Electric Grid and High Performance Computing (HPC) Challenges

Anna Maria Bailey, PE
Livermore Computing HPC Facility Operations Manager
HPC and Grid Focus

• HPC data centers are large Megawatt users
  • Sequoia – 9.6MW Peak – 20 Petaflops
• HPC applications can benefit from improved energy efficiency
• HPC can benefit from electric grid-level energy management
• HPC may impact or be impacted by the electricity quality and renewable generation
HPC Grid Challenges and Opportunities

- Utility Concerns
  - WAPA/PG&E cannot tolerate > 4MW unplanned swings
- Model large HPC block loads
- Address operational cost impacts
- Implement Power Management
  - What to monitor?
  - Log events to include maintenance and power interruptions

Sequoia at LLNL

MW

Time (s)

5.5 MW

5.5 MW → 9 MW → 5.5 MW

180 KW
Power Management is Challenging – “You Can’t Improve What You Don’t Measure”

- Numerous data streams
- Aggregate data into single source or platform
- Different timestamps and formats
- Coordinating with multiple owners of the data
- What data is significant?
- How will the data be viewed?
- Selecting the ideal interface
Data sources spread across LLNL

- PMU Grid Data
- ALC Building Mgmt. System
- Nexus HPC Rack Metering
- MV90/EEM Sitewide Metering
- Forseer Env. Monitoring
- LLNL Weather and Env. Info.
- SLURM HPC Resource Manager
- Siemens SCADA Electric Utility Data
- Front Range Ticket System
- Skumee HPC SNMP Info.
- Front Range Ticket System
- Skumee HPC SNMP Info.
- Siemens SCADA Electric Utility Data
- SLURM HPC Resource Manager
- Front Range Ticket System
- Skumee HPC SNMP Info.
- Siemens SCADA Electric Utility Data
- SLURM HPC Resource Manager
- Nexus HPC Rack Metering
- MV90/EEM Sitewide Metering
- Forseer Env. Monitoring
- LLNL Weather and Env. Info.
- SLURM HPC Resource Manager
- Nexus HPC Rack Metering
- MV90/EEM Sitewide Metering
- Forseer Env. Monitoring
- LLNL Weather and Env. Info.
- Skumee HPC SNMP Info.
- Siemens SCADA Electric Utility Data
LLNL Solution: Implemented Centralized System

Data Sources
- Rack, Equipment, Metering, Building Management, Utility

Interfaces
- Hundreds of Real Time Data Streams

Manage
- Gather and Evaluate Large Amounts of Data

Analyze
- Convert Real Time Data

Notify
- Centralized Event Notification

Visualize
- View Data and Reports

Goal = Lower power utilization, improve operational efficiencies and develop power management interfaces
Integrated Data From Multiple Sources

Power Provider

Operations Staff  PI Server  Management  NOC Dashboard

Data Collection Node

BACnet  SNMP  Modbus  OPC-DA

HVAC  Rack PDU  Power Meters, Branch Circuit Monitoring  BAS Systems

Regional Power Demand and Pricing Data  Regional Weather Data  HTML, XML

HTML  SNMP  Wireless Environmental Sensors
New Tools Allow for HPC Power Management Case Studies

- HPC maintenance can result in 5 MW load swings in a short period
- New tools identify amplified bursty behavior due to magnitude of HPC load
- Real workload indicates power fluctuations can be abrupt
HPC and the Grid Future Focus

• Continue to simulate data analytics on HPC loads to understand applications for future systems

• Continue to perform Power Management case studies

• Ultimately move from static to dynamic power management for improved grid analysis through extensive active case studies
HPC and the Grid Future Focus

• Continue to work with WAPA/PG&E to implement live feeds from HPC datacenters at LLNL to minimize unwanted large block load swings

• WAPA performs all LLNL grid scheduling – Long and short term forecasting – Load and Grid Integration is the future

- Environmental Monitoring System
- Load Integration to Respond to Demand Changes
- Power Management System
- Grid Integration to Implement Required Energy Transactions