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GridPACK™: Grid Parallel Advanced Computational Kernels

OBJECTIVE

The U.S. power system is now more complex and contains far more elements than ever before. Computational analysis of the power grid will have to evolve to ensure accurate and timely simulations.

However, the software tools available for power grid simulation today are primarily sequential single-core programs. The productivity of power engineers who need the results of these simulations can be greatly enhanced if a large number of cores can be used in parallel to reduce the execution time to minutes instead of days.

In order to take advantage of such parallel systems, a new software paradigm is required. Researchers at Pacific Northwest National Laboratory created a scalable software framework, GridPACK™, for the development of power system simulation applications that will be accessible to domain experts.

APPROACH

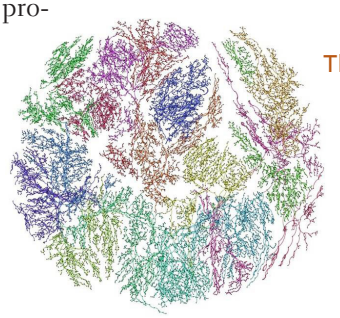
GridPACK™ was initially developed under PNNL's Future Power Grid Initiative (FPGI) before transferring to programmatic funding, and is part of the GridOPTICS™ tool suite. It can be used to develop power grid simulations that can run on today's parallel computers.

The current GridPACK™ implementation is built on top of the Portable Toolkit for Scientific Computation (PETSc) solver libraries, a Message Passing Interface (MPI)-based parallel linear algebra framework that provides access to many different solvers. These can be used to create application modules customized for the power grid domain.

Users will be able to combine these modules to produce custom algorithms. In addition, four technology demonstration programs are being produced to test the modules and provide guidance to others for building their own applications. The results of the GridOPTICS™ program and other tools developed at PNNL are being leveraged to provide synergistic tool development for power system domain experts.

IMPACT

GridPACK™ provides access to larger computers with more memory and processing power, enabling the simulation of models that contain vast networks and high levels of detail. This tool allows for an increased capacity in modeling contingencies and quantifying uncertainty while also greatly increasing the productivity of power grid engineers in the field by reducing the time to solution for systems of interest.



This representation of the Western Electricity Coordinating Council network illustrates how GridPACK™ partitions the network onto 16 processors. The partitioning divides the network into separate pieces that can be worked on concurrently using multiple processors to improve computational performance.

U.S. DEPARTMENT OF ENERGY
Office of Electricity Delivery and Energy Reliability (OE1)

GridPACK™ is available to the public for download.
Visit gridpack.org to learn more.

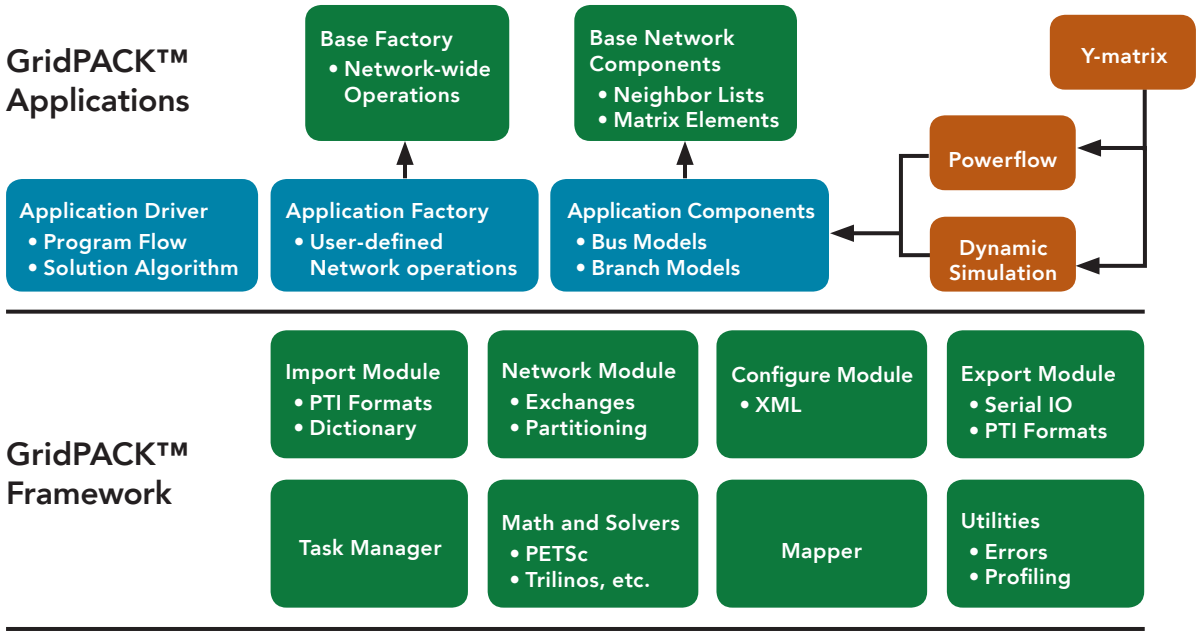
GridPACK™ has been used to implement several power grid applications:

- Powerflow simulations (linear and non-linear solvers)
- Dynamic simulation (advanced algebraic operations)
- Contingency analysis (multi-level parallelism).

For ongoing development, GridPACK™ gained funding from the U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability. The tool is open source and became available to the public in November 2013, benefitting power grid research on a global scale. Version 2.0 of GridPACK™, with new features that expand usability, was released in fall 2014.

ABOUT GRIDOPTICS™

The Grid Operation and Planning Technology Integrated Capabilities Suite (GridOPTICS™) is the core product of Pacific Northwest National Laboratory's Future Power Grid Initiative which concluded in 2015. GridOPTICS™ tools are designed to securely collect and manage data in real time, use data to drive modeling and simulation, and convert large volumes of data to actionable information. GridOPTICS™ concepts and tools show and analyze grid performance at an unprecedented speed, scale, and resolution and support operational and policy decision-making for the grid of the future. A key emphasis is on transitioning GridOPTICS™ tools to open-source status, supported in their future development and use by a "community" including PNNL, other national labs, academia, vendors, and utilities.



Schematic diagram of the GridPACK™ Software Stack

For more information, please visit the GridOPTICS™ website or contact:

Bruce Palmer
Pacific Northwest National Laboratory
(509) 375-3899 | bruce.palmer@pnnl.gov

gridoptics.pnnl.gov

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