Proper Cable Management Aids Data Center Cooling

By Lars R. Larsen and Lisa A. Huff

With the increased server densities and higher speed network equipment found in today's data centers, the heat generated by network equipment is creating new concerns over cooling. Where a rack of equipment generated two to three kW of heat only a few years ago, the trend is moving towards 50 kW. Throughout a computer room, the cooling load can be as high as 500 W per square foot. Since heat remains the most common reason for equipment failures, proper cooling is obviously essential to reliable operations.

Excessive heat can seriously disrupt efficient operations even when it does not cause shutdowns, since modern equipment contains internal thermal sensors that slow down the processing speed (and thus generate less heat).

Cooling and power remain top concerns with I.T. administrators and data center managers. In a poll at Gartner's "I.T. Infrastructure, Operations and Management Summit 2007," attendees judged that the greatest facility problems with data centers are insufficient cooling and insufficient power. In fact, the overwhelming majority said they will expand/upgrade, relocate or renovate their facility over the next year to accommodate power and cooling needs.

Deployment and management of the cabling system can impact the efficiency of the cooling system positively or negatively. Cooling depends on maintaining adequate airflow, in the room itself and in the underfloor and overhead plenums. Since cables also run in the plenums, care must be taken that they do not adversely constrict airflow. Similarly, cable management in racks must allow for proper airflow. A new generation of racks gives more options in combining cable management with superior airflow.

Good cable management can increase the efficiency of cooling and thereby cut power consumption. If the air conditioning system must work harder because cables hamper proper airflow, the costs of operating the data center increase. While major energy savings in a data center can be achieved by installing energy-efficient servers, UPS, and air conditioning and by techniques like server virtualization, poor cable management can sap these efficiencies. To prevent this, proper planning and advanced cable management are essential.

THE HOT AND COLD OF COOLING

The preferred method of cooling in today's computer rooms is the cold-aisle/hot-aisle approach, as shown in Figure 1. In a typical configuration, cooling air comes from the plenum up into the room through perforated floor tiles. This cool air is drawn through the equipment, where it picks up the heat generated by equipment, and exits the rear of the rack into the hot aisle. This warm air is then directed openly or through ducts for recirculation through the CRAC (computer room air conditioning) units. Racks are positioned to face each other, fronts

Racks and enclosures should be configured for maximum airflow from cold aisle to hot aisle.

on the cold and backs on the hot aisle. It is important that the cold aisles remain cold and hot aisles hot: mixing air from the two should be avoided.

Conceptually, this cold- and hot-aisle cooling works best when equipment draws air in the front and exhausts it out the back. Unfortunately, this is not always the case; some equipment draws air from the bottom and exhausts it through the sides or top. Other equipment draws and exhausts through the sides only.

Maintaining airflow is crucial to proper cooling. Underfloor cables should be routed to ensure cool air is delivered into the room. Cables should not block the perforated tiles in the cool aisle. Additionally, the underfloor plenum should not become filled enough to obstruct airflow.

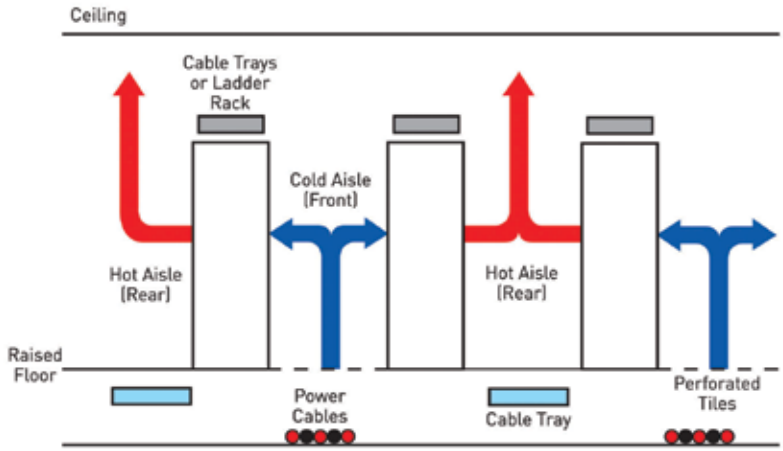
Newer reduced-diameter UTP and fiber-optic cables improve airflow by taking up less space. . With high-port-count equipment requiring large cable bundles, these reductions add up to significant space savings.

As much as possible, data center designers and operators should route cables under the hot aisle, in the same direction as the aisle, to minimize obstruction of cold airflow. Large cable bundles running at right angles to the aisles are more obstructive to airflow. When cables block airflow, the air conditioning equipment must work harder, thus increasing power consumption. This can also create hot spots.

Overhead routing is an attractive alternative because it opens up more of the underfloor plenum for air distribution. Cables are run above and in parallel with the equipment racks. If a crossover between racks is needed, it should be located as far from the source of cooling as possible. If you use curtains above the racks to separate hot and colds aisles, run the cable on the cold side.

Whether cables are run underfloor or overhead, mesh trays (Figure 2) provide better airflow than a solid conduit. Cable openings in the floor (or ceiling) should be sealed to prevent leaks and to help maintain the proper static pressure under the floor, because drops in static pressure reduce airflow.

Figure 1. Cold- and hot-aisle cooling



COOLING AND CABLE MANAGEMENT

Inside the room, the choice of racks and the use of good cable management practices also aid airflow. Spaces between racks or enclosures should be avoided to prevent air from the hot and cold aisles from mixing. Such mixing can raise the temperature of the cool air and thereby lower its effectiveness. Blanking plates can be used between rack and enclosures to keep the aisles separate. Similarly, use blanking plates in unused equipment positions within the rack to maintain the hot aisle/cold aisle separation. This will allow more cold air to be directed to the equipment rather than be wastefully passed through empty areas. Some enclosures use top fans to help exhaust the air out the top of the rack. Such fans can be a mixed blessing: they help move the air but are not as effective at passing the air directly into the hot aisle.

In choosing an equipment rack, consider the ventilation configurations of the active equipment to be stored in the rack. If all the equipment uses front-to-back airflow, your chore is easier and your range of cable-management choices wider. If the equipment is side or bottom venting, make sure the rack can accommodate this. Some racks combine baffles and perforations to direct airflow from side-ventilated equipment from the cold aisle to the hot aisle. The perforations allow ventilated air to be exhausted, while the baffles ensure the proper flow of air from cool aisle to hot aisle, even with side ventilation. In effect, the combination of baffles and perforations allow side-ventilated equipment to act like rear-ventilated equipment as far as cooling is concerned. Plus, the system is passive – it does not require the additional 15 to 20 W of power that each exhaust fan would consume. This makes for a more energy-efficient data center, reducing overall power consumption and therefore energy costs.

Vertical cable management is done at the side of the rack – not only because this approach is tidier and easier to manage, but also because it helps promote front-to-rear airflow.

Security concerns make many network administrators prefer to have lockable doors on enclosures housing equipment and cross connects. Doors, however, must not obstruct airflow. If equipment is housed in enclosed cabinets, doors should be perforated to permit air to circulate. Perforations must be sized to ensure that the airflow is sufficient for the needs of the equipment. At a minimum, the doors should offer a minimum of 50 percent open perforations, although 65 percent or better is preferable.

ADDITIONAL CONSIDERATIONS

The cable management solution must

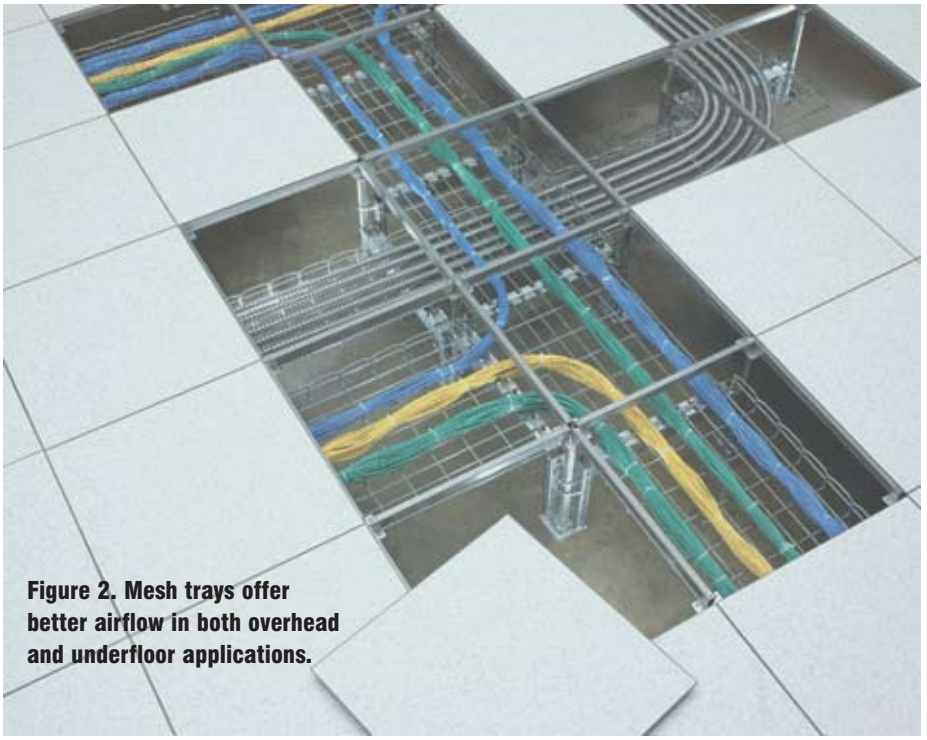


Figure 2. Mesh trays offer better airflow in both overhead and underfloor applications.

be able to handle the density of the system being installed while still allowing for easy moves, adds and changes (MACs). With some equipment it is necessary to route all of the patch cords in one direction to avoid a fan tray, power supply or other removable part of the equipment. Make sure your cable management solution can handle a minimum of 48 Augmented Category 6 patch cords per rack unit to a single side of the equipment. Where fiber optic patch cords are concerned, best practice is to select reduced diameter products in an effort to conserve valuable vertical cable manager space.

Thoughtfully designed cable management solutions also protect the cable and the equipment ports from damage. To guard the fiber jumpers and high-performance copper patch cords, the vertical managers must have fingers with the ability to meet the minimum bend radius as recommended by the cable manufacturer. To protect the ports in a patch panel it is possible to angle the panel so the plug is directed towards the vertical manager. Recessing the ends of the panel also help protect the ports and direct the plugs. The equipment cards are a different case altogether. In order to protect the end ports in a flat line card or switching module use a vertical manager with fingers that start at least 1-1/2 inches out from the face of the equipment. This will provide bend limitation for the cable and keep sideways torque on the plug and jack at a minimum.

ENERGY SAVINGS DEPENDS ON THE DETAILS

You obviously should not simply select a cable management system solely in terms of its compatibility with the network equipment cooling requirements. However, this is not something you can neglect. The right racks and enclosures, careful cable management, and attention to maintaining proper airflow can significantly affect how efficiently the cooling system and the equipment being cooled operate. ■

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Figure 4. Baffles and perforations can maintain front-to-back airflow in racks containing side-ventilated equipment.