Cooling Sun's Energy-Efficient Datacenters

Efficient, scalable cooling at the rack and room level

Summary

- Up to 50% savings on cooling efficiency in datacenters
- Scalable cooling design earned nearly $1 million in energy rebates and innovative design rewards
- More servers can be supported in the datacenter by reducing the kW consumed by cooling systems
- Groundbreaking manageability and predictability for controlled growth
- Exact cooling usage can be monitored in real time, enabling intelligent forecasting and growth
- Ability to limit raised floors in datacenters, and all of the costs and maintenance associated with them
- Sun's "pod" design enables modular, flexible cooling systems
- Modular, scalable cooling solutions enable Sun to cool racks up to 30 kW in its Santa Clara, California datacenter facility

Today's high-density compute systems are applying a tremendous strain on existing cooling systems. It is very difficult to effectively and efficiently cool datacenters with traditional/legacy datacenter cooling designs. The increased heat densities of new compute equipment are forcing many IT and facilities managers to rethink how to cool the datacenter.

Sun Microsystems solves these challenges in its new datacenters with a flexible, scalable cooling design that is so efficient and cost-effective that it earned nearly $1 million in energy rebates and awards.

Many existing datacenter infrastructure designs are based on providing less than 2 kW per rack and employ cooling design technologies that date back 15 to 20 years. To provide cooling for the entire room, large computer room air conditioning (CRAC) units are installed to push cool air under a raised floor and then up through perforated tiles where computing equipment is located. As rack densities increase, the raised floor begins to loose its ability to provide cooling to accommodate the servers' airflow needs. This design is unpredictable, unmanageable, and provides limited expandability when used to support today's high-density systems, where technology changes much faster than the datacenter infrastructure.

Consolidating and standardizing datacenters

To reduce its costs and impact on the environment, Sun is consolidating real estate, and in the process, datacenters and labs. One of Sun's biggest and most expensive assets is its extensive, worldwide technical infrastructure portfolio, which is the foundation for the engineering, services, sales, and support community at Sun. Sun's technical infrastructure is where the innovation happens, products are developed, testing is conducted, and customers are supported. It is critical that this environment enable the Sun community to continue to deliver the innovation that makes Sun thrive.

Until recently, however, many spaces developed on their own, sometimes in converted offices or conference rooms, without a standard design or methodology.

To eliminate inefficiency and reduce environmental and economic costs, an internal team was established and asked to develop datacenter design standards, manage the global portfolio, and bridge the gap between facilities and IT. Sun's philosophy for datacenters and lab spaces is to design everything to simplify inevitable changes. Everything is designed around the current and anticipated future requirements of a datacenter footprint. These requirements are then applied to a "pod," a self-contained group of racks and/or benches that optimize power, cooling, and cabling needs and form a standardized building block for the overall datacenter design and finally the mechanical service yard.

Given the state of technology today, the current design assumes a starting requirement of 4 kW per rack, upgradable in 4 kW chunks to 30 kW per rack. With these specifications in mind, Sun arduously searched for modular, flexible cooling systems that could meet the following day one and future needs without interrupting operations:

- Point cooling — The ability to cool on a per-rack basis, without increasing cooling for the entire datacenter or room. CRAC units should only be used to provide general room air conditioning for nonserver equipment and latent loads in datacenters.
- Scalability — Start with a 4 kW footprint minimum, scalable in increments of 4 kW. Traditional designs at this level of rack heat density are not easily scalable and can create numerous issues, including the need for very tall raised floors (in some cases exceeding 36 to 48 inches) and specialized humidity and temperature controls to prevent CRAC units from demand fighting, which wastes energy. This type of installation creates unpredictable cooling patterns, tall floor to ceiling requirements, special cabling, fire protection, and power needs.
- Flexibility — The ability to put low-density racks next to high-density racks anywhere in the space without creating a hot spot, as well as the flexibility to locate or move racks anywhere in the datacenter.
- Energy efficiency — Any approach must create predictable cooling environments and result in cooling and power efficiency to decrease Sun's carbon footprint and save energy costs.

Sun worked with APC, a global leader in network-critical physical infrastructure solutions, and Emerson Network Power, a global leader in business-critical continuity solutions, to create modular, flexible, scalable, and energy-efficient pod cooling designs, which form the standardize building blocks for the datacenter cooling systems. Both designs — APC's InfraStruXure InRow RC cooling with hot aisle containment system and Emerson's Liebert XD (X-treme Density) heat removal system — provide Sun with the flexibility to cover all the cooling needs for datacenter deployments while greatly increasing the efficiencies of the cooling systems. As a result of this effort, Sun now has the largest single install of APC hot aisle containment and Emerson Liebert XD systems in the world.

Cooling datacenter spaces

Sun bases all aspects of datacenter design on replicable pods, which typically consist of 20 to 24 racks with cooling units either installed in-row next to the server racks or above the racks. Pods can be designed to support 4 kW per rack or higher with growth in 4 kW increments per rack. The cooling units and racks within the pod can be replaced as needed to allow for changes that occur over time. The benefit of creating replicable pods is that it decouples the room cooling from rack cooling. In-row or overhead cooling units now provide the cooling directly where the heat is generated, which results in more predictable cooling airflow patterns.

Cooling efficiency is increased because the return air temperature is higher, creating more efficient heat transfer within the cooling unit. It also reduces fan energy requirements since the cooling fans no longer need to overcome static pressure losses caused by air delivery mechanisms such as raised floors or air ducts.

APC InfraStruXure InRow RC

One method of cooling pods is to use the APC InfraStruXure InRow RC cooling with hot aisle containment. The APC system combines several key elements to provide a highly efficient and scalable cooling solution for pod deployments:

- InfraStruXure InRow RC Cooling Module — Increases cooling efficiency by maximizing sensible cooling and reducing fan energy. The unit captures heat directly from the hot aisle reducing hot air recirculation and improving predictability of the cooling system.
- Hot Aisle Containment System — Helps ensure heat is completely captured by separating supply and return air paths. The hot aisle is sealed off using doors and transparent ceiling tiles that extend the width of the hot aisle.

To further increase efficiency, the InRow RC units feature built-in intelligence to dynamically control fan speed based on thermal changes in the pod. Each unit monitors the temperatures in the row and has the ability to be grouped and communicate with up to 12 other units within the same pod. In Sun's pods, all RC units within the pod communicate with each other to modulate fan speeds based on the thermal changes detected by the temperature sensors located throughout the pod.

"Our innovative cooling approach at both the rack and room level enables us to quickly and simply grow our datacenter spaces as needed using a modular approach. Instead of trying to reassess the entire room and figure out where the best location is for a rack, the infrastructure can actually adapt to where the user wants to put the rack."

Mike Ryan
Design Engineer, (PE)
and Datacenter Design Services

Since typical datacenters do not operate at 100 percent of their design load on day one, the variable speed fan technology enables the InRow RC units to conserve energy when operating below design load, for instance, if a pod is only three quarters populated.

The savings can be significant. For example, reducing fan speed by 30 percent cuts fan power usage by 60 percent. This means that a pod with InRow RC units operating at 70 percent of the design cooling load only consumes 40 percent of the full load of the power, providing greater efficiency and savings.

In addition, each InRow RC unit is equipped with a network management card, which can be accessed through a Web browser to provide access to set points, alarms, and associated control data. This feature further enhances the visibility of the health of the system to the IT manager.

Real-time capacity monitoring

InRow RC units provide visibility into the actual capacity provided by each unit, enabling datacenter managers to see any spare cooling capacity. Using this information and the performance specifications of the units, datacenter managers can effectively plan to add and upgrade computing equipment where spare cooling capacity is available. This provides knowledge that datacenter managers have never had before and improves the capability to manage how and where new servers can be efficiently deployed in the datacenter.

Cooling open datacenter spaces

Sun also utilizes Liebert XD systems as a cooling solution in the pod concept. Working together, Emerson Network Power created several cooling solutions that are employed in both open datacenter pods and very dense rack pods.

Liebert XD

The Liebert XD heat removal system is designed to address the higher heat loads generated by densely populated racks. Individual modules can improve enclosure airflow or cool hot spots, or zones.

The modules in the Liebert XD system feature a unique heat rejection process. The system uses a pumped refrigerant that operates at low pressure and becomes a gas at room temperatures, making it ideal for use around electronic equipment.

Emerson worked with Sun to create a highly flexible cooling environment utilizing the Liebert XD system and associated components:

- Liebert XDV Vertical Top Cooling Module — Provides flexible and scalable spot and zone cooling for high heat-density equipment. Sun suspends each unit from the ceiling over the racks to closely couple cooling to the heat source, which reduces fan power requirements and creates a very predictable airflow path. This enables Sun to move racks in and out of the pod without affecting the cooling systems. The ability to locate cooling close to racks results in scalability — new cooling systems can be added as the need arises.
- Liebert XDC Coolant Chiller — Connects directly to the Liebert XDV cooling modules through the Liebert XD Coolant circuit. The chiller can be installed in the same room or in an adjacent mechanical room.
- Liebert XDP Pumping Unit — When a building chilled water system is available, this unit is utilized as an interface between the Liebert XD Coolant circuit and the chilled water system.

- Liebert XD Piping — Using Liebert XD Piping and quick connection fittings throughout provides Sun with the flexibly it needs. The flexible piping comes precharged with refrigerant and the quick connection fitting makes it easy to change configurations or add capacity.

Cool benefits and savings

With cooling systems from APC and Emerson, Sun realizes dramatic savings in cooling and power costs and has the flexibility and scalability to expand efficiently and quickly.

- Energy rebates — More than $1 million in rebates and innovative design awards.
- Up to 50-percent savings in cooling efficiency — By localizing the cooling at the heat source the air moves a shorter distance, reducing the energy required for air movement by more than 70 percent. In addition, the Liebert XD system takes advantage of the energy-absorption capacity of a fluid as it changes state, which reduces pumping power by 85 percent compared to a water-based system.
- Up to 70-percent savings in datacenter spaces over traditional cooling systems — Closely coupling cooling with heat containment saves more than 40 percent in combined fan and pump power. The APC InfraStruXure InRow RC system saves up to an additional 70 percent in fan power by varying fan speed to right-size cooling output to heat load.
- Ability to support more servers in the datacenter — Many datacenters today are starting, or have already started, to run out of power and cooling capacity. Every kW saved in power and cooling is another kW that can be used for new servers, supporting more users, customers, and business. According to The Green Grid, an industry consortium focused on building energy-efficient datacenters, half to three quarters of power in the datacenter is consumed powering the infrastructure — power, cooling, lighting, and more — not computing equipment.

Best practices

- With many datacenters running out of power capacity, efficiency increases in infrastructure components can extend the useful lifecycle of the datacenter, as well as postpone the need to build a new one. By utilizing solutions that closely couple cooling systems to heat sources, Sun is able to drastically increase the overall heat densities of its datacenter deployments while greatly reducing the power required by the cooling systems.
- Manageability and predictability — Sun's pod designs enable manageability and predictability in cooling. Sun now knows exactly where the cooling is going, resulting in the ability to grow and increase density as needed while more effectively utilizing datacenter space. Cooling units can be installed in less than one day, and it is easy to expand from 4 kW to 8 kW per rack or more, simplifying the mechanical and electrical needs to support change. All of this combines to create a level of predictability, simplicity, and scalability that is unknown in traditional datacenters. Datacenter managers now know where the heat is and what is being cooled, which also provides the predictability necessary for realistic capacity forecasting.
- Limits the need for raised floors — In most cases, Sun does not specify raised floors for cooling purposes. In fact, more than 80 percent of the Santa Clara, California, facility uses a slab-floor design. The remainder is raised floor to enable Sun to test equipment in this environment. This enables Sun to reduce the cost and complexity of a raised-floor environment, for a savings of up to $50 per square foot. In this new environment, overhead cabling becomes more complex, but this is a workable issue because the cabling is now more accessible and issues such as fire suppression, ramp, and higher ceiling height requirements are eliminated.

Learn More

For more information on Sun's energy-efficient datacenters and additional design features, go to sun.com/eco. To learn more about APC, visit apc.com. And for additional information on Emerson, visit emerson.com.

Energy-efficient, modular, flexible, scalable, and cost-efficient cooling

Sun's new modular pod design provides the foundation for implementing flexible, adaptable, scalable, and efficient cooling systems for the company's datacenters. With APC InfraStruXure InRow RC and Liebert XD systems, Sun now has the ability to expand and grow in a modular fashion with energy-efficient point cooling systems. In addition, real-time data enables Sun to grow datacenter capacity intelligently and as efficiently as possible, saving money while supporting more users and customers, without drawing more power from utilities.

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