Experiments in Integrated Data Center Power and Cooling Analysis

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About the project

- The need for large scale computing continues to rise, and companies are turning to data centers to meet those needs
- Large clusters of servers are expensive to run, and expensive to cool
- Cooling devices (especially chillers) consume lots of power and are subject to physical wear
- Data center operators need access to as much information as possible!

About the data

- Data for this project was collected from a number of sensors at the PNNL Energy Smart Data Center
- 8 server racks (1 network, 2 air cooled, 5 liquid cooled)
- Two application loads (high density / low density)
- Three different application test runs

Approach 1: Analysis with Scripts

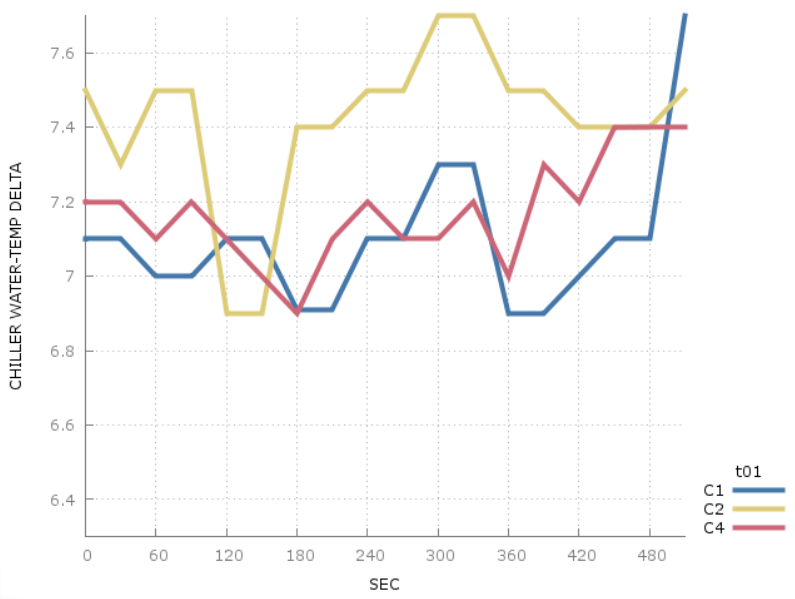
- A set of custom tools was written to work with sensor data provided in CSV format
- Mostly Haskell with calls to Gnuplot (earlier prototypes also used C, Perl and shell)
- Generates a complete report including tables and graphs
- Calculates and graphs metrics such as temperature deltas, COP (coefficient of performance) and power usage

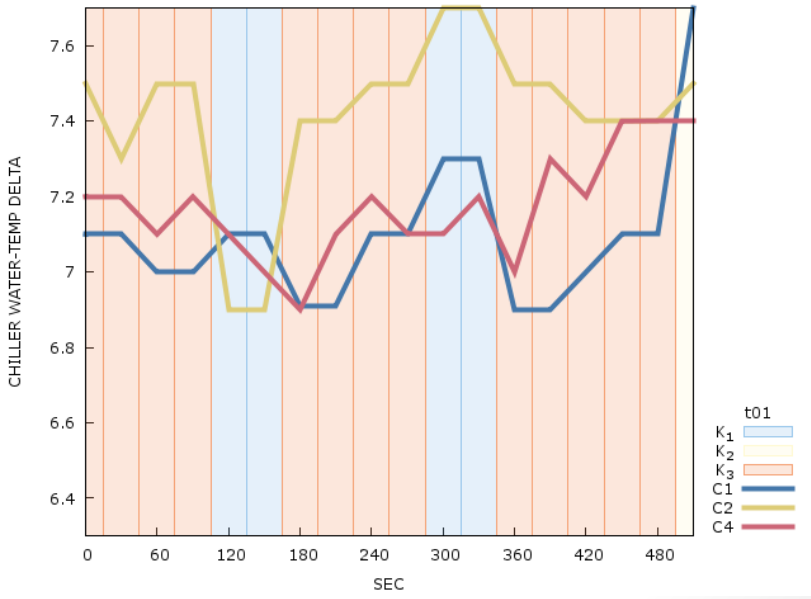
Analysis with Scripts (cont.)

- Cluster analysis based on output of metric calculations
- Our work uses ELKI, an open source data mining tool with many customizable options (such as choice of clustering algorithms)
- We tried clustering on various metrics, including chiller water temperature deltas, coefficient of performance (COP) and cooling load
- We developed a method to overlay cluster information over previously generated graphs

Time-correlated cluster charts

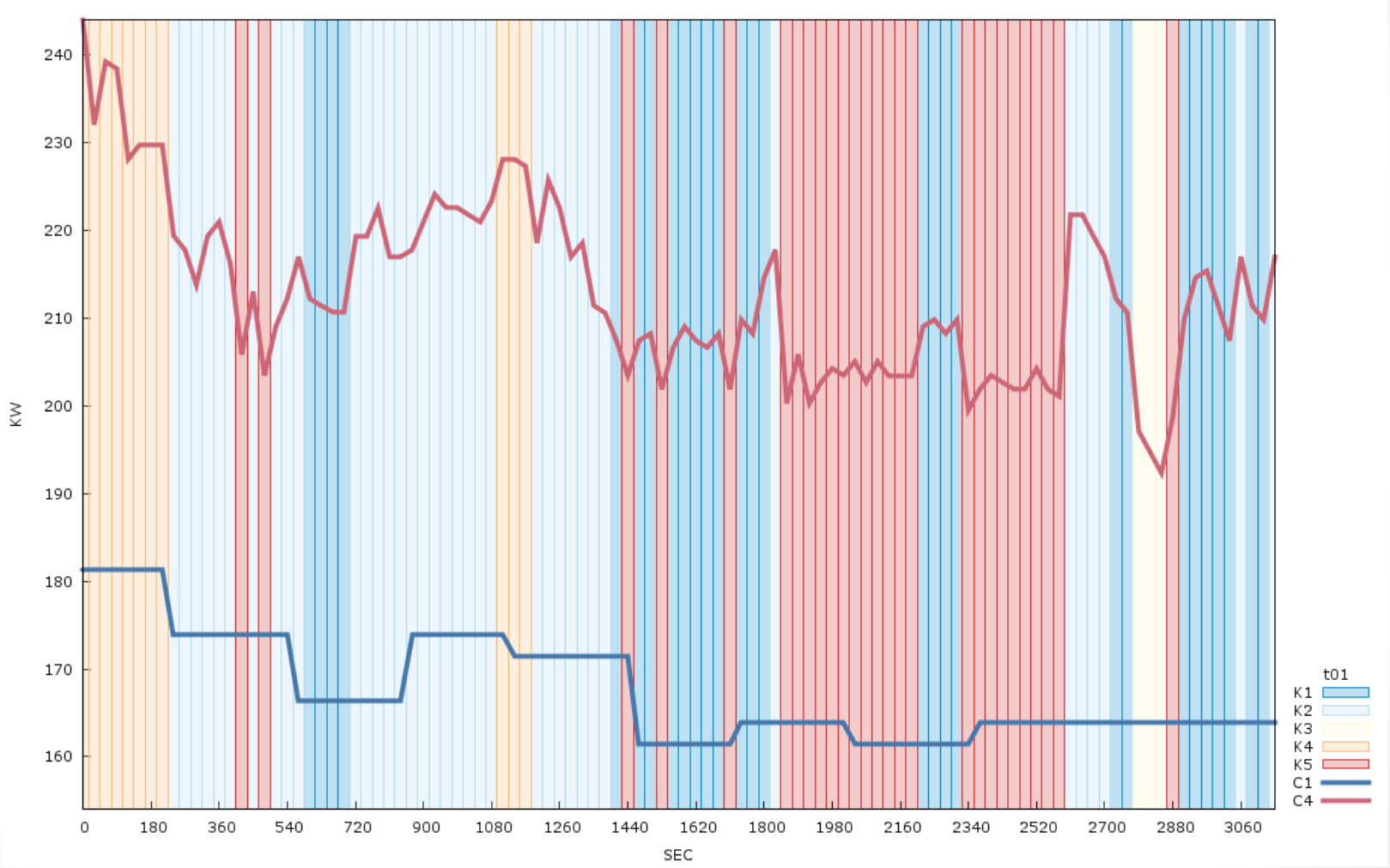
- On the left – low density chiller temperature delta chart
- On the right – the associated time-correlated chart





Chiller Power (KW) chart, HD data

Associated time-correlated cluster chart



Approach 2: Perftrack Modifications

Perftrack Modifications (cont.)

Limitations / Future work

- Need more (and more accurate) data!
- Full integration of script work into Perftrack
- Modification of scripts to support direct connection to FRED in place of CSV file access
- Experiment with motif-based cluster analysis (this would require more data)