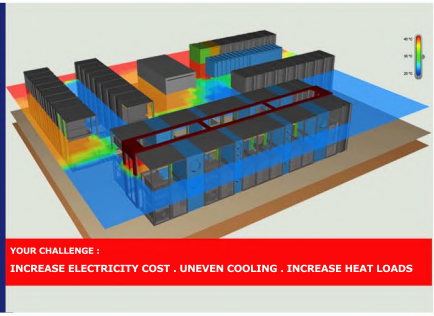
Computational Fluid Dynamics Helps Cut Cooling Costs



As server density grows, so does the need for better cooling. That's where computational fluid dynamics come in.

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The first data centers housed large, incredibly energy-inefficient mainframes that emitted tremendous heat. Ways to cool, and therefore maintain, the integrity of the machine were devised. In most cases, water was used—which was an unfortunate choice if there were leaks, as computers, electricity and water do not mix.

The problem eased with the emergence of distributed computer architectures. Each server came in its own tower case, fans could be placed inside to blow air over the critical components —mainly CPUs and storage devices—and hot air could be vented to the outside.

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Once more of these servers were put in the data center, the need to provide cooler input air grew, leading to the use of computer room air conditioning (CRAC) units and raised floors to pump the air through. Different form factors, such as a move toward blades and "pizza box" servers, have eliminated the need for large axial fans that shift large volumes of air to smaller, less volume-capable radial fans.

Meanwhile, energy prices have skyrocketed and come into focus. Power usage effectiveness (PUE), which compares the amount of energy used by the total data center facility with that used by the IT equipment, shows that an "average" data center facility uses more than 1 watt in energy for cooling and other peripheral systems for every watt used for purely IT purposes.

Diagram of Power sage effectiveness (PUE)

Utility Company

Power In ▶▶▶

Facility Power
- Switchgear
- UPS
- Battery backup
- Chillers
- CRACs

Power In ▶▶▶

IT Equipment Power
- Servers
- Storage
- Telco equip.

We cool data centers,
reduce power consumption, and save your money.

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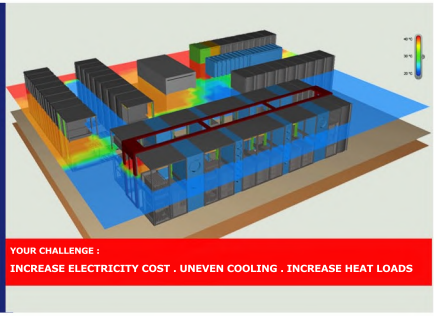

EQUIPMENT DENSITY AND ECONOMIC DRIVERS

While the energy efficiency of IT equipment is improving rapidly, the massive growth in equipment density is making it more difficult to ensure that systems are running economically.

Sure, there are many ways of approaching the overall cooling needs of a data center, such as using hot and cold aisles, running the facility at a higher overall temperature and using free air cooling. But the problem remains. Higher densities of equipment have created hot spots within the equipment that are difficult to cool effectively.

Lurking in the dark has been an approach that engineers have used for many years. Computational fluid dynamics (CFD) is a means of visualizing the heat map of an environment and then playing what-if scenarios to optimize a system. In areas such as turbine and boiler design, CFD is a proven and useful approach, but it's rarely present in data centers.

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EQUIPMENT DENSITY AND ECONOMIC DRIVERS

To understand why, we have to look at where CFD and data centers have already touched. The facilities team has a strong interest in ensuring that physical disasters don't befall a data center.

Therefore, using infrared and temperature sensors in a facility could highlight issues before they become major problems. A CFD system can minimize false positives by obtaining a view of what is normal throughout a data center and producing a log of places where hot spots are acceptable.

Until now, the IT team didn't see this data. Facilities rarely saw the usefulness of sharing this information with IT because the sensors and systems that used the data were for facilities systems, such as building information modeling/management (BIM) systems.

But data center infrastructure management (DCIM) systems came along from companies such as Eaton, Nlyte Software, Romonet, Intel, Schneider Electric and others. These vendors saw how computational fluid dynamics could predict the effectiveness of a particular layout of IT equipment.

But, at that time, facilities were still predominantly purchasing DCIM. Now, IT groups know what DCIM can do for them and are seeking out products that make sense.

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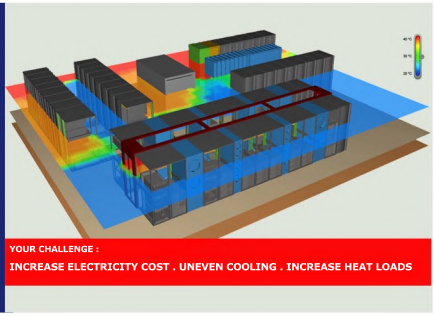

HOW IT SHOPS USE CFD

First, IT finds the baseline in an existing data center that shows where cooling is required. Identifying the hot spots allows for targeted cooling rather than a scattershot approach to containing the average temperature of the data center within certain limits.

Many organizations are surprised by how much they can save just by targeting the cooling and removing any focus from those components that run well within a recommended thermal envelope without any cooling.

Next comes finding the know-how for optimizing the environment. For example, it may be beyond the capabilities of existing system to effectively cool a certain rack full of spinning disks. Splitting the disks across two racks, however, plus placing low-energy network equipment in the space cleared, could enable the cooling process to deal with the heat load without incurring additional expense.

After that, IT will look into introducing new equipment. Administrators could explore in a virtual environment the question of whether existing cooling can deal with the addition of 100 new servers here or a new storage system there. They would have to choose the least expensive, most effective solution before the equipment is even on-site.

Last—and probably most important—is dealing with new architectures. How well will the facility handle a move from build-your-own racks to modular computing platforms, such as Dell vStart, IBM PureFlex or Cisco Systems' Unified Computing System? How will cooling need to change if the network is flattened to make the most of a fabric approach? And, what if the existing CRACs are replaced with free air cooling or other lower cost systems? Where will cooling need to be focused to ensure the data center still provides continuous high availability?

CFD is a hidden technology that IT and facilities groups should consider using more often. CFD should be a hotter topic than it is today.

—Clive Longbottom, March 2013

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About the Analyst
Clive Longbottom is the co-founder and service director at Quocirca and has been an ITC industry analyst for more than 15 years.