HiPAS GridLAB-D: High-Performance Agent-based Simulation for GridLAB-D

CEC EPC 17-046 Fact Sheet

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SLAC National Accelerator Laboratory

The Issue

Comparative analysis and computational efficiency enabling high performance computing in grid modeling is needed to help customers design DERs into systems that minimize grid impacts. Speeding up the analysis and computational efficiency will help inform agencies, utilities, and ratepayers participating in distribution planning processes of methods to better integrate DERs onto the distribution system.

Integration Capacity Analysis is an iterative method requiring many power flow simulations while varying the DER level throughout the distribution system to determine the maximum amount of DER that can be installed without causing distribution system problems. Due to the large number of iterations required (hundreds or thousands per feeder); iterative analysis can result in long processing times, especially when expanded to large numbers of distribution circuits. Measurably improving the speed and accuracy of an open-source modeling tool capable of dynamic time series modeling is critically needed. Doing so will enable quick and accurate distribution studies that include smart inverters, single phase line sections, and transmission impacts.

Project Description

HiPAS is an open-source upgrade to GridLAB-D that speeds up the analysis performance and computational efficiency of GridLAB-D, a tool that helps inform agencies, utilities, and ratepayers about the benefits of planning processes that integrate DERs onto the distribution system. HiPAS includes methods that parallelize many of the iterative methods used in simulations, such as reliability metrics calculations, end-use load calculation, distributed energy storage and distributed generation. HiPAS is intended for both desktop HPC multicore processors and cloud platforms. HiPAS uses intelligent adaptive multi-threading to deploy highly granular parallelization in agent-based simulations. It improves the time-series analysis speed by parallelizing independent agents automatically and using machine-learning to improve powerflow solution performance.

The HiPAS version of GridLAB-D will continue to support the many existing capability of GridLAB-D, which is an open-source distribution system simulation and analysis tool capable of dynamic analysis. It can estimate the benefits and impacts of smart grid technologies including demand response, detailed unbalanced per phase impacts from DERs, and impacts from behind the meter assets such as storage, photovoltaics and wind generation. It models real

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world conditions such as allowing unlocked voltage regulating devices. GridLAB-D is fully functional, made freely available and has been fully supported by the user community and the system developers at the US Department Energy's national laboratories for the past 10 years, and will continue to be supported in this manner.

GridLAB-D has a rich depth and breadth of supported research capabilities of the modeling software including Volt-VAR optimization and conservation voltage reduction, demand response research, smart appliance controls, microgrid integration, transactive modeling and simulation, storage integration, DER impacts, behind the meter assets, the use of advance metering infrastructure, and complex multi-disciplinary problems presented by new smart grid technologies. In addition, GridLAB-D has also been used to study the impact of microgrid islanding, feeder reconfiguration, and the interaction of multiple islandable and reconnectable microgrids in the presence of high penetration distributed energy resources. GridLAB-D also provides the ability address the study of the impacts of rates and tariffs, as well as the integration of wholesale DER markets.

Anticipated Benefits for California

The HiPAS enhancements to GridLAB-D achieved through this project will increase utility analyst productivity in performing DER integration studies, providing specific utility and ratepayer benefits by improving the accuracy and timeliness of results supporting DER interconnection and grid planning. HiPAS establishes a foundation for long-term user and developer support of high-performance versions of GridLAB-D for California utilities, regulators and DER designers. These capabilities can be applied to integrated capacity analysis to help customers and third parties design DER systems that do not exceed hosting capacity by providing accurate information about the amount of DER capacity that can be interconnected at a specific location without significant distribution system upgrades. These results may best be achieved through iterations of successive power flow simulations at each node on the distribution systems. HiPAS GridLAB-D addresses the primary barriers to analyzing more locations, for more points in time, more frequently by reducing the computational costs associated with these kinds of analyses.

Project Specifics

Contractor: SLAC National Accelerator Laboratory

Partners: GridWorks, Oakland, California (subcontractor)
Pacific Northwest National Laboratory, Richland, Washington (subcontractor)
National Grid, Hicksville, New York (cost-share)

Amount: $3,068,781

Co-funding: $300,000 (cost-share)

Term: June 2018 to March 2023

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