic view (versus today's static view) and predictive control capabilities through look-ahead dynamic simulation and dynamic contingency analysis.

- **Real-time predictive grid operation** for faster response and emergency management
- **Effective management of large-scale integration of smart grid technologies** such as renewable generation, demand response, plug-in hybrid vehicles, and distributed generation.
- **Better asset utilization** to maximize power transfer capabilities and defer transmission expansion.

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