Workshop on Challenges in Next-Generation Analytics for the Future Power Grid

Data to Knowledge to Actions by way of Advanced Computing

Henry Huang, Jeff Dagle
Pacific Northwest National Laboratory
Seattle, WA
September 19, 2013
Over the next several years, we expect

- More electricity generation from intermittent renewable power
- Generation changing from centralized to distributed, more two-way flows
- Millions of smart meters and sensors, plug-in hybrid vehicles, and electricity storage coming online

New challenges

- How can we manage large-scale data in real time?
- How do we safeguard high reliability and security?
- How will we run such a complex grid?

Need new concepts and tools to transform grid operation and planning
Our Answer - Future Power Grid Initiative

- The Future Power Grid Initiative (FPGI)
  - A multi year, multi million dollar, interdisciplinary initiative
  - Funded through PNNL’s Laboratory Directed Research and Development Program
  - Led by Henry Huang, Ph.D., P.E., and Jeff Dagle, P.E.

- Technical Approach
  - Combining PNNL’s distinctive capabilities in power systems, data-intensive high-performance computing and visual analytics
  - Designing computational approaches to deliver a new class of real-time tools for grid modeling and simulation
  - Expanding power grid networking to support large scale and secure real-time data flow
  - Advancing state-of-the-art visual analytics to convert very large volumes of multi-domain real-time data into actionable information
Point of Departure

Renewable
(Renewable energy technology, interconnection standards)

Renewable Integration
(Renewable Integration Modeling)

Transmission Grid

Smart Grid
(Deployment of smart devices, empowering customer involvement and innovation)

Storage and Storage Integration
(Deployment of cost-effective storage)

Transmission Reliability
(Advanced measurement and control technology, e.g., synchrophasors)

Future Power Grid Initiative
With end-to-end grid in mind, address questions:
- What can we use the data for (what data network is required?)
- How will we address the complexity in order to understand the grid?
- How will we run such a complex grid?
Future Power Grid Initiative (FPGI)

- Data
- Knowledge
- Actions

Power Grid
- Weather and Climate
- Policy/Regulatory
- Economics

Networking and Data Management
- Data infrastructure
- Real-time data access
- Cyber security integration

Modeling, Simulation, and Analysis
- Next-generation models
- Real-time simulation
- Long-term assessment

Visualization and Decision Support
- Real-time global visualization
- Multi-domain visualization
- Decision reasoning

Computational Platform

Security and Reliability

3 Fusions
- Op + Planning
- Trans + Distri
- Grid + Data

Refine R&D agenda
Power grid transition requires new computing capabilities

Drivers

Fusion #1: power grid + data network
Bring big data to applications
Enable “all-hazard” analysis

Fusion #2: operation + planning + market
Minimize overhead in communication
Improve responses w/ RE & smart loads

Fusion #3: transmission + distribution
Model end-to-end grid
Understand emerging behaviors

Requirements

Bigger Data
Bigger System
Bigger Model

Needs

Advanced Math
Advanced Computing
Data-Driven Computation and Visualization

Data
*Large volume
*High speed
*Dynamic
*Heterogeneous
*Multi-domain

Computation
*Larger models
*Larger equations
*Distributed
*Real-time
*Multi-core
*Clusters
*Cloud

Visualization
*Cross-boundary
*Multi-domain information
*Global view
*Complex info

Parallel computing is essential for developing future tools.

Fusion #1:
grid + data

Fusion #2:
ops + plan + mkt

Fusion #3:
trans + distri
GridOPTICS™ Architecture: links data to computation to visualization

- Open Source; Open Format; Open Forum
  - Enable interoperability and accelerate development of advanced technologies and tools for the future power grid.

GridOPTICS™

- **Data**
  - Data Processing
  - Data Mgmt
  - Research Datasets

- **Computation**
  - Numerical Lib
  - Adv. Solvers
  - Adv. Algorithms

- **Visualization**
  - Visual Analytics
  - New Viz Concepts
  - Human Factors

---

Power System Data Structure and Software Interface

---

Actionable
Community Building: 1st FPGI Workshop

- Time and Location: Nov 29-30, 2012; Seattle, WA.
- Theme: Workshop on Challenges in Next-Generation Analytics for the Future Power Grid
- Objectives:
  - Build a shared vision
  - Identify research needs
  - Foster a community
- Format: Plenary on challenges; breakouts on technology needs – numerical library and visualization/decision support.
- 29 Participants: National Labs, Universities, Power Companies, Vendors
Major Workshop Findings

- A power-grid-specific open software architecture is needed.
- Building such an open software architecture requires a community.
- Business models need to be defined for the evolution and support of such an open architecture.
- Numerical libraries can help overcome the barriers to parallel computing.
- The community needs to advocate for the importance of visualization.
- Survey today’s grid software tools in terms of the use of advanced computing and identify common and essential elements for a numerical library.
- Building datasets for research is a priority.
- Bring a core group together in about six months to focus on developing an action plan.
2nd FPGI Workshop

Time and Location: September 19-20, 2013; Seattle, WA

Objectives
- Extend the shared vision to research requirements;
- Share progress since prior workshop; and
- Foster a community.

Format: Plenary on challenges, vision, and business model; Breakouts on technology needs

Data
- Data Processing
- Data Mgmt
- Research Datasets

Computation
- Numerical Lib
- Adv. Solvers
- Adv. Algorithms

Visualization
- Visual Analytics
- New Viz Concepts
- Human Factors

Power System Data Structure and Software Interface
Workshop Planning Committee

- David Callahan, Chair, PNNL/UW
- Gil Bindewald, DOE
- Henry Huang, PNNL
- Chen-Ching Liu, WSU
- Tom Overbye, UIUC
- David Sun, Alstom
- Paul Whitney, PNNL
Questions?

Henry Huang
509-372-6781
zhenyu.huang@pnnl.gov

Jeff Dagle
509-375-3629
jeff.dagle@pnnl.gov