Airflow model helps meet thermal demands of supercomputer

With more than 16,000 IBM Cell Broadband Engine processors, IBM's Roadrunner supercomputer will be capable of a sustained speed of up to 1,000 trillion calculations per second, or one petaflop.

Such a large and powerful computer generates heat that must be actively managed. The Roadrunner occupies 12,000 square feet (1,115 square meters) of the Nicholas C. Metropolis Data Center at the U.S. Department of Energy's Los Alamos National Laboratory in New Mexico, which also houses other high-performance computing equipment. During the last several years, IDC Architects, a division of CH2M HILL, has assisted with the enormous challenges involved in keeping one of the world's largest data centers cool.

A conventional data center has rows of racks that typically give off between 2 and 6 kilowatts (kW) of heat. The high-density racks in the Los Alamos facility have much higher heat output—up to 20 kW per rack.

Los Alamos first contracted with CH2M HILL several years ago to begin planning for the installation of the Roadrunner, as well as other expansion projects in the Metropolis Center. CH2M HILL's airflow modeling experts have used computational fluid dynamics (CFD) technology to help the facility manage increasing thermal loads while minimizing cooling costs. CFD software calculates and graphically depicts airflow patterns on a computer screen. It visually animates and color-codes such critical criteria as airflow velocity, pressure, and temperature.

"The CFD simulations have saved money by determining exactly how much cooling capacity is required to handle current and projected thermal loads, and identifying design improvements that boost cooling efficiency," said CH2M HILL mechanical engineer Andy Solberg.

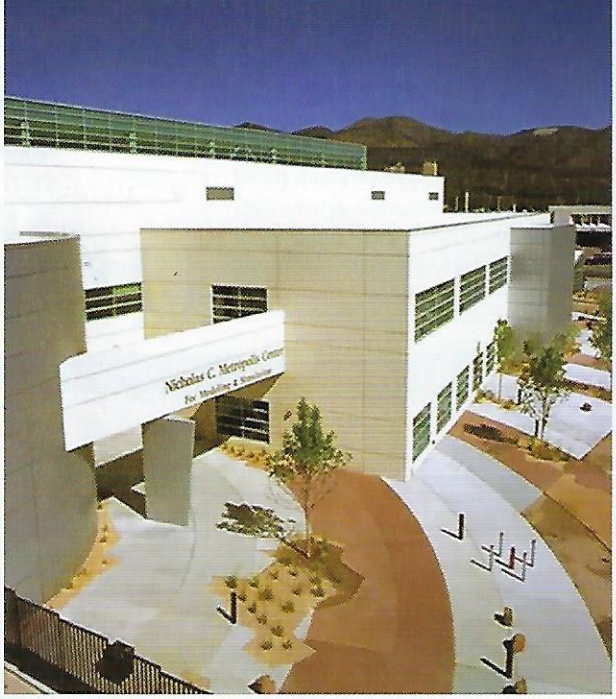
"We use the Flovent model at CH2M HILL because it provides many features that simplify the task of modeling data centers," Solberg said. "The application provider, Flomerics, also has a team of support engineers that are experienced in addressing data-center cooling issues."

The Flovent model includes all key features that drive the dynamics of airflow and thermal flow, including:

- Cold aisle and hot aisle configuration
- Temperature rise across servers and resultant airflow
- Pressure drop through various types of floor tiles, including grating at the Roadrunner areas and perforated floor tiles at areas of lesser heat density
- Airflow, thermal capacity, and temperature design limits of computer room air-conditioner units

As a result, the airflow modeling provided the energy department with assurance that the data center would be able to handle the high heat loads generated by Roadrunner.

"The simulation demonstrated that the heat loads involved in the operation of this data center were managed well by the existing design of the Metropolis Center," said CH2M HILL's Keith Kibbee. "It showed that the data center could handle all of the equipment that had been planned and projected without adding any cooling capacity. Furthermore, the simulation demonstrated that with some relatively inexpensive improvements, the existing cooling capacity would be able to handle another 20 percent increase in thermal load beyond current plans. This application demonstrates how simulation can save money in the data center by more efficiently using available cooling resources."



The Nicholas C. Metropolis Center at the Los Alamos National Laboratory in New Mexico is home to the Roadrunner, one of the world's fastest supercomputers.

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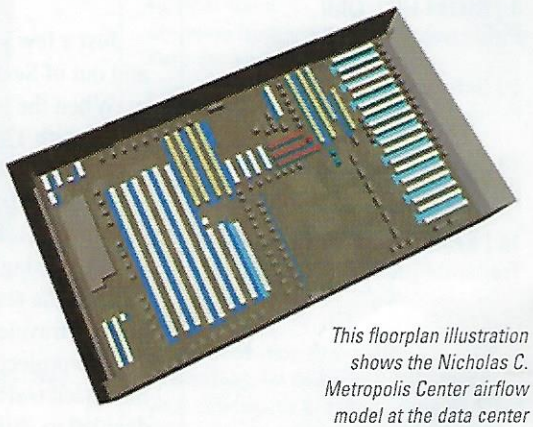

This floorplan illustration shows the Nicholas C. Metropolis Center airflow model at the data center level. Airflow models are used to manage high heat loads and optimize cooling costs for mission-critical facilities, such as high-density data centers.