DATA CENTER OPERATING TEMPERATURE: WHAT DOES DELL RECOMMEND?

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There is lots of hype these days about operating your data center at higher temperatures. You may be asking several questions regarding this topic:

- How much does it save and do the savings outweigh the risks?
- What temperature should I target?

I hope to answer the risk question in subsequent papers dealing with reliability impacts and "ride through time". Having participated in both Green Grid and the ASHRAE datacom technical group, these are questions we discuss at length. ASHRAE, the American Society for Heating, Refrigeration, and Air Conditioning Engineers, has recently increased its recommended operating temperatures by several degrees. At a recent meeting, I approached an APC colleague on the topic of increased IT temperatures. My theory was that although an increase in IT inlet temperatures enables energy savings in the cooling process, it might be that the increased fan power associated with higher IT inlet temperatures might negate the facility efficiency advantages. What we found confirmed my hypothesis. There is a "sweet spot" operating temperature when you are using mechanical means to cool your data center.

DATA CENTER TEMPERATURE

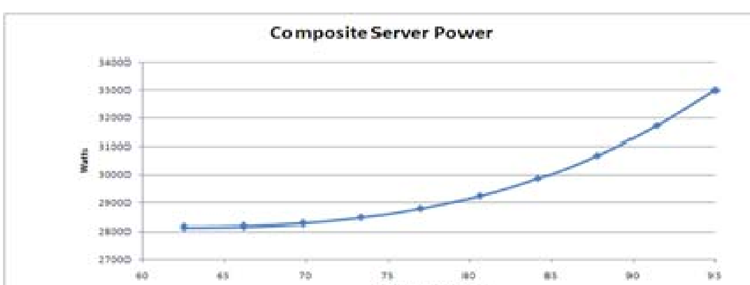
Air conditioning systems are commonly controlled by monitoring and maintaining a specific return air temperature. When discussing the room temperature or set-point, you are usually talking about the return temperature. This is NOT the temperature that is critical for IT equipment. The only temperature the IT equipment cares about is the inlet temperature, so in most cases you are talking about apples and oranges. This paper will suggest a temperature in the mid to upper 70's as being ideal for IT equipment when using mechanical cooling. But if this temperature is describing the return air temperature, the supply air temperature entering the IT is likely in the 50's. This is entirely too cold and is probably the single worst contributor to the inefficiency of the data center.

THE HYPOTHESIS

IT equipment can be really quite efficient with respect to cooling when delivered low to moderate temperatures. Designed to accommodate hot temperatures (95 degrees), internal fans spin fast and consume larger amounts of air to maintain acceptable component temperatures. With a moderate temperature of, say 75 degrees, the fans spin down, consuming a relatively small amount of air and fan energy. 75 degrees is generally the temperature where the IT fan speeds bottom out. Without selectively turning some fans off, air consumption is usually about as low as it will go at this moderate temperature. Today's Dell servers, for instance, use about 10 watts to power an entire fan bank at this temperature. But when spinning up to accommodate high temperatures, the fan power can grow 5-10X.

Prior to this experiment, the hypothesis was that there was a point somewhere between the moderate 75 degree and the high 95 degree temperature where the fan energy increase might be greater than the energy saved in the chilling process. We set out to test this hypothesis.

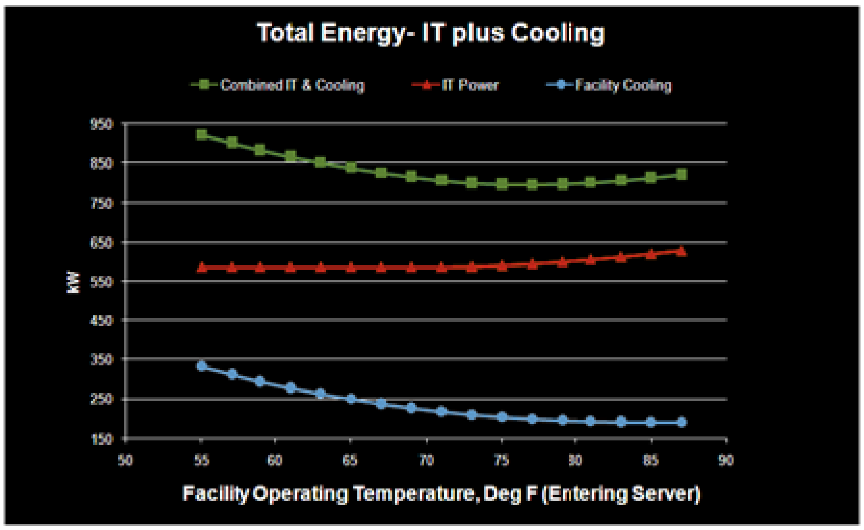
In a controlled thermal chamber, energy and airflow consumption was measured for several active servers over a broad range of inlet temperatures.



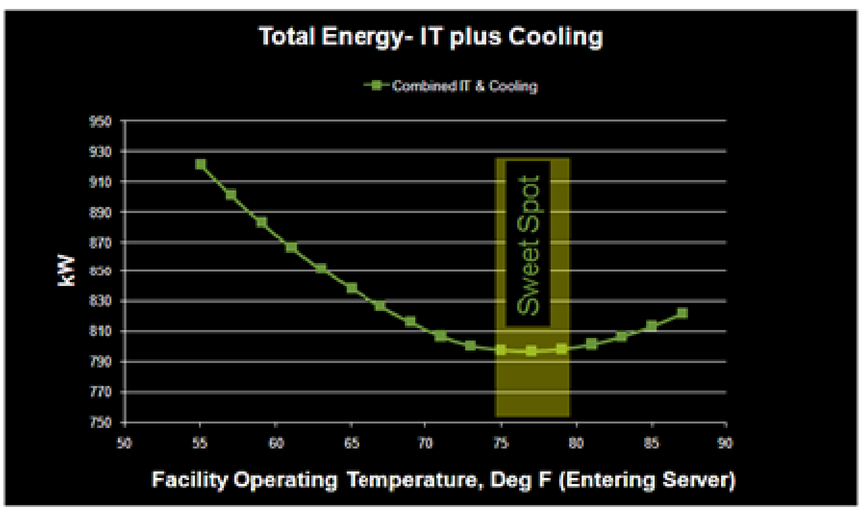
(from: "Energy Impact of Increased Server Inlet Temperature"; David Moss, John H. Bean, Jr., 2009)

THE FACILITY TEST

These server characteristics were later recreated in an APC test facility capable of measuring facility power and cooling energy use. APC sectioned a portion of their data center test facility to isolate the test from the remainder of the room. They essentially built a little room within the lab. Using racked simulator units to produce the power and flow characteristics of the servers, cooling was adjusted within the "test room" to provide cooling to the servers. Chilled water and supply air temperatures were adjusted to deliver a range of server inlet temperatures similar to the server tests run at Dell. As would be expected, the facility cooling energy decreased with increased operating temperature. But the IT power starts to increase at a temperature in the mid 70's. When combined, the total energy, including IT and cooling, hits a minimum between 75 and 80 degrees.



Zooming in on the total combined range, it is a bit easier to see where the sweet spot falls:



CONCLUSIONS

When using mechanical means to cool a data center, the highest operating temperature may not be the most efficient. This paper points to an example facility where above a certain temperature, its incremental IT power increase grew faster than the decrease in energy expended in the cooling process. ASHRAE recently adjusted their upper temperature recommendation to 27°C (80.6°F). This temperature may be slightly higher than the ideal operating temperatures for some data centers. Large energy savings are possible, primarily in the chilling process, if a data center adjusts its operating temperature upward. Attention should be paid to existing hot spots or equipment not capable of running at higher temperatures before attempting an increase in operating temperatures. Some data centers utilize economizers to substitute for the mechanical cooling process. In these facilities, the temperature of minimum facility energy would be higher.

For more information, please consider the following links:

Energy Advantages of Containment Systems:
http://content.dell.com/us/en/corp/d/business~solutions~whitepapers~en/Documents~dci-energy-advantages-of-containment-systems.pdf.aspx

Energy Impact of Increased Server Inlet Temperature:
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