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# Data Center Cooling Based on Predicting Power

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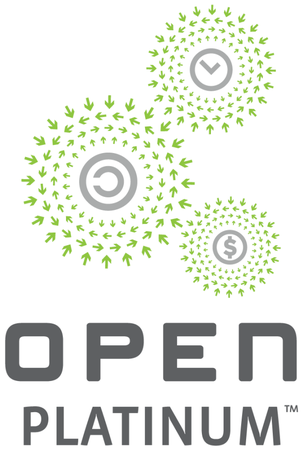

# Increasing DC Electricity Use and Optimizations

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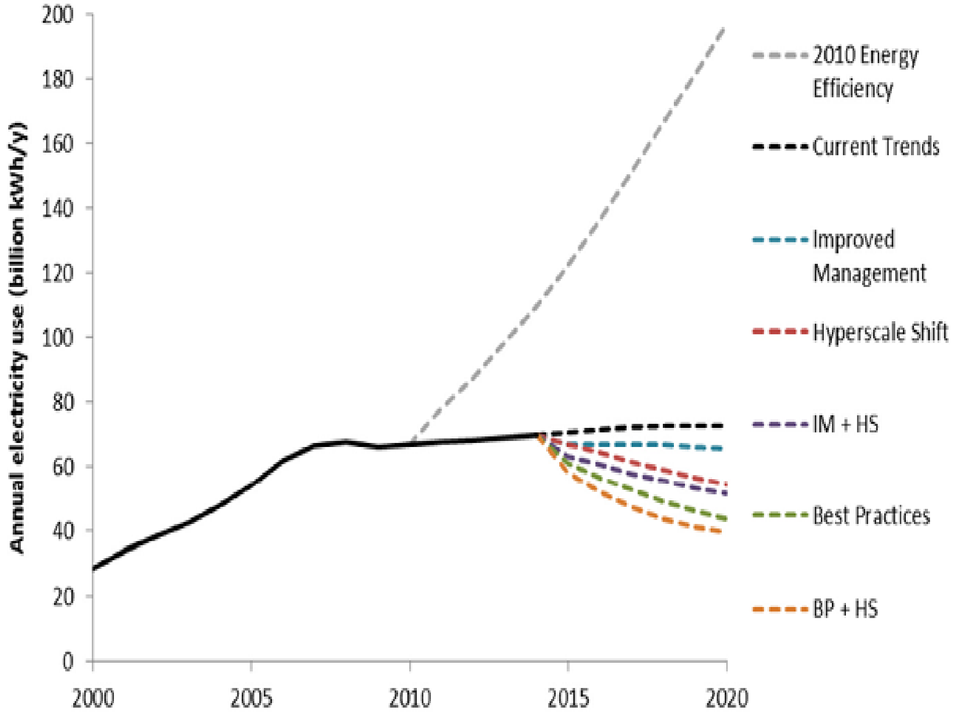
Improved Management + Hyperscale:

- Monitoring power, thermal and compute usage (determine under-utilized servers)
- Connect IT and Facilities (for improved efficiency and performance)- Dynamic changes based on demand

Best Practices + Hyperscale:

- Expanded environmental range - high temperature operations
- Free air cooling
- Use of liquid cooling when applicable
- Custom server / rack design - squeeze as much compute in same footprint
- Efficient power delivery

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# Industry Trends : Automation using Machine Learning

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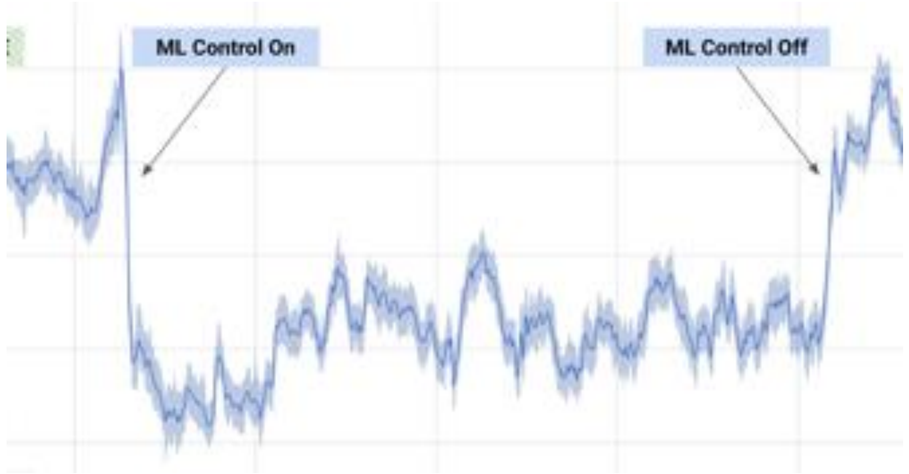
AI reduces Google Data Center cooling bill by 40% and overall PUE reduction of 15%

- Historical data collected by thousands sensors
- Data included: thermal, power, pump speeds, setpoints
- Neural network framework




rhttps://www.computerweekly.com/news/252447126/Google-Deepmind-doubles-down-on-AI-led-efforts-to-improve-datacentre-energy-efficiencyg

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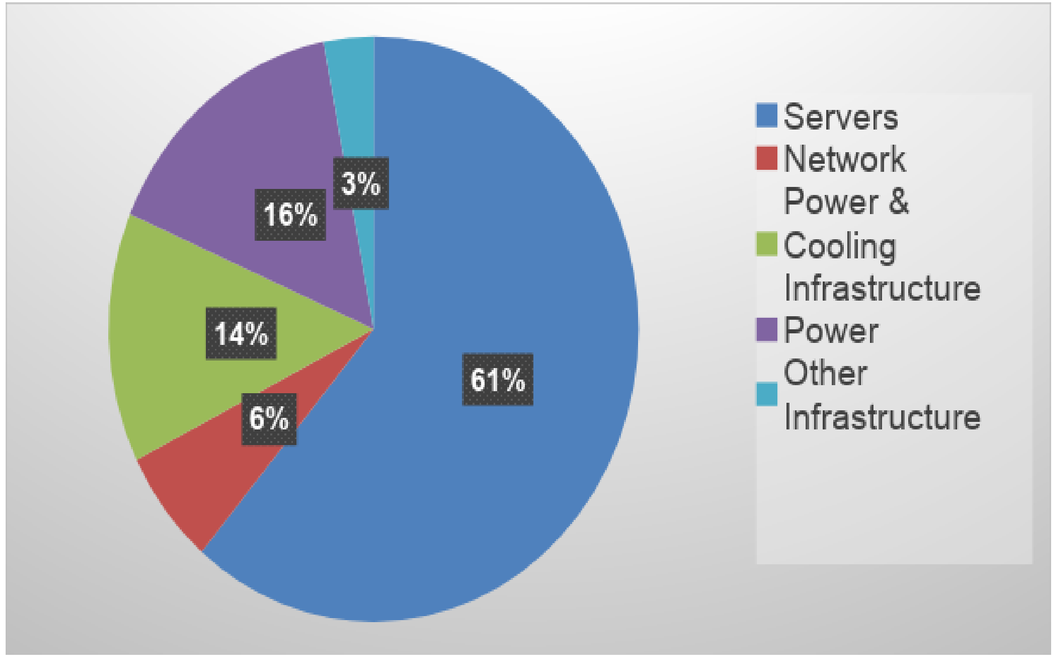
# Overall TCO at HyperScale

- Power/Cooling 30% of TCO
- Goal for optimization:
  - Lower Power/Cooling
  - More Compute




Source: AWS Distinguished Engineer - James Hamilton Blog

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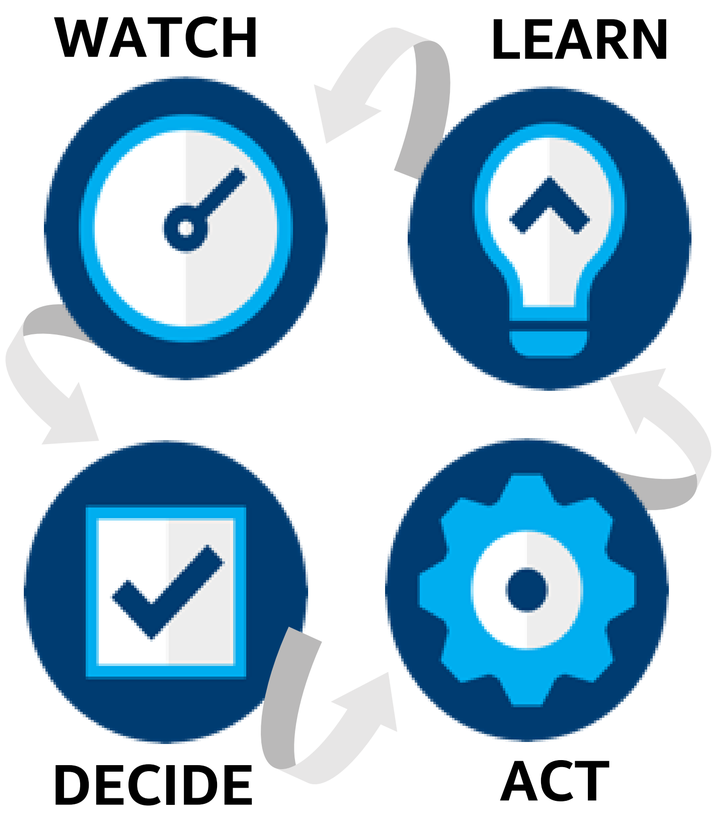
Assumption: 10MW facility ; PUE 1.25; $0.10c/KWhr power cost; 3 year server amortization; 15year datacenter amortization

# Telemetry and Analytics – Approach to automated Data center

Telemetry
Expose infrastructure attributes through standard API approach (e.g. Redfish)




Learning
Vast data sources drive continuous improvements

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Analyze
Rules based event provisioning and optimization heuristics

Control
Control mechanisms and API for dynamic policy activation(e.g. leverage Redfish)

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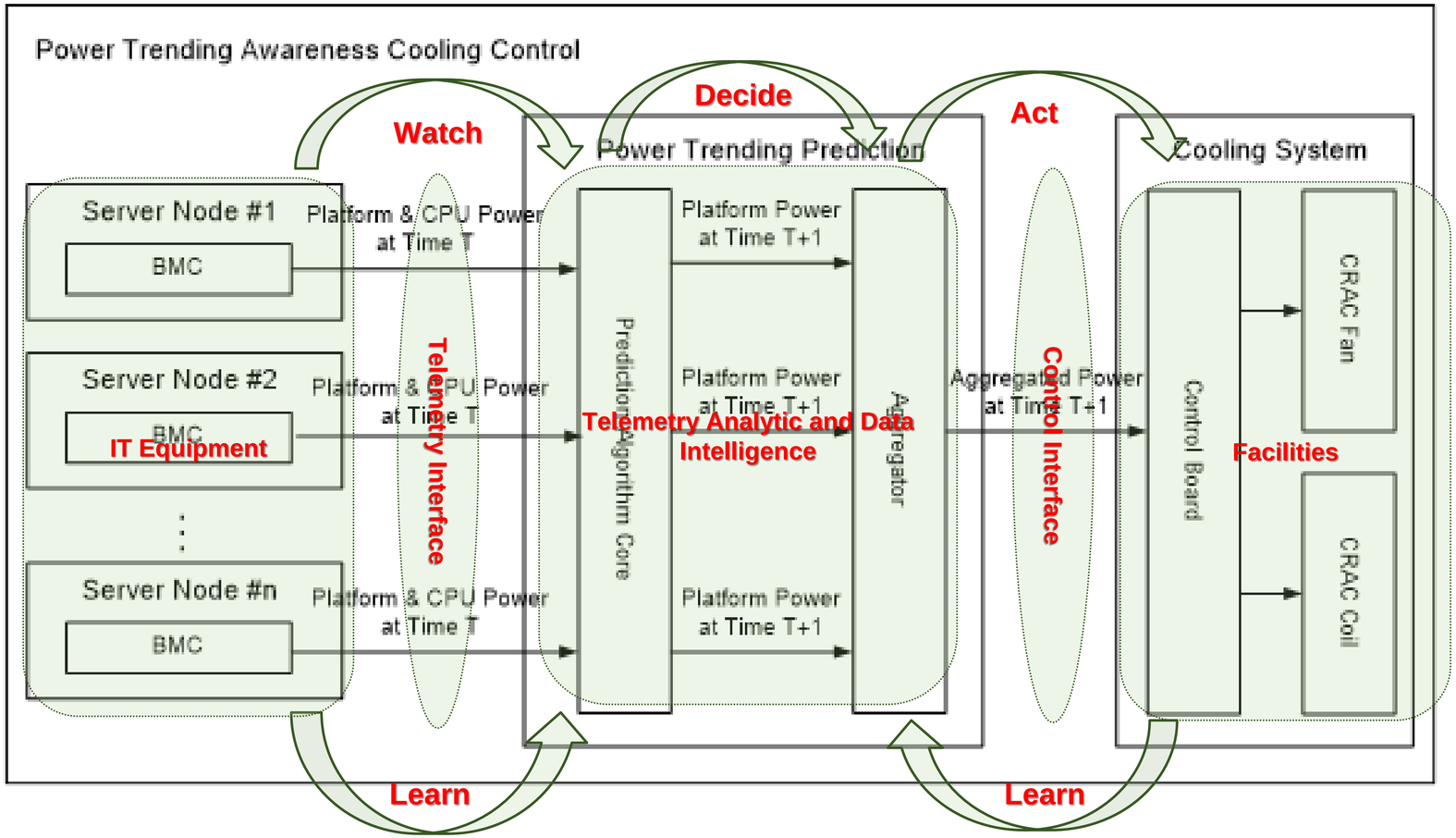
Infrastructure Telemetry based analytics is the foundation required to develop trust and raise the data center IQ

# Case - Machine powered control loop to reduce overcooling

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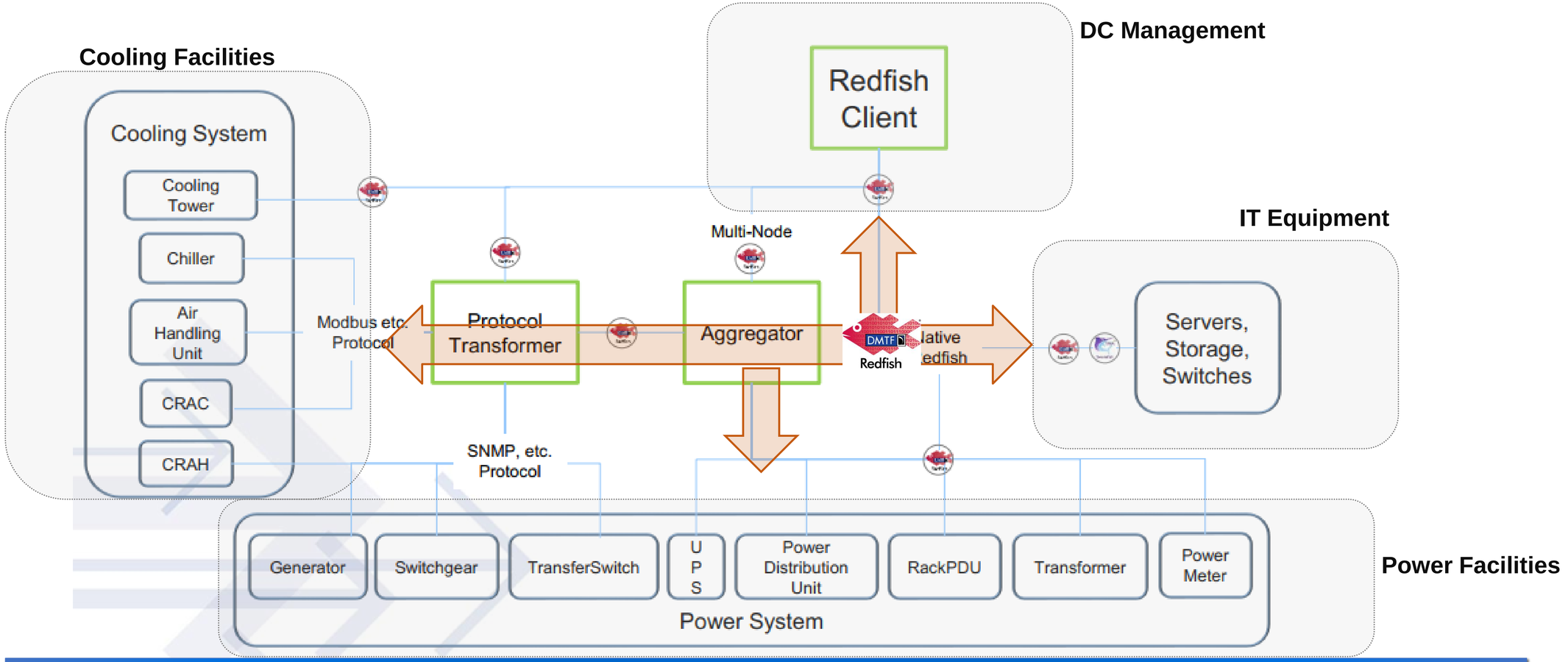
Saved 24% cooling energy cost for a large CSP by controlling facility fans and temperature setpoints to match IT equipment needs

# Redfish API Example [1] to support DC interoperability




Opportunity for a common resource model and API among IT equipment, DC facilities and DC management to reduce integration cost

[1] Refer to DSP_IS_0005.pdf (https://www.dmtf.org/sites/default/files/standards/documents/DSP-IS0005_0.8a.zip )

# Data Center Thermal Management

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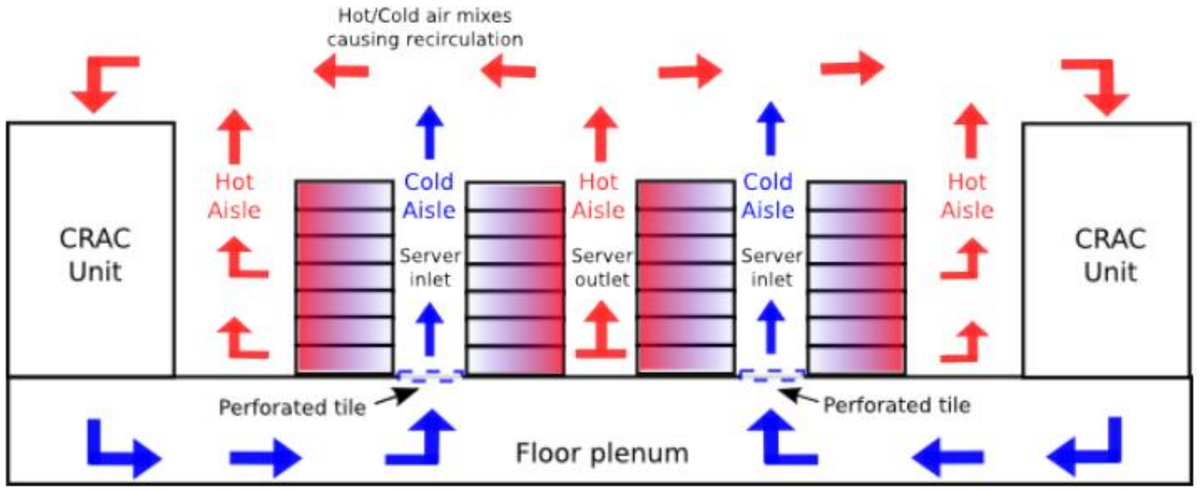


## Typical Data Center Cooling Management

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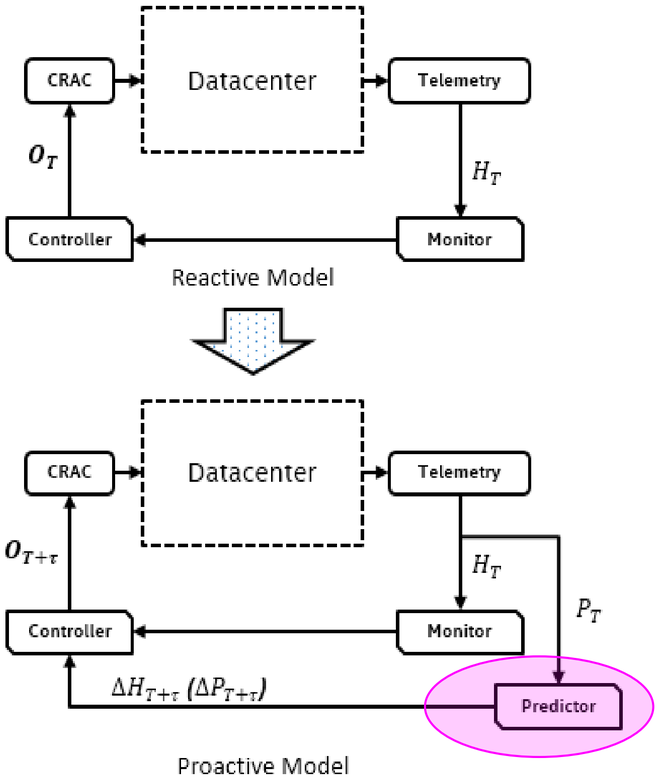
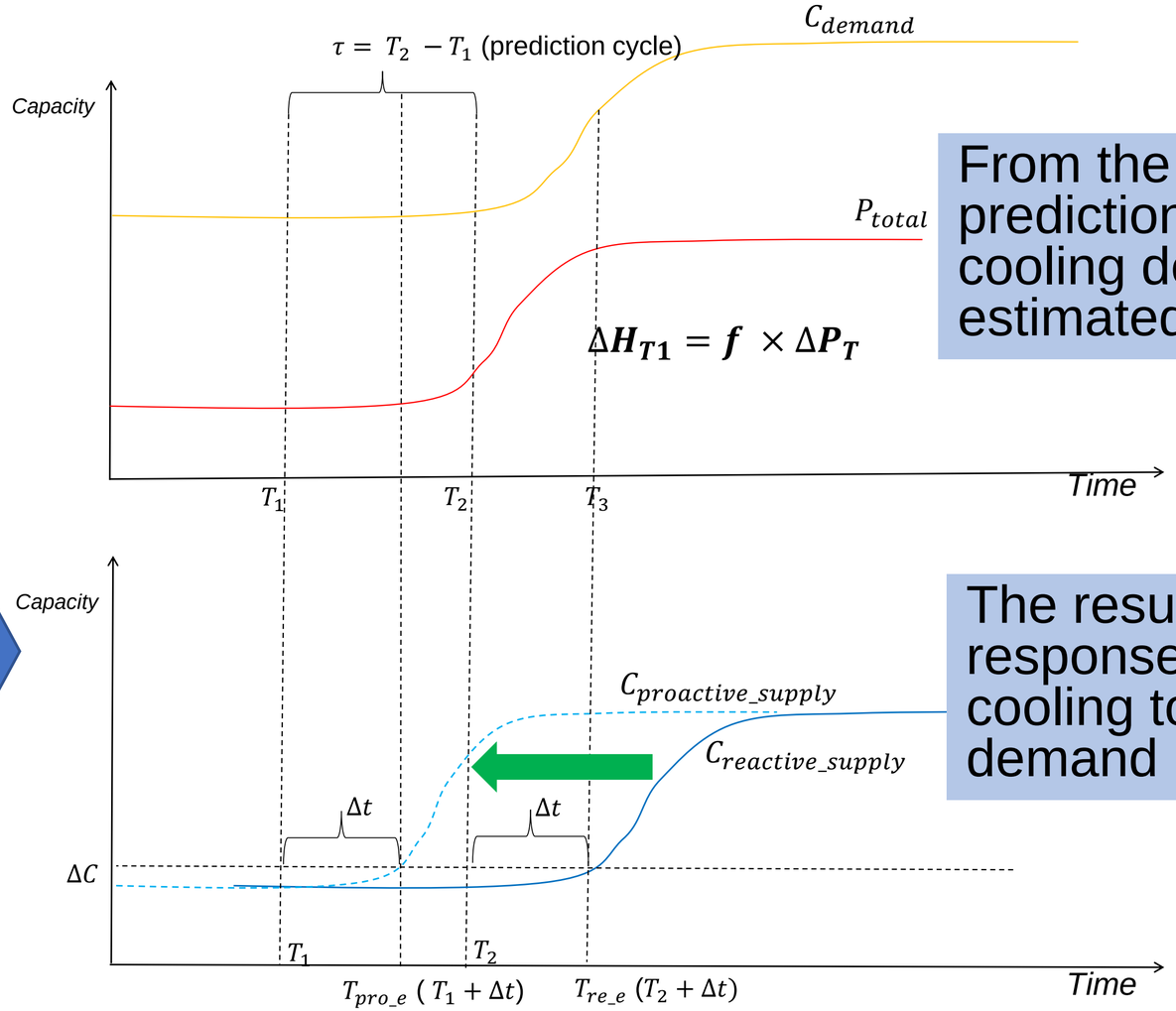
# Power Prediction in Cooling Management




Adding power predictor into cooling control loop

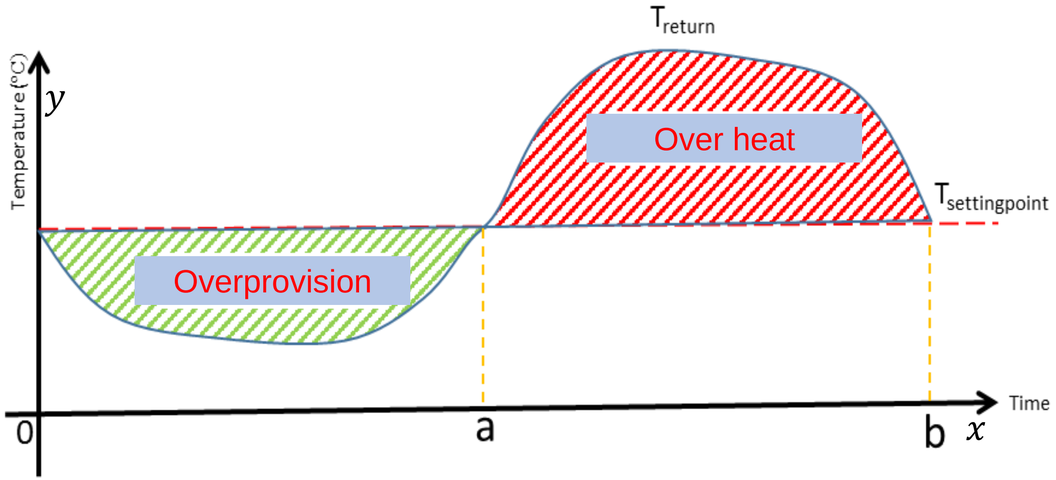



From the power usage prediction, the change in cooling demand can be estimated

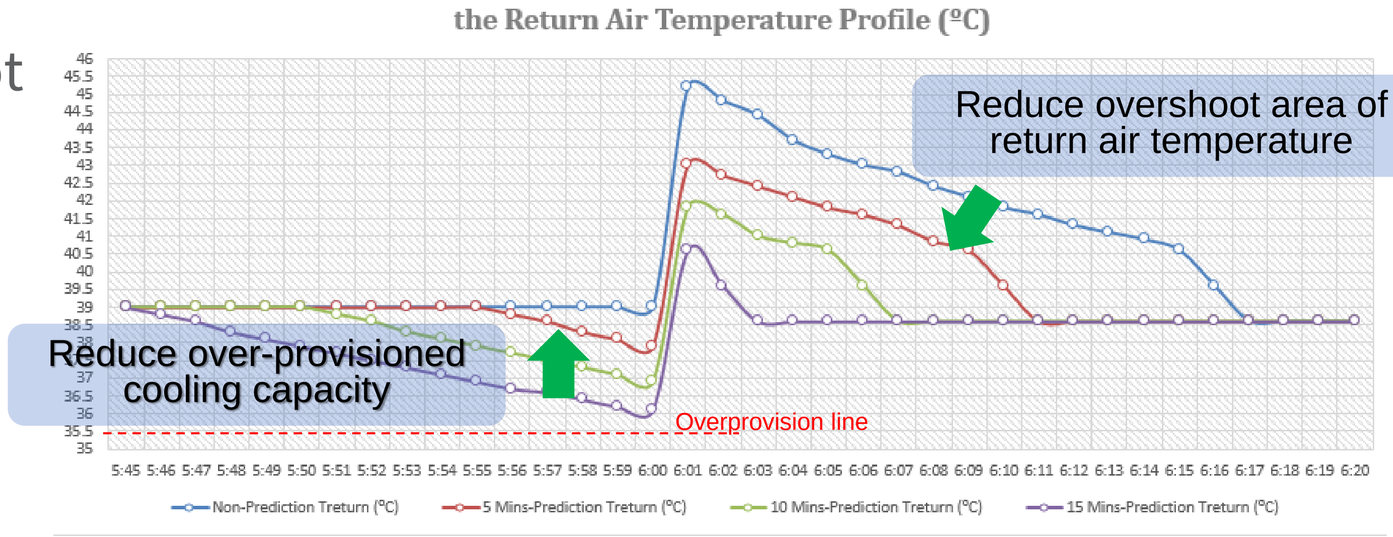
The result is an earlier response in supplied cooling to meet cooling demand

# Evaluation Model and Result

- Overshoot and Undershoot
  - Overshoot – over heat risk
  - Undershoot – no over heat risk but with overprovision, implicated cooling waste




- Cooling Risk Indicator ($R_c$)
  - Definition: Integral calculus of overshoot area
  - Equation: $R_c = \int_b^a (T_{return\_x} - T_{setting\ point})\ \mathrm{d}(x)$



# Call to Action

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- IT platform telemetry intelligences are important to drive data center facilities optimization for overall PUE efficiency. Need more value add solutions and design cases for using IT platform telemetry in data center facility management.
- Big challenges for DC wide interoperability, especially IT platform telemetry integration with data center facilities. Need industry collaboration to define telemetry requirement spec. and API model in OCP community to support such case.
- Be part of the hyper-evolution of the data center, get involved with OCP-DCF project: https://www.opencompute.org/projects/data-center-facility

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