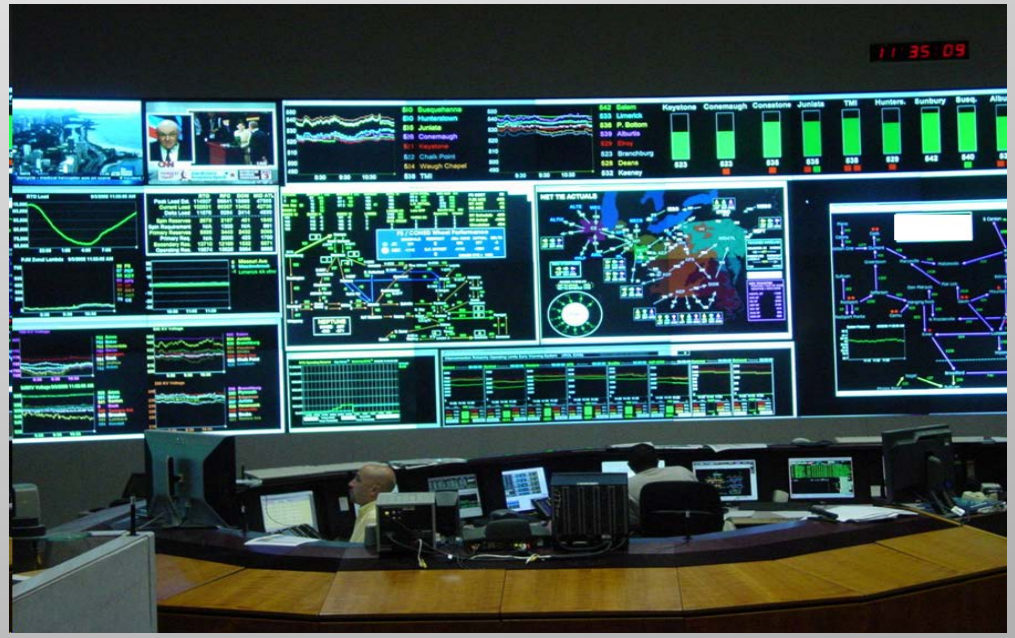
Value of Measurement and Power Provider Communications in High Performance Computing

Supercomputing 2013

November 17, 2013

Bob Conroy, OSIsoft



HPC - Value of Metrics and Communications

- HPC – What is being measured?
- Operational Questions
- Data from Disparate sources
- Operational Challenge
- Power Provider Perspective
- Communications between HPC Center and Power Provider

Measurement and Communications

Measure to Manage

MEASUREMENTS

Power
- Quality
- Load
- UPS Batteries
  - Float Voltage
  - Temperature

Mechanical
- Chillers
  - Set points
  - Efficiencies
- CRAC
  - Humidity
  - Temperature
- Liquid Cooling
  - Water quality
  - Flow
  - Pressure

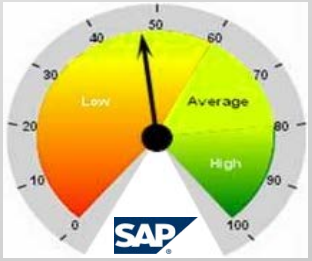
IT
- Network
- Device Performance
- Server
- Job scheduling

OPERATIONAL QUESTIONS

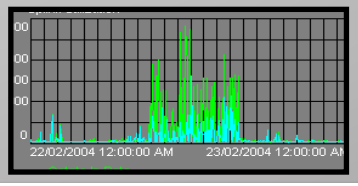
- How are these measurements monitored?
- What is impact of job scheduling on power demand variations?
- What is impact of scheduled maintenance?
- What provisions are made to communicate variations to power provider?
- Impact on performance

OUTCOME

- Power forecasts based on real data
- Improved efficiency



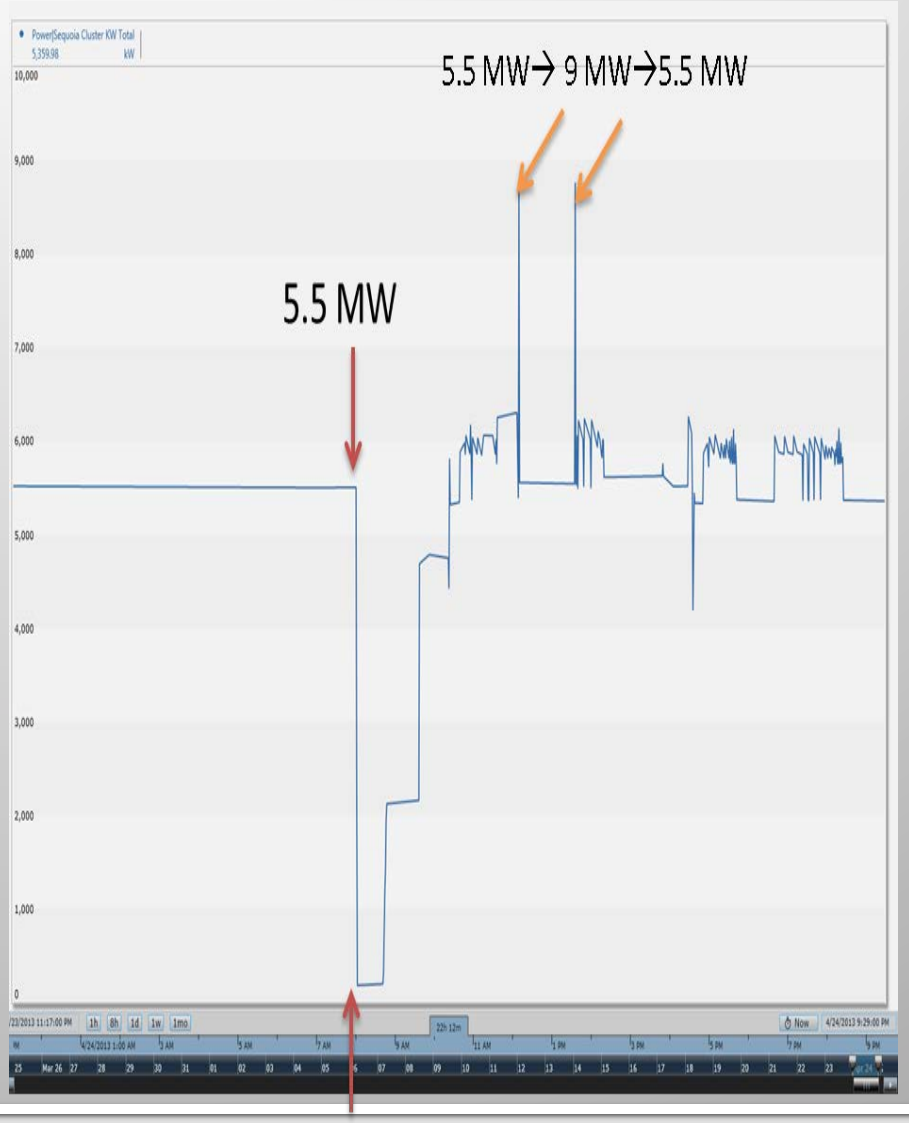
- Predictability
- Reliability
- Provider relationship



Operational Challenge

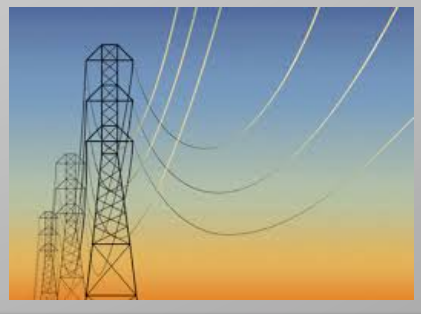
From Anna Maria's Intro:

- 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



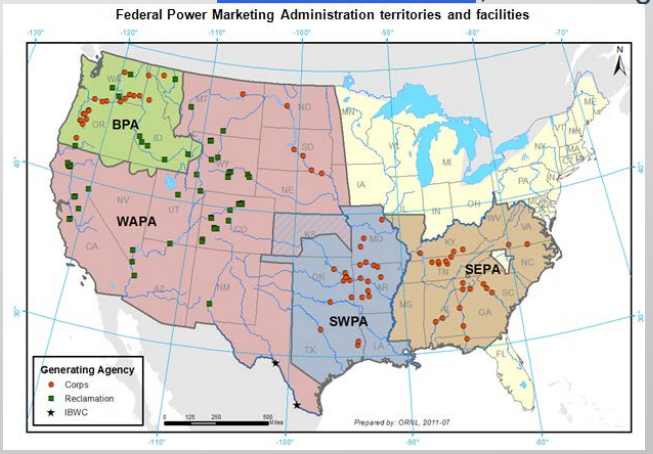
Communications With Power Provider

- HPC facilities are using increasing amounts of power
- Top 25 HPC sites use between <1 and 20+ MW
- Scheduled maintenance can result in 5 MW load swings to the grid in a short period of time
- Other sources and patterns of power variation need to be better understood
- HPC centers are just beginning to engage in demand dialog with their power providers
- For larger HPC Centers, there is value in regular communications with providers



Power Provider Perspective - WAPA

- Western Area Power Administration (WAPA) markets and transmits hydroelectric power from 57 powerplants operated by the Bureau of Reclamation, the U.S. Army Corps of Engineers.
- WAPA's Sierra Nevada Region manages transmission facilities in California:
  - 50% of SN's load is located in the Sacramento Municipal Utility District's balancing authority area.
  - 50% is located in the California Independent System Operator (CAL ISO) balancing authority area.
- WAPA must operate the balancing authorities in accordance with NERC standards, including:
  - Operating Reserves
  - Automatic Generation Control
  - Frequency Response
  - Power Balancing Control Performance
  - Emergency Operations
  - Capacity Emergencies
  - Verification of Power Capability
  - Voltage and Reactive Capacity



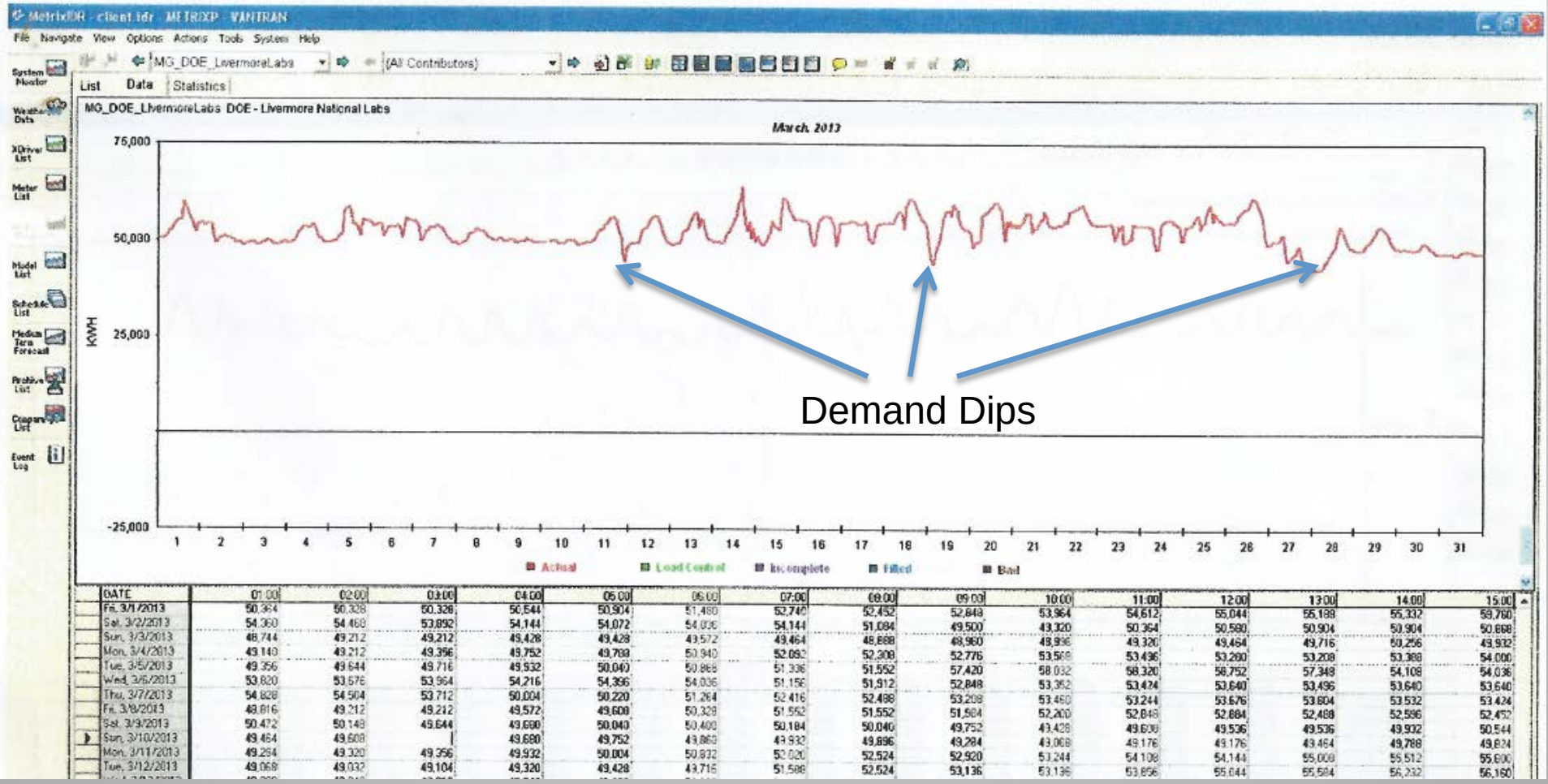
- Failure to operate in accordance with guidelines can cause grid instability, fines.
- WAPA needs to understand the dynamic load characteristics of its large power users
- WAPA adjusts dam gate flow and spill based on power forecasts

WAPA-LLNL Relationship

- WAPA supplies power to LLNL, LBL and SLAC
- Power forecasting at LLNL and elsewhere can be challenging – 5 MW swings
- LLNL HPC Maintenance occurs every Wednesday. Neither depth nor duration of power dip is sufficiently predictable. Not enough cycles.
- LLNL is capturing additional data on load profile during maintenance and other times
- WAPA requirements
  - Want demand variation to be <5%
  - Want forecast 2 days in advance; 5 days in advance for holidays.
- WAPA has 90 minute window in which to do power forecast
- Data at WAPA's planning desk is 6 hours old.
- WAPA needs data by 10AM Monday for Wednesday (LLNL maint day) forecast.
- Opportunity to explore secure link between LLNL and WAPA to eliminate time lag

Power Provider – WAPA View of LLNL Load

March 2013:



DATE	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00
Fri, 3/1/2013	50,364	50,328	50,328	50,544	50,904	51,480	52,740	52,452	52,848	53,964	54,612	55,044	55,188	55,332	58,760
Sat, 3/2/2013	54,360	54,468	53,892	54,144	54,072	54,036	54,144	51,084	49,500	49,320	50,364	50,580	50,904	50,904	50,868
Sun, 3/3/2013	48,744	49,212	49,212	49,428	49,428	49,572	49,464	48,888	48,960	48,996	49,320	49,464	49,716	50,256	49,932
Mon, 3/4/2013	49,140	49,212	49,356	49,752	49,788	50,940	52,092	52,308	52,776	53,568	53,496	53,280	53,208	53,388	54,000
Tue, 3/5/2013	49,356	49,644	49,716	49,932	50,040	50,868	51,336	51,552	57,420	58,032	58,320	58,752	57,348	54,108	54,036
Wed, 3/6/2013	53,820	53,676	53,964	54,216	54,396	54,036	51,156	51,912	52,848	53,352	53,424	53,640	53,496	53,640	53,640
Thu, 3/7/2013	54,828	54,504	53,712	50,004	50,220	51,264	52,416	52,488	53,208	53,460	53,244	53,676	53,604	53,532	53,424
Fri, 3/8/2013	48,816	49,212	49,212	49,572	49,608	50,328	51,552	51,552	51,984	52,200	52,848	52,884	52,488	52,596	52,452
Sat, 3/9/2013	50,472	50,148	49,644	49,680	50,040	50,400	50,184	50,040	49,752	49,428	49,608	49,536	49,536	49,932	50,544
Sun, 3/10/2013	49,464	49,608		49,680	49,752	49,860	49,932	49,896	49,284	49,068	49,176	49,176	49,464	49,788	49,824
Mon, 3/11/2013	49,284	49,320	49,356	49,932	50,004	50,832	52,020	52,524	52,920	53,244	54,108	54,144	55,008	55,512	55,800
Tue, 3/12/2013	49,068	49,032	49,104	49,320	49,428	49,716	51,588	52,524	53,136	53,136	53,856	55,044	55,584	56,232	56,160

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Power Provider – WAPA View of LLNL Load

June 2013:

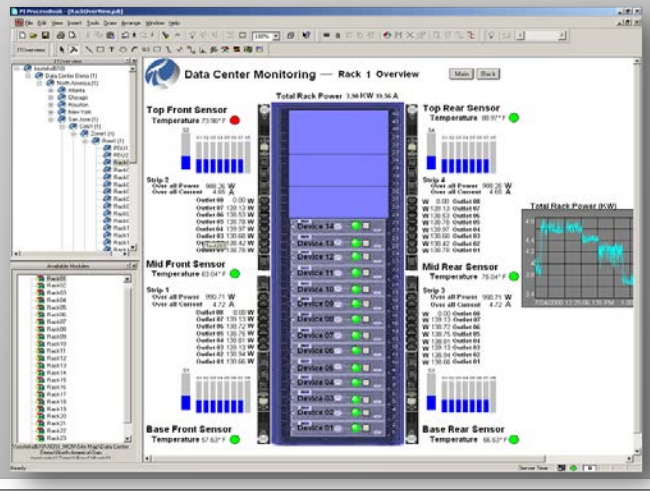
DATE	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00
Sat, 6/1/2013	50,004	49,968	49,644	49,392	49,140	49,212	48,780	49,356	50,364	51,732	53,136	53,892	54,720	55,260	55,836
Sun, 6/2/2013	50,760	50,436	49,824	49,608	49,068	49,924	48,168	48,600	49,428	50,580	51,480	52,128	52,920	53,712	54,360
Mon, 6/3/2013	49,572	49,644	49,320	48,780	48,636	49,780	49,320	50,364	52,308	54,648	56,988	58,284	59,112	59,904	60,372
Tue, 6/4/2013	49,392	49,608	49,860	49,932	49,176	49,644	50,508	51,480	52,056	52,236	53,496	55,476	56,160	57,204	57,888
Wed, 6/5/2013	49,320	49,500	49,356	49,356	49,356	49,896	50,796	51,660	51,480	51,696	53,352	55,260	56,196	56,880	58,176
Thu, 6/6/2013	49,248	49,212	49,104												

Value of Communications

- With near real time connection, WAPA will have better information with which to prepare power forecast
- Known power variations (heavy loads, scheduled maintenance, vacation days) can be built into WAPA forecasts.
- Improved forecasts and communications can help avoid unexpected peaking or sell-off effects for WAPA.

Summary

- Have a plan for sensors and measurements – fill in gaps
- Track power usage and patterns for different operational situations
- Build model for power forecasting
- Adjust model with cycles and experience
- Improve Communications with Power Provider



Questions?

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