Computational Science for Grid Management

ANL, PNNL, NREL, SNL, LLNL, LANL

GRID MODERNIZATION INITIATIVE
U.S. Department of Energy

Project Description

- **Computational algorithms** in today's planning and design codes are **too slow** for new mixes of generation, 'smart' controls, and distributed resources.
- Project focuses on key technology gaps for scalable math libraries / frameworks that unify algorithms for optimization, dynamics, and dynamics required in a wide range of grid modeling.
- This project aims to develop a software framework and solvers and reduce time to solution by >100 fold, leading to higher reliability and flexibility.

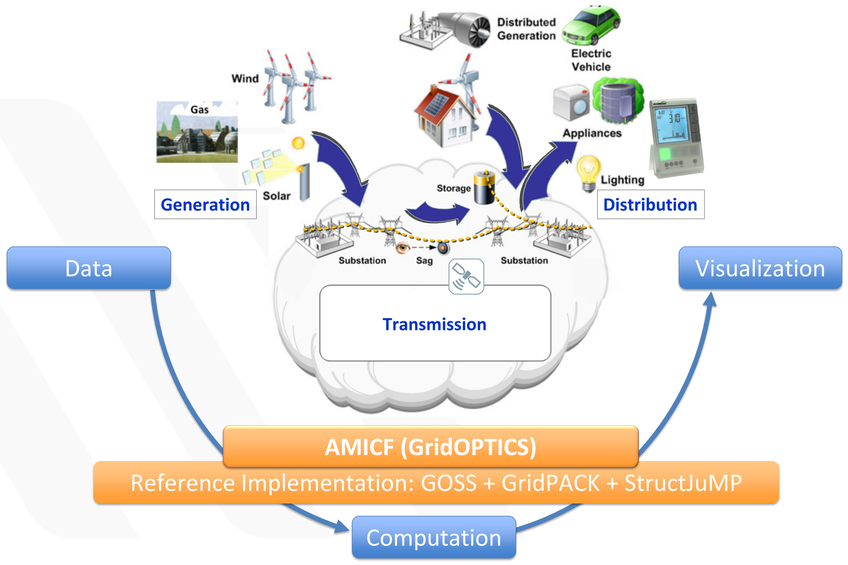
Expected Outcomes

- Improve computing performance – Design and develop open-source solvers for 100x faster performance in grid applications on optimization, uncertainty, and dynamics.
- Reduce software costs – Apply innovations in new computational tools (StructJuMP) to develop advanced framework (AMICF) that allows 10x faster prototyping of computationally-intensive analyses.
- Demonstrate value – Show benefits of the framework and solvers through high-value use cases with interconnection-scale power grids.

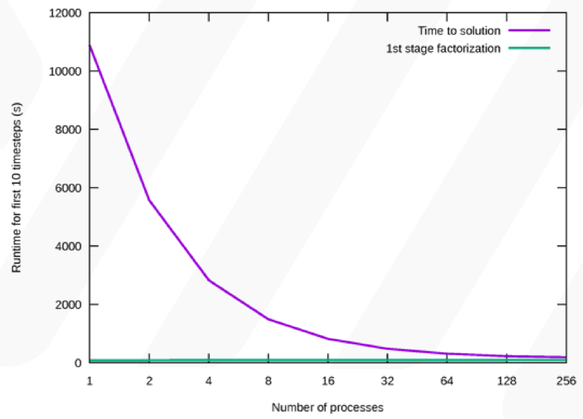
Expected Impact

- Enable leaner-margin grid operation by reducing assumptions and conservativeness through high-efficient computation.
- Improve reliability with predictive analytics only achievable with the improved computational capabilities.
- Increase flexibility of operation and planning through efficient holistic analysis and optimization of the grid and its dependency on other energy systems.

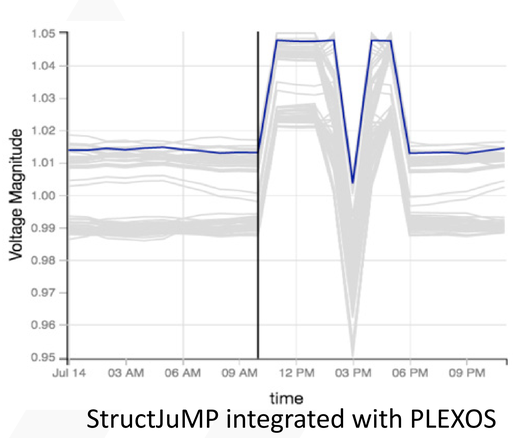
Significant Milestones	Date
Middle of the road parallel runs for SCOPF with the PIPS-NLP suite using StructJuMP annotations.	09/30/2016
Conduct a stakeholder workshop and produce framework design document.	11/23/2016
Demonstrate AMICF prototype on Industry inspired use case using NREL data.	03/31/2017
AMICF parallel nonlinear optimization under uncertainty capability run.	03/31/2017
Estimation of margins reduction due to transient expression in optimization problem.	03/31/2017



Complexity in grid and energy systems demands new computational framework and solvers



PIPS-NLP, reduces StructJuMP SCACOPF Runtime from 10 hours to 10 minutes



StructJuMP integrated with PLEXOS produces voltage swing information

Progress to Date

- StructJuMP, an open-source HPC library for scalable, parallel nonlinear modeling was released in FY 16 Q4.
- Reference implementation of the AMICF framework with GridOPTICS components (GOSS + GridPACK) and StructJuMP, linking data to computation and visualization.
- PIPS-NLP was optimized to solve StructJuMP SCACOPF with *2869 buses and 512 active contingencies in 10 minutes.*
- StructJuMP was integrated with PLEXOS to evaluate uncertainty effects at voltage and congestion levels.
- An industry-attended stakeholder workshop as organized in November 9-10 to provide feedback on framework and the use cases defined to guide the framework/solver development. Industry articipants included ISO-NE, MISO, SCE, General Electric, Powertech Labs, UTRC, GEIRI-NA SGCC, and Glarus.