OVERVIEW
Pacific Northwest National Laboratory’s Future Power Grid Initiative (FPGI) developed data-driven solutions to manage the nation’s increasingly complex power grid. Since 2011, FPGI research in data management, simulation and visualization has advanced new tools that help power system operators, planners and policy makers effectively comprehend and utilize the future grid. This family of tools is collectively known as GridOPTICS™ (Grid Operation and Planning Technology Integrated Capabilities Suite). GridOPTICS™ provides capabilities to address three “fusions” occurring today between grid and data networks; transmission and distribution networks; and operations and planning systems with markets.

HOW GRIDOPTICS™ RESEARCH HAS BEEN COMMUNICATED

| 112 national and international presentations |
| 47 publications/conference papers |
| 3 technical reports |
| 1 book chapter |
| 5 videos |

GridOPTICS™-related Workshops
Attended by research, industry, and academia.
4 Next-Generation Analytics Workshops
3 High-Performance Computing Workshops
2 Software Engineering Challenges Workshops

65% Power Model Integrator (net inter-change scheduling) reduction of error in energy forecasts.

GRIDOPTICS™ DEVELOPMENT TIMELINE

Year 1 (FY2011)
Three research focus areas defined: 1) Networking and Data Management; 2) Modeling, Simulation and Analysis; and 3) Visualization and Decision Support
Nine projects initiated in support of the three focus areas

Year 2
Four new projects initiated to address three power grid fusions
GridOPTICS™ tool suite concept framed

Year 3
VOLTTRON™ distributed control/sensing platform developed
powerNET power system communication testbed developed
Three new projects initiated in support of GridOPTICS™ development
Two Next Generation Grid Analytics workshops conducted
Framework for Network Co-Simulation (FNCS) developed

Year 4
GridPACK™ software framework receives DOE funding
GridOPTICS™ Software System (GOSS) middleware developed
Third Next Generation Grid Analytics workshop conducted

Year 5
Focus on effort to transition GridOPTICS™ to broader use
GridPACK™ 2.0, FNCS 2.0, and VOLTTRON™ 3.0 released
Fourth Next Generation Grid Analytics workshop conducted
GRIDOPTICS™ OPEN SOURCE SOFTWARE

VOLTRON™
VOLTRON™ is an innovative distributed control and sensing software platform that creates an environment in which appliances and other devices are represented by “agents,” communicating amongst each other to prioritize power needs and deliver electricity accordingly. https://github.com/voltron/voltron

GRIDPACK™
GridPACK™ is a software framework that harnesses high-performance computing to facilitate the development of programs that model the future grid. https://www.gridpack.org

GRIDOPTICS™ SOFTWARE SYSTEM (GOSS)
GOSS facilitates data exchange and enables interoperability for development and deployment of new applications for the future grid. https://github.com/GridOPTICS/GOSS

GRIDPACK™ DEVELOPERS REPRESENT A WIDE RANGE OF EXPERTISE
FPGI drew staff from the following PNNL mission areas:

- 43% Energy and Environment
- 30% Fundamental & Computational Sciences
- 25% National Security
- 2% Other

INTELLECTUAL PROPERTY SNAPSHOT

- 17 disclosures
- 4 copyrights
- 6 patent applications

SHARED PERSPECTIVES:
When combined and demonstrated with other FPGI-developed tools, Shared Perspectives allows simultaneous and selective sharing of information between two different entities. This is expected to provide a key resource for effective communication, collaboration, and coordination among electric utilities.

EXTERNAL RELATIONSHIPS
Agencies (all provided funding):
Department of Homeland Security
DOE Office of Advanced Scientific Computing Research
DOE Office of Electricity Delivery and Energy Reliability
DOE Office of Energy Efficiency and Renewable Energy
Small Business Innovation Research

Key Partners:
IncSys
Lawrence Berkeley National Laboratory
NERC Reliability Coordinator Working Group
Northrop Grumman
Oak Ridge National Laboratory
PJM Interconnection
South East European Research Centre
The Ohio State University
Transformative Wave
University of Illinois at Urbana-Champaign
Virginia Tech
Washington State University
Yale University

EXTERNAL SUPPORT FOR GRIDOPTICS™ TOOLS
Funding, obtained from government and other clients, for use or development of GridOPTICS™ tools

<table>
<thead>
<tr>
<th>Year</th>
<th>Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY12</td>
<td>$1,305,000</td>
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<tr>
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$3,945,000 FY15 funding as of April 2015

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