Data Center Power and Cooling: Plan Ahead

High density servers and rising utility costs pose a major challenge for IT managers trying to keep their networks from overheating.
Managing power, cooling and associated energy costs is a challenge all IT managers and data center managers now face. According to IDC estimates, it could cost nearly $400,000 annually to power a 1,000 volume server-unit data center. In addition, power server densities have increased tenfold in the last 10 years.

With ever-higher volume density servers packed into older data centers, keeping the network from a complete meltdown is essential. And while there are many ways to address the issues, most experts concur that planning for the future is key to making it all work.

“You need to ask: What is the life expectancy? Technology is changing so fast that deploying a cooling technology now may not be enough two years from now,” says Steve Madara, vice president and general manager for Liebert Precision Cooling Business, Emerson Network Power. “The servers you deploy may not be compatible.”

Scott Tease, worldwide product manager, IBM BladeCenter, agrees. “Many data centers weren’t designed to handle the power density heat load of what we can build today, so data center managers are running out of power long before they run out of real estate.” And the power used is not just to keep the servers running — keeping them cool takes power as well. “Part of it is a density issue,” says Tease. “Many [data centers] can’t handle 42 1U servers or 84 blade servers, leaving partially full cabinets.”

“Servers today have higher processing speeds. They have to draw more power in order to do that, which produces more heat,” says Dennis VanLith, senior product manager, enclosures, for Chatsworth Products Inc. “In a data center you have a raised floor environment, and cold air is forced into that space and into the area where the cabinets and servers are. So the cabinets need to effectively handle the cold air and isolate the hot air that’s expelled from the servers.”

With a capacity of 42 1U servers in a single cabinet, it’s easy to see the cooling issues involved. With the advent of blade servers in the last two years, a lot of different processing power is now available within one chassis. Each one of those blades could have 12 different processors. That produces a lot of heat from one unit that’s 10-to-12 inches tall.

In the past, according to VanLith, as long you kept turning the thermostat down, you were in good shape. But that’s not the case today. “[Then] air conditioning was enough. You didn’t have the heat output years ago. Now the increase in high-density blade servers requires more power. They also generate more heat, which requires more cooling, which requires more power,” says Monty Wilsher, technology specialist for enclosure products at Black Box. “It’s a vicious circle.”

And, as a result, the servers aren’t getting the cold air they need to operate effectively. “The air starts recirculating inside the data center, and as the hot air is expelled out of one cabinet, the cabinet next to it will take that hot air in and recycle it,” says Chatsworth’s VanLith. “It needs to be a fairly consistent temperature. When you look at the basic heating and air conditioning rules, it’s really not about cooling the air, it’s about taking the heat out.”

John Niemann, cooling solutions product manager for American Power Conversion (APC) Corporation, agrees that getting the heat out is key. “If you look at traditional data centers designed for 2-to-4 kilowatts [kW] per rack, they utilize a downflow air conditioning unit,” (which takes return air from the room, cools it, and blows cold air underneath the raised floor).
“Customers are finding they cannot adequately cool above 5kW per rack using this approach,” he says. “Placing the air conditioner in the row of IT equipment ensures you capture the heat and eliminate hot air from mixing in the room. This produces warmer return temperatures, thus increasing the capacity of the air conditioning unit and improving efficiency.”

Strategy and Best Practices

“While it’s key to plan for future growth when building a new data center, current data centers that are outagegrowing capabilities require workarounds,” says Black Box’s Wilsher. “cooling manufacturers are developing products along with server manufacturers. It begins at the design stage to incorporate enough cooling and power.”

But how do you develop an efficient workaround for an overloaded cooling system? It’s important, according to Chatsworth’s VanLith, to check the efficiency of the air conditioning system. “Holes in the floor used for wiring may leave too much extra room around the cables. Those need to be sealed to keep the cold air in the room.”

Adding blank filler panels to keep hot air from circulating back around equipment can help to prevent it from getting to the front of the rack. Setting up a hot aisle/cold aisle can also help. In that setup, all the fronts are on the same side with the cold air coming up into them and the hot air going to the back aisle without vented tiles.

Power is needed to keep servers running. Power is also needed to keep them cool. Part of it is a density issue.

But that may not always work, since the air gets hotter and hotter and just mixes with the rest of the room. One solution is a vertical exhaust duct, or (ducted exhaust), where you put a chimney on top of the cabinet that takes the hot air off the servers. Instead of expelling the hot air back into the room, it expels it into a vented duct, which goes back into the air conditioning unit.

That’s why APC’s Niemann suggests placing the air conditioner in the row of IT equipment. “If customers are looking at compacting heat loads, then they should choose to couple the cooling to the heat load,” he says. That way the cooling is tightly coupled with the heat that’s being generated. “Assign cooling systems to specific racks or a set of racks and move that cooling system closer to the heat load,” he says. What’s the benefit? “Besides improved efficiency, you can completely contain the hot air using rack- or row-based containment systems, allowing the air conditioning units to neutralize all that heat.”

Liebert’s Madara sees a lot of customers simply deploying fans at the bottom of the rack. But that doesn’t necessarily help. “Fans don’t cool, they create heat. Just moving the air around doesn’t solve the problem. You need to look at real solutions that are going to provide sensible cooling.” In addition, just because you can fit blade servers in a rack doesn’t mean you have the power to keep it running or that you can cool it. “It doesn’t mean the data center can handle the heat load. You need to understand what the data center room can handle so you don’t exceed that density level,” says IBM’s Tease.

Once traditional and in-row cooling have been maximized, end-users can add overhead cooling, according to Liebert’s Madara. “Overhead supplemental cooling solutions work in concert with traditional under-floor cooling systems for both existing and new data centers,” he says.

Power Play

“There are parallels in the power and cooling world,” says Kevin McCalla, director of product marketing, Liebert Power Solutions, Emerson Network Power. “Our customers are seeing the impact of high-density equipment on both power and cooling. They are facing the challenge of deploying new equipment that’s very dense, and they’re trying to do this at a time when the sites have become more critical.”

In addition, when you combine the huge increase in the amount of power it takes to run a single server (or even a single processor) with the increased cooling requirements, the cost becomes a sizeable portion of the users’ budget, says IBM’s Tease.

“A decade ago, power and cooling only represented a [small] percent of your annual budget; today it’s quite easily 13 percent or more of what you pay for those servers,” he says. “If you spent $1,000 on IT this year, you’re going to spend at least $130 for power and cooling. It’s become a significant cost issue.”

And the relative cost of power and cooling isn’t the only concern many medium- to large-size businesses face. According to the U.S. Department of Energy, power outages, caused by an aging electrical grid — stressed by the ever-increasing demand for power — are on the rise and costing U.S. businesses $80 billion annually.

“If you look at acquisition costs of IT equipment, energy costs are becoming a big piece of the total cost of ownership or the data center’s operational budget,” says Sriram Ramakrishnan, business unit manager for Powerware Data Center Solutions, Eaton Powerware. “We’ve been talking to customers with respect to power systems, and reliability is always a key factor,” he says.

“Over the last 12 months, customers are asking about the energy efficiency of products more and more. They are concerned about utility bills they’re paying.” And since oil prices aren’t likely going down, over the long run energy costs are only going to increase. Data center managers need to take energy costs into account when it comes to deploying new IT equipment and all other supporting power and cooling products involved.

Power Backup

Another way to avoid problems is to plan for future growth, according to Black Box’s Wilsher, who also recommends developing and regularly testing a good backup and data recovery plan. Other pitfalls to avoid, according to Wilsher: “Not paying attention until a problem occurs, not staying current with technology that’s being developed and not using surge protection on usable power.”

With the dramatic increase in power you need to bring to the enclosure, having a power backup plan is key. “If it’s fully loaded with a blade server chassis, you could deploy
25-to-30kW per rack. Not many customers are doing this today, but it is possible,” Eaton’s Ramakrishnan says. “In the past you could bring single-phase power, but now you need to bring three-phase power to the rack to support even 5-to-8kW per rack.”

Businesses also need to ensure that the power feeds to the enclosure are backed up by an uninterrupted power supply (UPS). “Depending on the size of the data center, you need to consider having the UPS protection inside the computer room or in a separate equipment room supporting the data center,” he says. Another trend Ramakrishnan sees is IT equipment deployed with redundant power supplies. “If one power supply fails, you still have another power supply that will pick up the full load. To fully leverage this redundancy you need to ensure that you have redundant power feeds to the enclosure — each backed up by a UPS.”

If you look at a server rack in a data center from five years ago (half-a-dozen servers in a rack and half-a-dozen power cords that you need to power up) and compare it with one today, the equipment has gotten smaller, so now there are 30 or 40 servers in the rack. So how do you get that many cables into a rack? “It becomes a power distribution issue,” says Liebert’s McCalla.

“All those cables can interfere with the power and cooling system.” An emerging trend is installing power strips in the row with the IT racks. But that’s not all. “The strip needs to be monitored so you know the load that’s on that circuit,” he says.

Whether it’s about power or cooling, planning for the future is critical. IT managers need to look at what they will need three- to five-years out and plan accordingly.

Liebert’s McCalla notes: “Many customers don’t think they need stuff today, but they might tomorrow.” Having an adaptive architecture that you can migrate from not-so-critical to super-critical and deal with changes on the fly is the best way to go. “It’s important to understand what the load on a circuit is before you add a new piece of equipment,” he says. “Otherwise, you put everything in the rack at risk.”

In addition, not having a strategy for how to build the system in a data center and not monitoring the UPS and the infrastructure from a maintenance standpoint, is asking for trouble, says McCalla. “The biggest challenges are sites that need to add capacity but don’t have a plan and approach to do it.”

Business trends spotlight the growing power problem, says IDC analyst John Humphries. His firm’s customer surveys show:

- Servers that consumed an average of 100 watts of power 10 years ago now consume an average of 400 watts.

- Of the money spent to operate data centers, 15-20 percent goes toward power and cooling.

- Each rack of computer gear held an average of seven servers 10 years ago. Now they hold an average of 20 to 22 servers.

- Electricity distribution systems 10 years ago were designed to deliver 5-to-8 kilowatts of power. New data centers are designed for 20kW and up.

- Ten years ago, there were about 6 million servers worldwide. Now there are 24 million, and IDC projects that number to grow to 35 million by 2010.