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Data Centers Sacrifice Reliability for Efficiency

December 2018

The eighth annual Data Center Survey by the Uptime Institute has shown that the data center industry is struggling with the complexities of hybrid IT and is failing to maintain historic levels of reliability. The survey included nearly 900 data centers across 50 countries.

Power usage effectiveness (PUE) is a measure of how efficiently a computer data center uses energy; specifically, how much energy is used by the computing equipment (in contrast to cooling and other overhead). It is calculated by dividing the power used by the computing equipment by the total power entering the data center. The lower the PUE, the more efficient the data center. For instance, Google boasts a PUE of 1.12, though some of its data centers have a PUE as low as 1.06.

The Uptime Institute's survey found that the average PUE across the data center industry had reached a record low of 1.58. The rapid growth in the implementation of cloud and hybrid IT are largely to be given credit. The survey pointed to hybrid IT as the culprit in obtaining better performance as organizations struggled to manage hybrid architectures that combined on-premises infrastructure, co-location, and public clouds.

The survey also found that the typical data center was more likely to suffer an outage, and the outages were more damaging, than they were during the last year. Hybrid IT has reduced the resiliency of the average data center. Severe service degradations were experienced by 31% of data centers over the past year, an increase of 25% over the number reported during the prior year.

According to respondents, 80% of these outages were preventable, being caused by human error, power outages, network failures, and configuration errors.

Increasing Efficiency

However, efficiency can be increased without sacrificing reliability. For instance:

- Airflow into the data center can be balanced to meet the IT requirements rather than blowing excess air into the data center.

- Fans can be upgraded.

- Running redundant cooling systems can be reduced.

- Temperature set points can be raised as most IT equipment can tolerate a warmer atmosphere than currently maintained.

There are several reasons given by data center operators for not incorporating these efficiency measures into their data centers:

- We don't pay the bills, but we are responsible for SLA (Service Level Agreement) violations.

- Efficiency doesn't do anything. A BTU is a BTU.[1]

- We haven't touched these temperature set points in years.

- My economizer is more trouble than its worth.

- Our space has lots of storage, and tapes need tighter control bands.

- Raising temperatures causes dehumidification issues.

- The customer doesn't want to introduce risk to save $30,000 per year in energy when they are transacting $1 million per day.

- Raising temperatures too high will cause my server fans to ramp up, increasing energy consumption and reducing fan life.

- If the cooling fails, I'll have less thermal ride-through before I get outside my SLA.

Thermal Ride-Through

Thermal ride-through is the time that a data center will maintain the SLA temperature requirements during a cooling outage. How long does the data center have before its temperatures exceed the point at which IT equipment may be damaged?

Most data centers do not test thermal ride-through in a live operating environment for fear of damaging IT equipment. But every data center is different. Considerations include:

- Understanding existing conditions.

- What is the data center's risk tolerance?

- What is the data center's budget?

- What is the data center's utility cost and the true opportunity for savings?

- Is the rate of temperature change important or relevant?

[1] A British Thermal Unit (BTU) is the amount of energy required to raise the temperature of one pound of water by one degree Fahrenheit.

- What is the health of the Air Management System?

Assess Existing Conditions

One systematic approach for an existing data center is to assess the existing conditions relative to efficiency for the data center:

- Is the Air Management System balanced?
- What are the rack inlet temperatures?
- What are the temperature set points?
- Are the controls and alarming sufficient?
- What are the utility bills?

Improvements to the data center efficiency can then be implemented:

- Improvements can be made to the Air Management System.
- Temperature controls can be optimized and the improvements can be validated.
- There must be a plan to react to unforeseen conditions when they happen.
- The temperature set points can be raised slowly (like 1° Fahrenheit per week) and the effect on the data center equipment can be re-assessed.
- The Air Management System and sensor calibration must be monitored and failures corrected.

A typical rack inlet temperature diagram is shown in Figure 1:

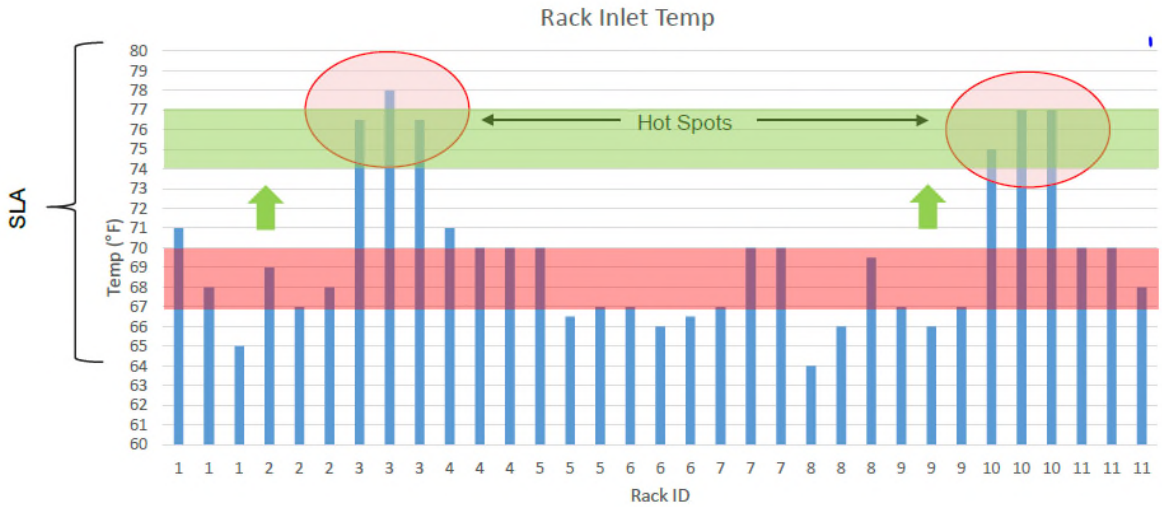

Figure 1: A Typical Rack Temperature Distribution

For this particular data center, supply temperatures are 55° F. Return temperture set points are between 67° F and 70° F. Note that racks 3 and 10 appear to be hot spots. Why? For this data center, a goal would be to get the temperatures for racks 3 and 10 into the red band.

Economizers

An economizer is a mechanical device used to reduce energy consumption. Economizers recycle energy produced within a system or leverage environmental temperature differences to achieve efficiency improvements.

Economizers are commonly used in data centers to complement or replace cooling devices like computer room air conditioners (CRACs) or chillers. Data center economizers generally have one or more sets of filters to catch particulates that might harm hardware. These filters are installed in the duct work connecting an outside environment to a data center. Outside air also must be monitored and conditioned for the appropriate humidity levels, between 40% and 55% relative humidity.

There are two versions of the device used in data centers: air-side economizers and water-side economizers:

- Airside economizers pull cooler outside air directly into a facility to prevent overheating.
- Water-side economizers use cold air to cool an exterior water tower. The chilled water from the tower is then used in the air conditioners inside the data center instead of mechanically-chilled water, reducing energy costs. Water-side economizers often operate during night time to take advantage of cooler ambient temperatures.

Economizers can save data center operators substantial operating costs. Economization has the potential to reduce the annual cost of a data center's energy consumption by more than 60 percent. Use of cooler external environmental temperatures to preserve hardware is an important component in sustainable green computing practices in general. Unfortunately, economizers are only useful for data centers located in cooler climates.

How Much Does Power Efficiency Really Save?

Experience in the field indicates that power efficiency can save 1% to 2% in power cost per 1° F temperature increase. Economizers can improve this figure somewhat.

For instance, one study showed that an economizer could reduce the annual energy cost from $350,000 to $141,000.

A Case Study

An organization with eleven data centers was chosen to evaluate the cost savings of energy efficiency. Air management was improved to provide outside cooling for the IT equipment. Temperature set points were raised to the point that the IT equipment could tolerate. Fan redundancy was eliminated.

The result was a 12% improvement in PUE. The total energy made available was increased by 18%, and the IT available energy was increased by 34%.

These changes did not appear to have impacted the data center reliability.

Summary

There are several methods available to increase power utilization efficiency without affecting data center reliability. These methods can make significant savings in the cost of power to a data center.

Acknowledgements

Information for this article was taken from the following sources:

Uptime Institute: Data centers sacrifice reliability for efficiency, *Data Center Dynamics*; August 8, 2018.
Energy Efficiency Without Sacrificing Reliability, *Intuit*; undated.