Redefining Cool

Better energy management could lead to cooler data centers that consume 50% less power, says HP's Chandrakant Patel.

Q&A by Robert L. Mitchell

OCTOBER 31, 2005 (COMPUTERWORLD)—*As compute density has increased, temperatures have been rising in the data center. Hewlett-Packard Co.'s "Cool Team" is working on innovative ways to dissipate the heat. Lab inventions range from ink-jet pumps that spray coolant on hot chips to more efficient designs for computer room air-conditioning systems. Cool Team founder* **Chandrakant Patel** *spoke with* Computerworld*'s Robert L. Mitchell about how current research is making for cooler data centers.*

What is the Cool Team? It is a community of engineers across HP founded in 1996. The idea was to create a virtual team that can apprise each other of the challenges ahead and funnel research ideas and technologies at HP Labs out to the divisions.

What research are you pursuing with regard to data center cooling issues? The data center is the next challenge. The aggregation of high-density, commodity servers in data centers will cause a problem from a management point of view. It's akin to cooling a system enclosure, but now the enclosure is the data center, with the walls of the data center being the walls of the enclosure.

Fifty percent of the cost of a data center is associated with what I call burdened cost of power, which is all of this expensive power and cooling equipment that is needed to support the computers.

How big of a burden is that in actual dollars? Let's say you have 100 racks of servers. Each rack is on the order of 12 to 13 kilowatts, [and] the power required by the servers is 1.3 megawatts. The power required by the cooling resources to remove that heat generated is almost equal to that dissipated by the servers. So the air conditioning will take another 1.3 kilowatts of power. If you look at the cost of electricity today, 1.3 megawatts at 10 cents a kilowatt-hour at 24/7 operation is $1.2 million per year. This is quite significant.

What we've said is, "OK, how do I reduce that by half?" If you can provide products and services which [do that and] have a payback of one year, that's a very compelling proposition.

How do you do that? We look at the layout of the air conditioning and we run a fluid-dynamics model. For this fixed distribution of AC resources, how should the customer lay out the racks and the vent tiles, and how should they lay out their exhaust air? How do they do that minimally, without impacting the data center? We believe we can get 25% savings.

Where does the other 25% come from? In order to get energy savings, we can minimize the thermodynamic work. By that we mean, how do we make sure the compressor doesn't work too much? How do we use sophisticated refrigeration systems that have the ability to change capacity, and how do we change the air flow?

We can add this flexibility fairly easily. That's needed to do dynamic, smart air conditioning.

Isn't retrofitting the air-handling system expensive? It doesn't mean you have to chuck out the air conditioner. You add the capability to change flow and temperature.

What else is required? In a data center, [having just] one thermostat won't work. In order to determine the need, we need a rich sensing environment. I have to give you *x* volume, *x* cubic meters of air at 75 degrees Fahrenheit, for example. I don't want to give you any more—I don't want to give you it at a lower temperature.

Ideally, I want sensors on the inlet of every server. That's not readily available, so we can get a robot with a sensor on it and make it go along the aisles autonomously, with a wireless device to send us the information wirelessly.

We have created algorithms that sense those points and send out new settings to the air conditioners. Based on that, the air conditioners change their capacity, and that gives us demonstrated savings of 50% in our data center here in Palo Alto.

Why use a robot? I can provision the flow and temperature based on the needs of the rack, and the robot is a means to that end. I would like to understand what is the temperature in the aisles, and it's very hard to correlate that. The environment in the data center is so complex that there is no linear correlation between temperature at a given location and the [server air] inlet. The robot can be sent out to get fine-grained measurements in the aisles.

How will the systems HP builds change to run cooler? In the future, systems will have the ability to change power settings—not only cooling, but power. Processors will have voltage frequency scanning, where there will be various power states. That's flexibility I can exploit. If an AC unit fails, why don't I ask a given region in the data center to scale its power down instead of having excessive redundancy, which costs me a lot of money? We call that smart redundancy.

We have the ability to migrate compute workloads from one machine to another in the data center. I want to use every flexibility, from moving workloads to scaling power down to scaling air conditioning. All of this can be done quite easily.

What else are you working on to make data centers more efficient? If you have to place a workload in a mix of data centers around the world, I'd like to pick the right data center in the right part of the world in the right ambient temperature. If New Delhi is sitting at 45 degrees centigrade, Phoenix might be sitting at 20 degrees. So I might choose to put all of my workloads in Phoenix because my compressors don't have to work as hard. Then, inside the data center, I'd like to put the workload on a given row in a given rack, in a given system, in a given board, on a given processor, in a given core. I want that flexibility of cooling at the global level.

When will these technologies be available? The static provisioning is already out there. All of these other things, we are now deploying in internal data centers. I foresee this happening in customer sites in a year or two years.

Chandrakant Patel
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ACCOMPLISHMENTS: Patel is involved in thermomechanical research that ranges from the microprocessor to the data center. He founded the thermal technology research program, formed HPÕs Cool Team and led cooling and packaging research efforts for the development of the Itanium processor. Patel has been granted 51 U.S. patents in the area of electronics cooling. He is a senior member of the IEEE and holds a master of science degree in mechanical engineering from San Jose State University.