OSIsoft at Lawrence Livermore National Laboratory

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Agenda

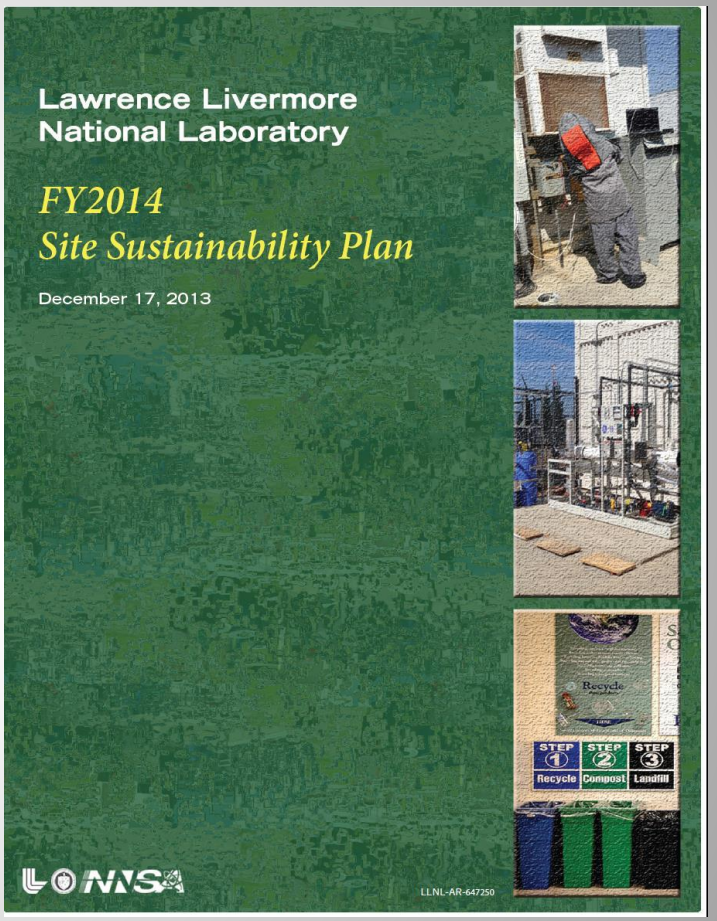
- Computation Overview
- Energy Efficiency and Sustainability
- PI Structure at LLNL
- Projects
- Comments/Discussion

High Performance Computing at LLNL

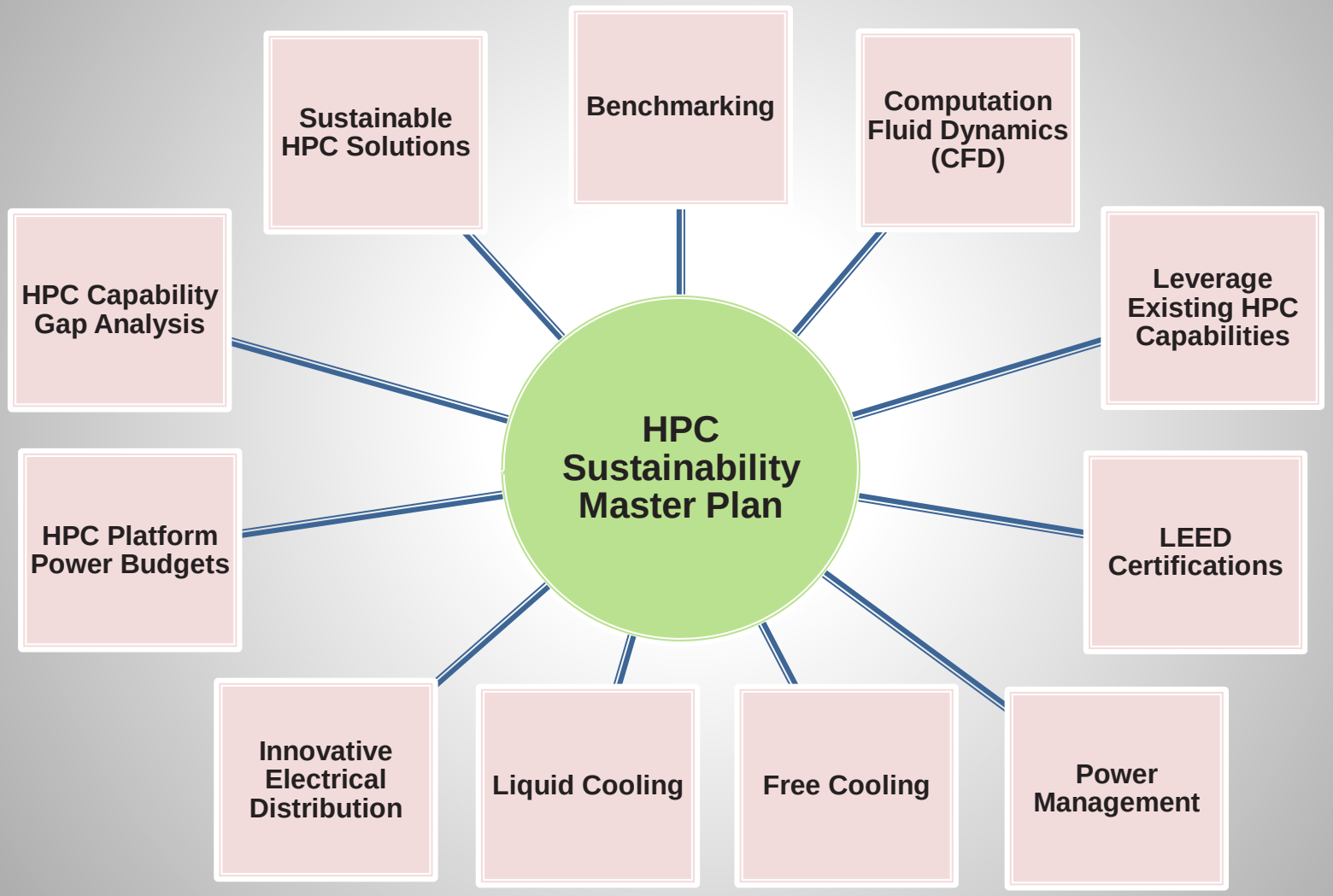
- HPC is spread across 5 buildings at LLNL
- 30% of LLNL's load
- B453 houses some of the fastest supercomputers in the world
- Power consumption per rack 10-100kW

HPC at LLNL strives to reduce energy consumption and ultimately reduce operating costs

- Energy conservation is critical to improve efficiencies and reduce operational costs
  - Operational efficiencies are vital to future of HPC - **Exascale Computing**
- Executive Order DOE 430.2B
  - Reduce energy intensity 30% by 2015 from baseline (FY03)
- Address High Performance Computing (HPC) capabilities and gaps as well as energy impacts site wide
- Developed HPC Sustainability Master Plan to feed into overall LLNL Sustainability Program
- Participate in the Energy Efficiency High Performance Computing Working Group



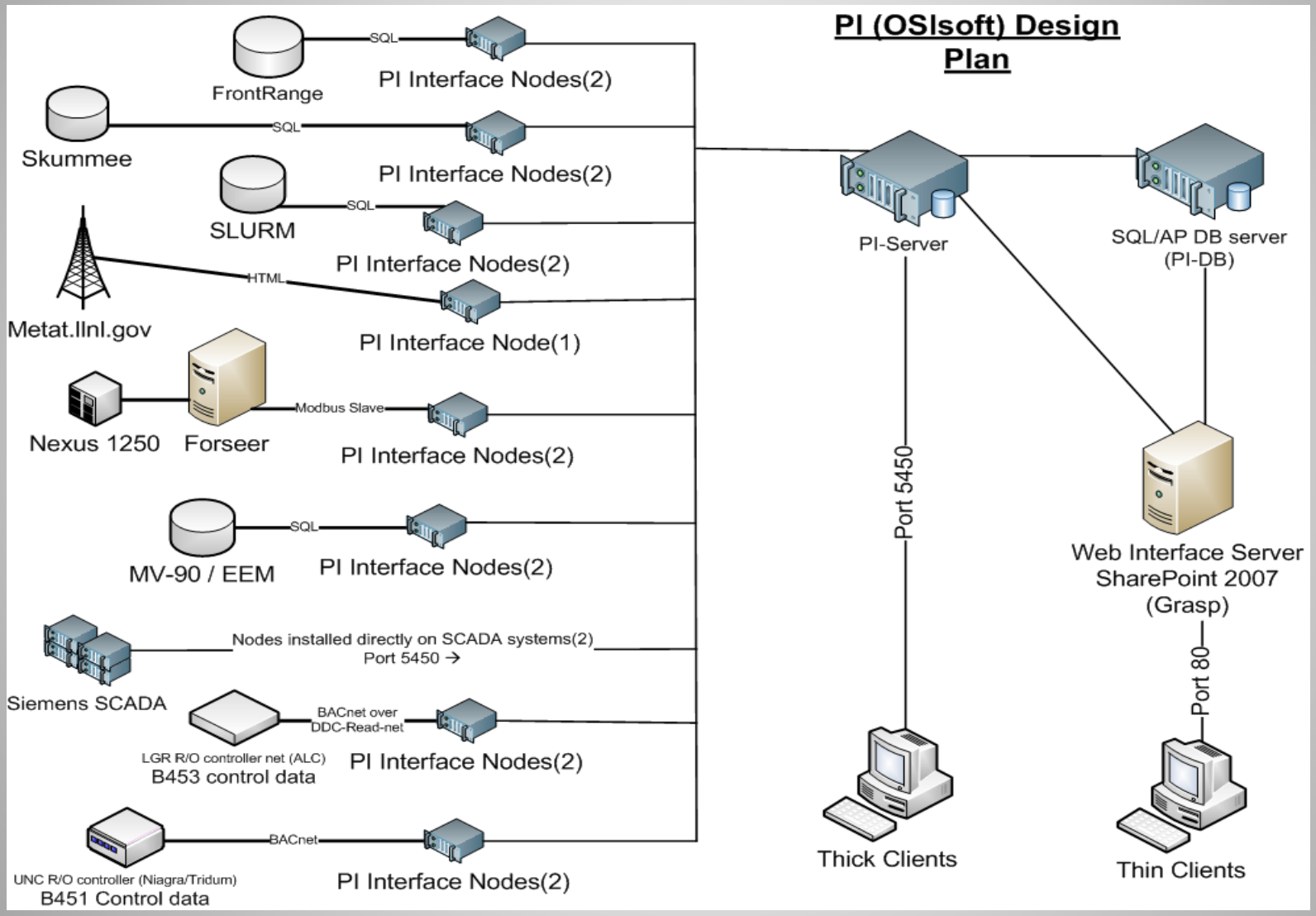
HPC Sustainability Master Plan Core Competencies



HPC's goal is to develop efficiencies across TSF complex "Turn Megawatts into ExaFLOPS"

- Highlights:
  - Capitalized on flexible and scalable infrastructure of the facility and computational platforms
  - Performed extensive benchmarking
  - Prepared comprehensive computational fluid dynamics (CFD)
  - Improved operational efficiencies
    - DOE FEMP 2009 Energy Award
    - B-453 LEED Gold Certified Awarded December 2009
    - B-451 LEED Silver April 2011

PI Architecture

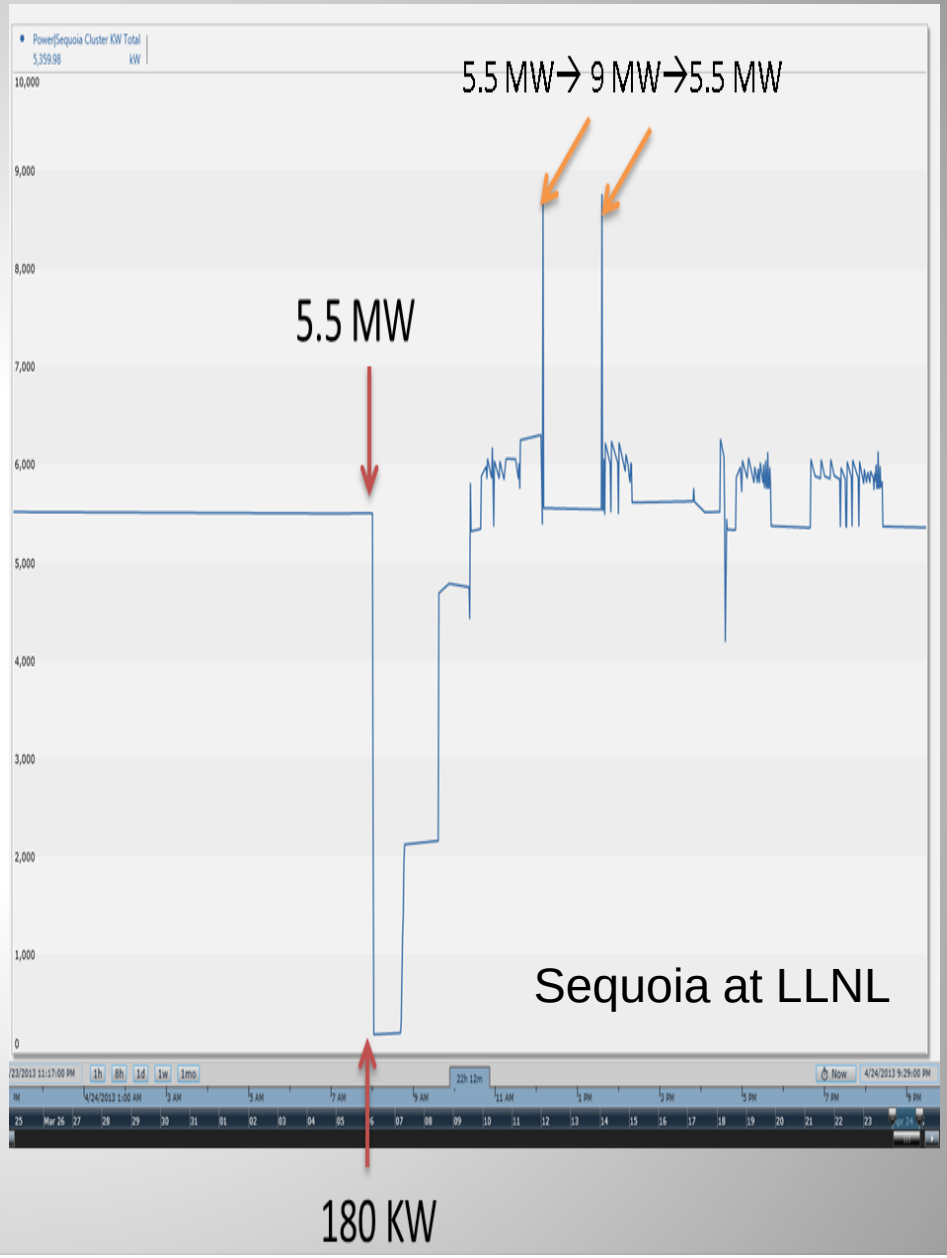


Current Uses at LLNL

- Coresight
- Power Usage Effectiveness PUE/Total Usage Effectiveness (TUE)
- Metering HPC
- Power Anomalies
- Top 500, Green 500
- Programmatic Mission
- NIF - Beta Testing for Programmatic Use

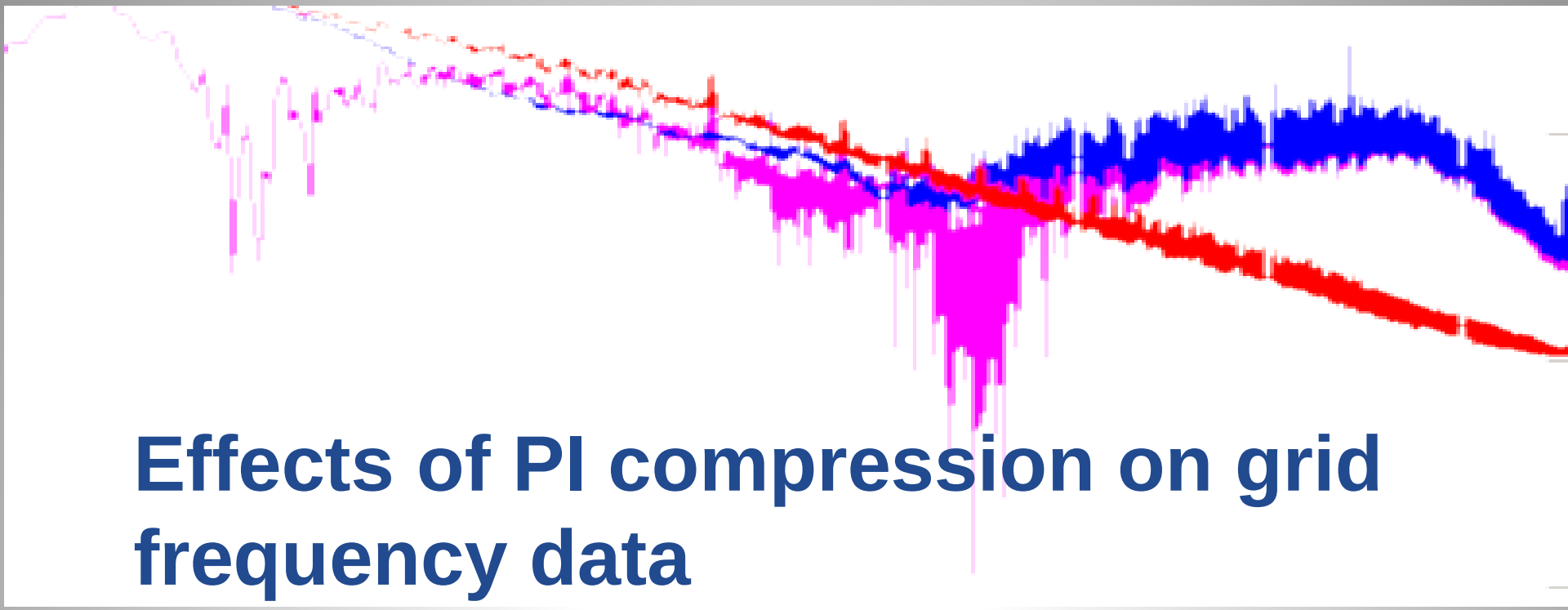
Load Swings

- Recent installed HPC systems have raised concerns with some utilities
- Requires modeling power consumption and quality of large HPC computational block loads
- Requires the need to address operational cost increases with larger load
- Requires the ability to know what to monitor
  - Continually log events of HPC workload to include scheduled maintenance, unscheduled power interruptions, power glitches, etc. to gain broader knowledge



Amplified Bursty Behavior Due to Magnitude of Computer

- Scheduled maintenance can result in 5 MW load swings to the grid in a short period of time
- Bursty behavior of real workload indicated that real power fluctuations can be more abrupt



Effects of PI compression on grid frequency data

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1/22/2014

LLNL

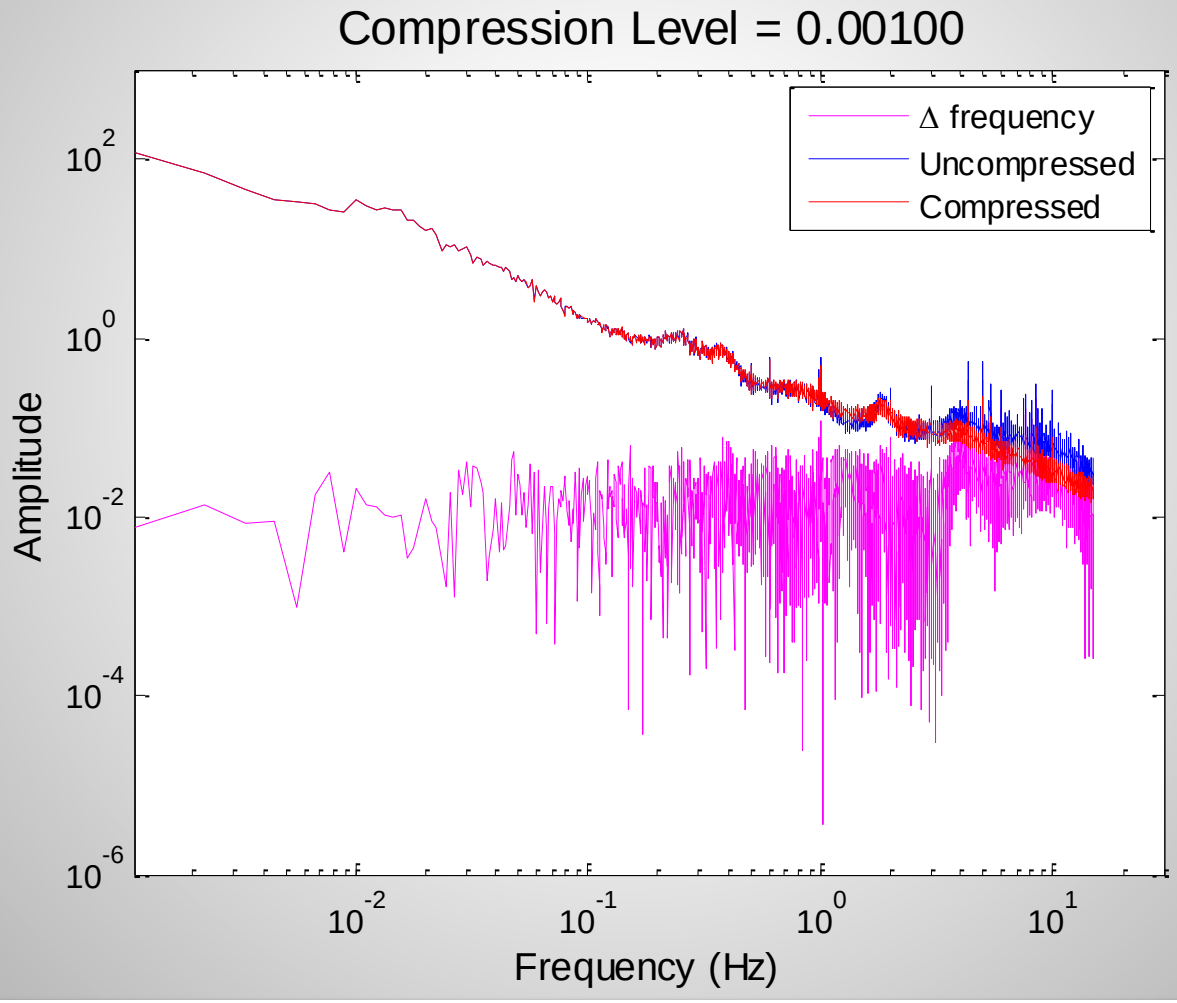
Experiment

- Collect raw frequency data and store it in binary format on the file system
- Collect data into PI with different levels of compression
- Use Fast Fourier Transform (FFT) analysis to compare the signal with no compression and different levels of compression
  - Averaging 6 hours over 15 minute window

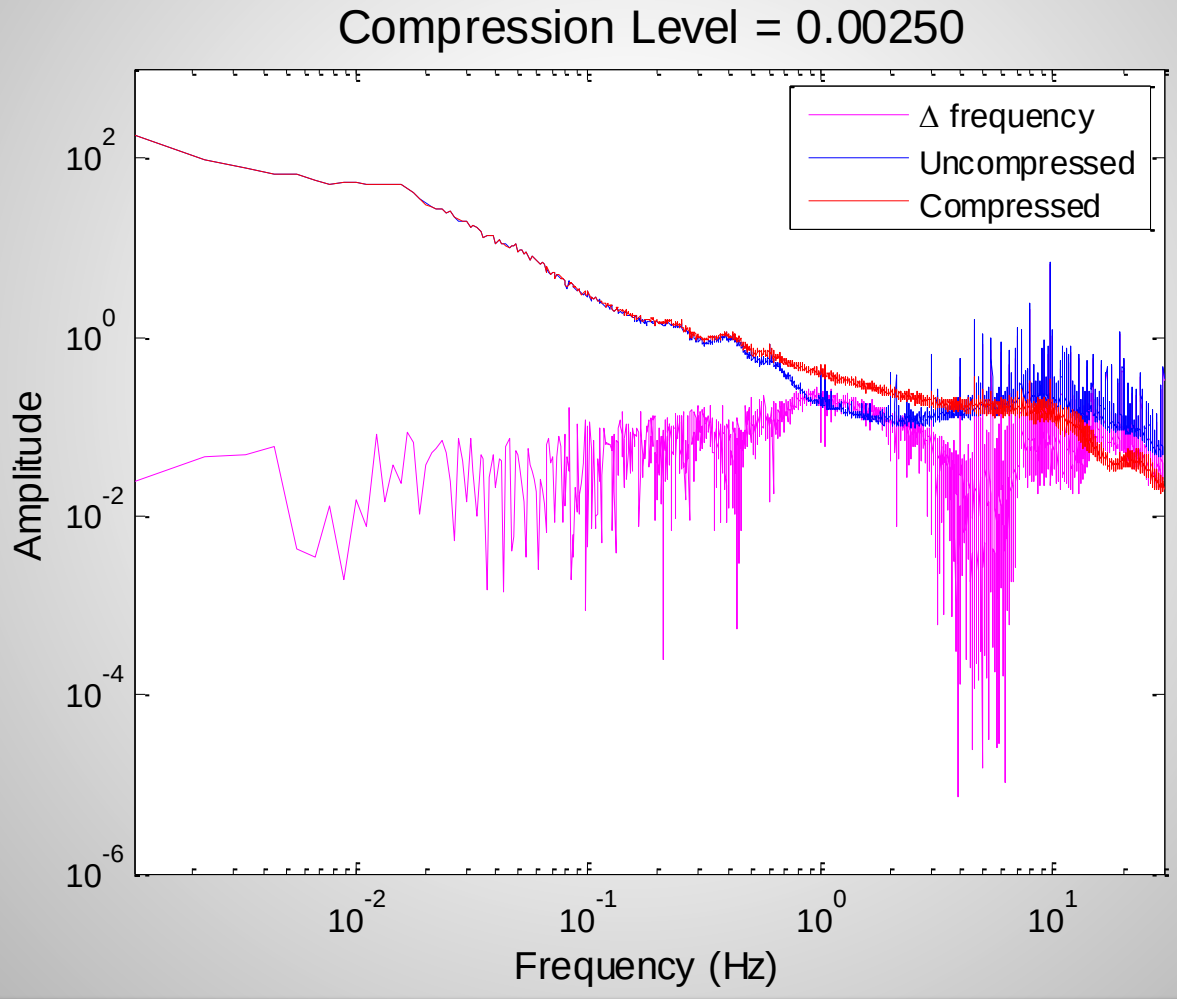
Summary

- Collected data with different compression levels and from different locations
- Used FFT to study the effect of the different compression levels
- Compared the signals from the same Power Management Units (PMU) with different sampling rates
- Compared the signals from PMU's at different locations

Distortion and compression level



Distortion and compression level



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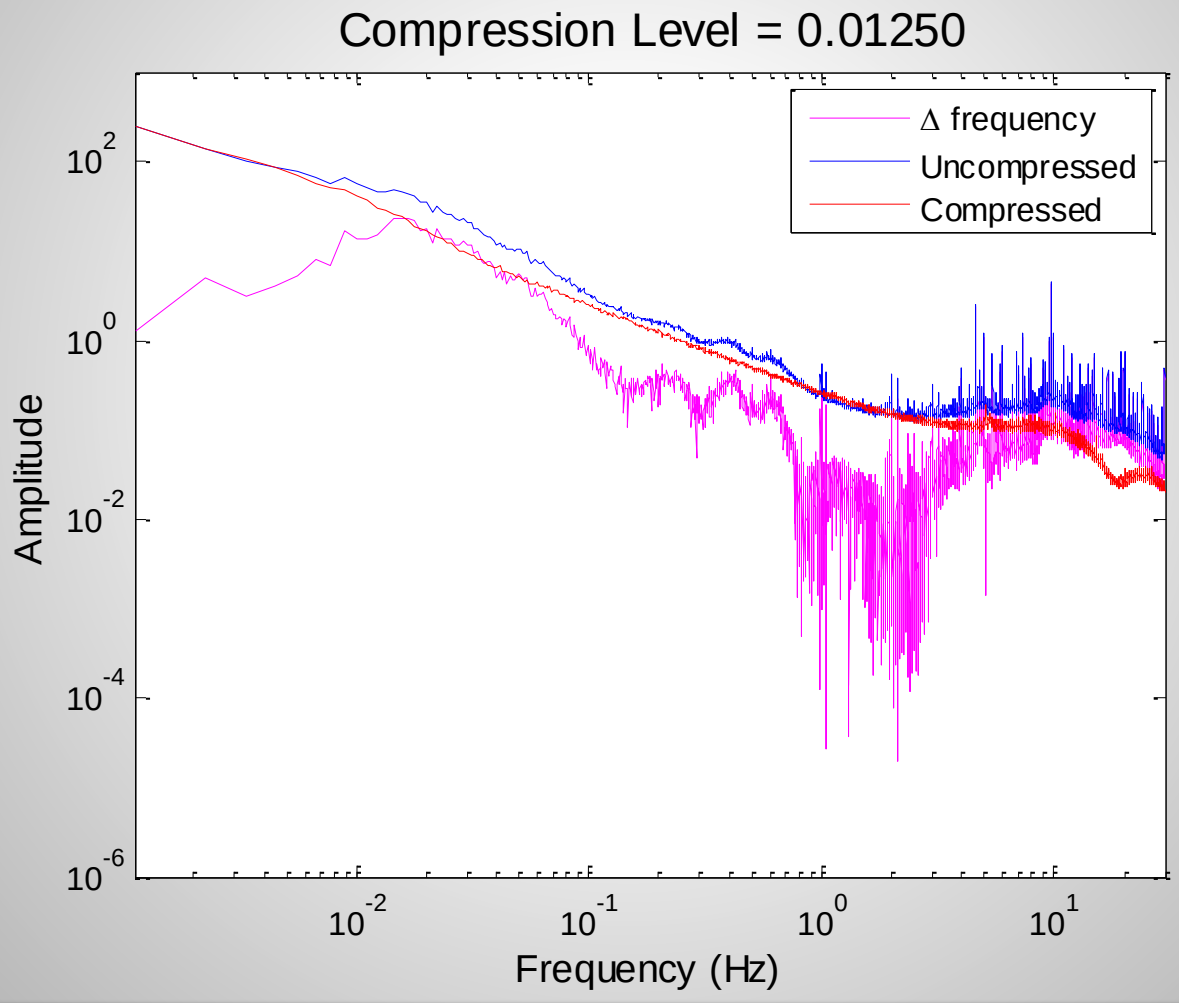
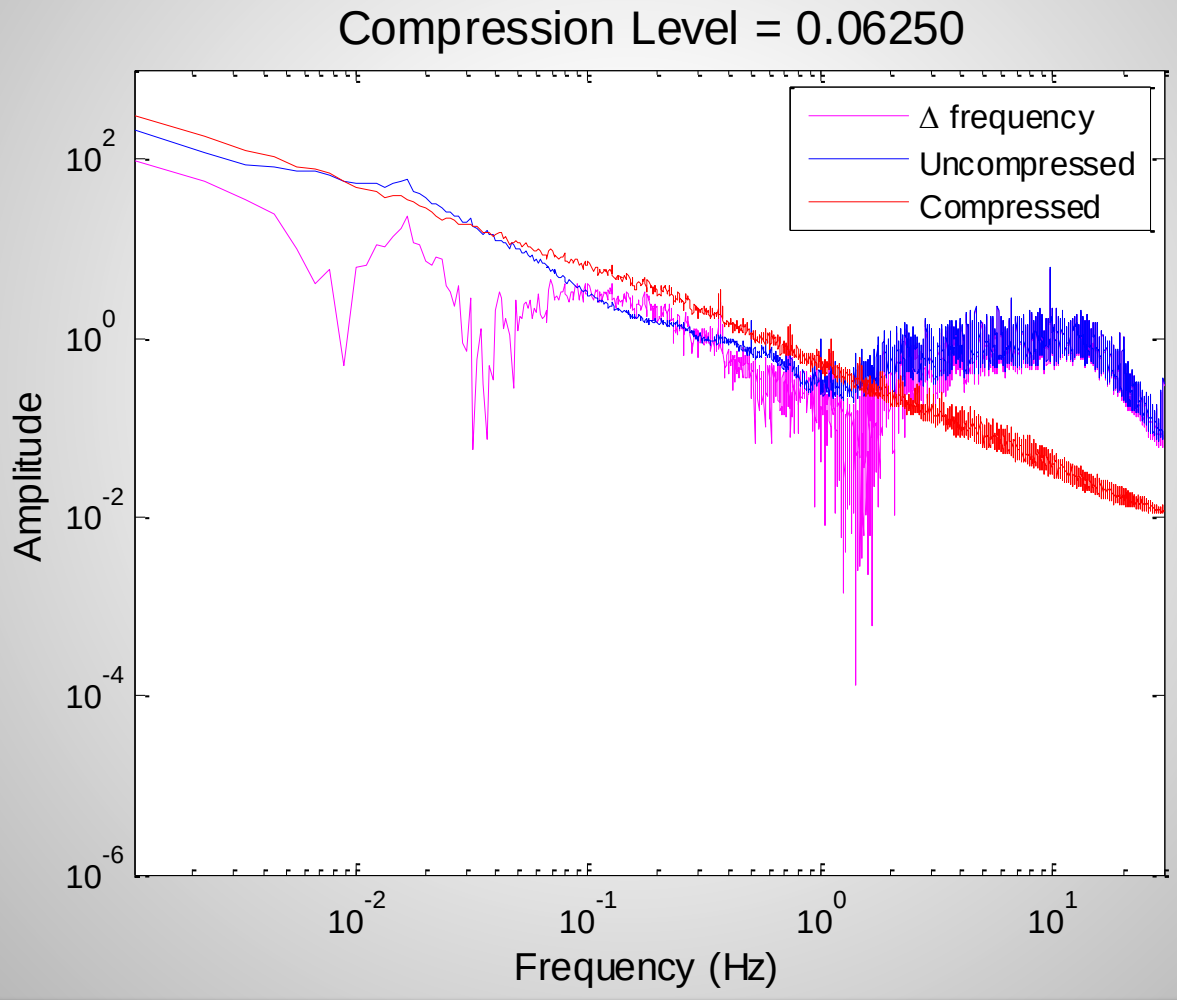


Distortion and compression level



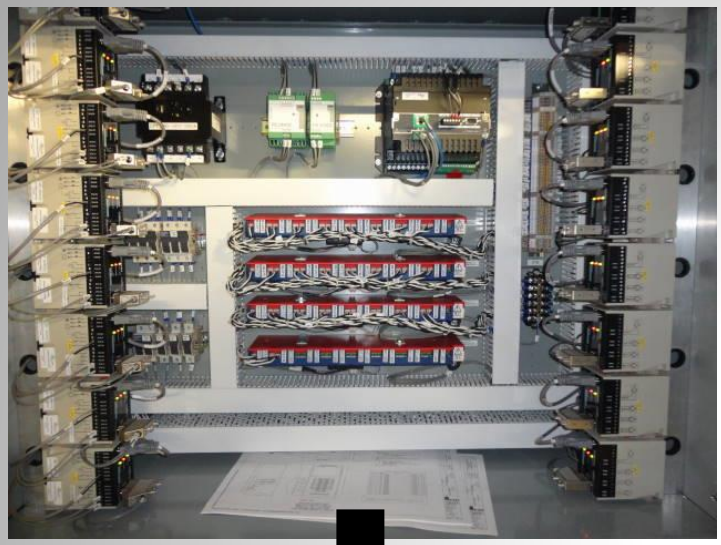
Conclusions

- Based on this data the recommended value of PI compression with limited impact on the data is 0.0007 Hz, this corresponds ~ 66% space savings

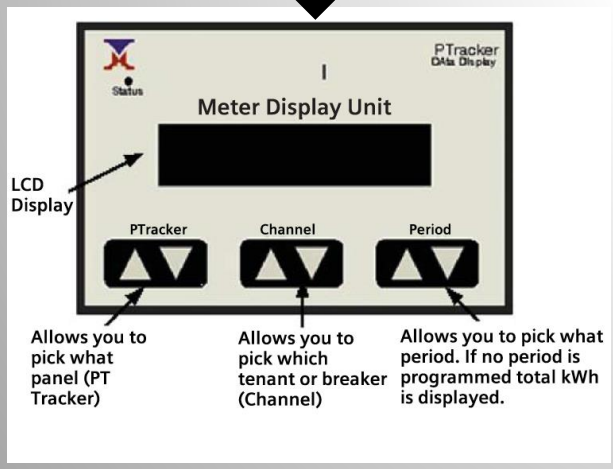
Sequoia Overview

- Sequoia
  - IBM Blue Gene*/Q machine
  - 98,304 nodes
  - 1,572,864 cores
  - 20 PF
  - 96 racks
  - 91% liquid cooled
  - 30 gpm at 62 F
  - 9% air cooled
  - 1700 cfm at 70 F
  - 4000 sf

Sequoia Meter Data Collection



Data from Sequoia power meters, along with other LLNL HPC systems and facilities data, is collected and analyzed by the OSIsoft PI infrastructure management system.



#1 on June 2012 Top500 and Green500

Questions

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