Pacific Northwest NATIONAL LABORATORY

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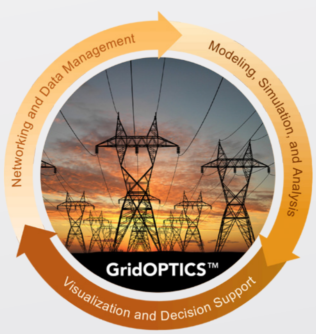


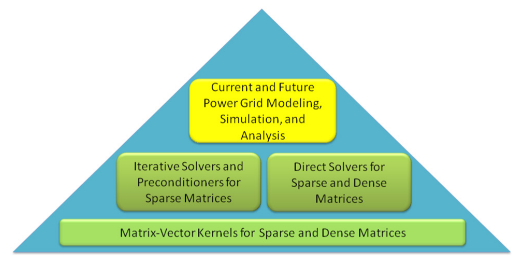
FUTURE POWER GRID INITIATIVE

Linear Algebra Solvers and Associated Matrix-Vector Kernels for Power Grid Simulations

OBJECTIVE

This project develops mathematical algorithms and software for linear algebra needs in power grid applications, utilizing high-performance computers when appropriate. These are important tools that

- support dynamic/static state estimation
- analyze small-signal stability
- establish stability security margins



This year's goal was to develop efficient eigenvalue solvers and implementation for small-signal stability. With these methods and software, scientists at PNNL and other DOE facilities can perform fast analysis to determine the stability of a power grid system, e.g., to determine the load feasibility boundaries.

APPROACH

For this year's linear solver goal, the approach taken was

- a shift-and-invert implicitly restarted Arnoldi (SI-IRA) method for finding a selected number of eigenvalues in a small-signal stability problem
- utilizing high-performance computers with each processor simultaneously taking a different shift in the complex plane and finding only a small number of eigenvalues closest to that shift

To achieve efficient computation, a sparse matrix representation of the Jacobian is explicitly used, and an iterative Krylov method with a suitably designed preconditioner is applied in solving the linear systems at each cycle of the SI-IRA.

IMPACT

Finding eigenvalues is at the heart of small-signal stability analysis of power grid systems. As the future power grid system becomes more complex and as more model variability are used to accurately represent the future system, determining the stability security margins will become more important and challenging to compute. The developed eigenvalue methods and software will provide the prototype computational tools for domain scientists at PNNL and other DOE facilities to determine efficiently these security margins that insure a stable operational system.

U.S. DEPARTMENT OF ENERGY

FOCUS AREA

Focus Area Two targets research in the areas of advanced mathematical models, next-generation simulation and analytics capabilities for the power grid. Projects in Focus Area Two will use high-throughput data streams produced by projects in Focus Area One and integrate them with sophisticated mathematical models to conduct large-scale power grid simulation and analysis. Focus Area Two strives to advance the state-of-the-art in modeling and simulation in order to achieve much higher fidelity situational awareness and global comprehension for power grid stability, efficiency and flexibility. **Focus Area Leads:** Ian Gorton (ian.gorton@ pnnl.gov), and Ning Zhou (ning.zhou@ pnnl.gov)

ABOUT FPGI

The Future Power Grid Initiative (FPGI) will deliver next-generation concepts and tools for grid operation and planning and ensure a more secure, efficient and reliable future grid. Building on the Electricity Infrastructure Operations Center (EIOC), the Pacific Northwest National Laboratory's (PNNL) national electric grid research facility, the FPGI will advance the science and develop the technologies necessary for meeting the nation's expectations for a highly reliable and efficient electric grid, reducing carbon emissions and our dependence on foreign oil.

ABOUT PNNL

Pacific Northwest National Laboratory is a Department of Energy Office of Science national laboratory where interdisciplinary teams advance science and technology and deliver solutions to America's most intractable problems in energy, the environment and national security. PNNL employs 4,900 staff, has an annual budget of nearly $1.1 billion, and has been managed by Ohio-based Battelle since the lab's inception in 1965.

For more information, please visit the FPGI website or contact:

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