WHITE PAPER

Increase Rack Cooling Efficiency and Solve Heat-Related Problems

Low-Cost and No-Cost Cooling Best Practices Provide Exceptional ROI for Small to Mid-Size Data Centers

Executive Summary

Cooling tends to take a back seat to other concerns when server rooms and small to mid-size data centers are first built. As computing needs grow, increased heat production can compromise equipment performance and cause shutdowns. Haphazard data center expansion creates cooling inefficiencies that magnify these heat-related problems. End users may assume that they need to increase cooling capacity, but this is expensive and often unnecessary. In most cases, low-cost rack cooling best practices will solve heat-related problems. Best practices optimize airflow, increase efficiency, prevent downtime and reduce costs.

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Data centers do not need to be kept freezing cold. The ideal temperature is actually 25° C.

Intake Air Temperature Guidelines for IT Equipment

>37,8° C
- High risk of damage and downtime
- May invalidate equipment warranty

32,2° to 37,8° C
- Risk of damage and downtime
- Short bursts (seconds to minutes) may be acceptable, depending on availability goals

27° C to 32,2° C
- Within the "allowable" range
- Okay for brief periods (hours to days)
- Longer periods may compromise equipment life

25,1° C to 27° C
- IT equipment operates reliably
- Equipment fans use more electricity, negating other efficiency gains

25° C
- Ideal temperature for IT equipment
- Both highly reliable and highly efficient

18° C to 24,9° C
- IT equipment operates reliably
- As temperature drops, efficiency drops
- Costs increase without added benefits

<18° C
- Same as above, but even more inefficient
- May require costly make-up humidification

The Ideal Intake Temperature – And Why it Matters

It's a common misconception that data centers need to be kept freezing cold. In fact, manufacturers recommend IT equipment intake air temperatures at, or slightly above, room temperature for maximum reliability, availability and performance – as high as 27° C. (You will find that temperature recommendations vary somewhat depending on the type of data center, equipment and cooling methods employed. The recommendations listed in this document are appropriate for the majority of small to mid-size, mixed-use data centers we encounter.)

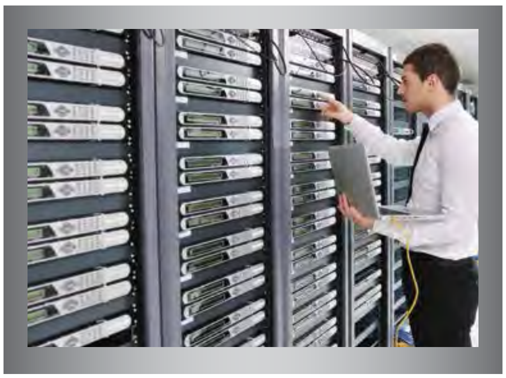
"Allowable" temperatures can drift as high as 32,2° C for limited periods of time without affecting short-term operating reliability. Most IT equipment is even designed to survive temperatures above 32,2° C, though it may not run reliably. However, running at these elevated temperatures will shorten the equipment's lifespan. (Long-term temperature increases are especially problematic for UPS batteries. For example, the estimated service life of a typical UPS battery decreases by 50% when the ambient temperature increases from 25° to 32,2° C)

25° C is the "sweet spot" for IT equipment:

- Maintaining intake air temperatures below 25° C does not improve operating conditions or provide other benefits, so it's simply an unnecessary and costly waste of energy. (If temperatures naturally fall below 25° C without any associated electricity cost or temperature swings, that isn't a problem.)

- Although IT equipment can run reliably with intake air temperatures above 25° C, the increased speed and power consumption of cooling fans inside the equipment tends to counteract (or even exceed) further energy and cost savings.

- If you have an unusual situation where maintaining 25° C seems too costly, understanding the drawbacks of higher intake temperatures will help you balance budgetary considerations against equipment reliability and system availability.

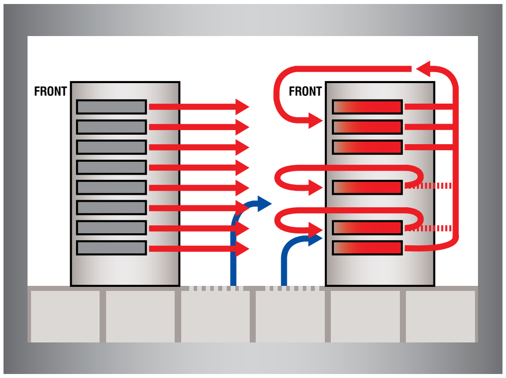


Before you turn down the thermostat, conduct a site audit to identify hot spots and cooling inefficiencies. This will help you find solutions that are less expensive and more efficient.

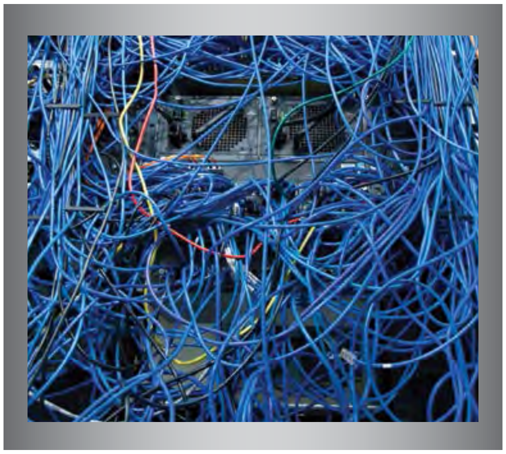
As Computing Demand Heats Up, So Do Data Centers

Many data centers start out as a few racks in a computer room or network closet. As computing needs grow – driven by factors ranging from business expansion to VoIP to virtualization – more equipment and higher wattages are packed into each rack, often without following a master plan. More equipment means more power consumption and more heat. At the same time, disorderly growth leads to haphazard rack layouts and unmanaged airflow. The result is a cobbled-together environment characterized by cooling inefficiencies.

When users experience malfunctions, shutdowns, premature equipment failures or other heat-related issues, they frequently assume that pumping more cold air into the room from the facility HVAC (heating, ventilation and air conditioning) system or CRAC (computer room air conditioner) will provide an easy solution. However, a smart first step is conducting a site audit to identify where and why hot spots and cooling inefficiencies exist. This evaluation supports informed decision-making about the most effective strategy, which often turns out to be implementing low-cost cooling best practices rather than purchasing and installing additional cooling capacity. Not only is "brute force" cooling expensive and power hungry, turning down the room temperature will only provide a temporary fix for many heat-related problems – if they are fixed at all.



When hot air recirculates, it will increase the intake air temperature. Even in a chilly room, a server under load can feed itself hot air until it shuts down.



Poorly managed cabling can block equipment cooling fans and interfere with airflow

Common Causes of Cooling Inefficiencies

Efficient and effective data center cooling is not simply a matter of supplying cold air – it's actually all about separating hot air from cold air. IT equipment generates heat non-stop, so even if cold air is directed at the rack, problems will occur if the hot exhaust from the equipment recirculates. Recirculation will pollute the cold air supply and raise the air temperature at the equipment intakes. One of the best ways to prevent this is to contain the hot air and remove it from the rack enclosure and the room before it can mix with the cold air supply.

Potential trouble spots:

- ***Internal and external rack layout.*** Hot air from equipment exhaust must not be allowed to recirculate and mix with cold air (a relative term, since 25° C is ideal). It is absolutely critical to arrange rack cabinets and the equipment inside them to block the recirculation of hot air. Air seeks the path of least resistance, so even a modest barrier can make a big difference. If racks are arranged front to back, or if servers and racks are mounted with too much open space around them, hot air will recirculate and increase the intake air temperature. Even in a chilly room, a server under load can feed itself hot air until it overheats and shuts down.

Problems can also arise when poorly managed cabling blocks fans and interferes with airflow, or when vented side panels are used in an enclosure (or left off entirely). Without solid side panels in place, hot exhaust air will flow through the sides of the enclosure, recirculate and contaminate cold air.

Dissipation removes heat from the room, but it can't always keep up with the amount of heat generated.

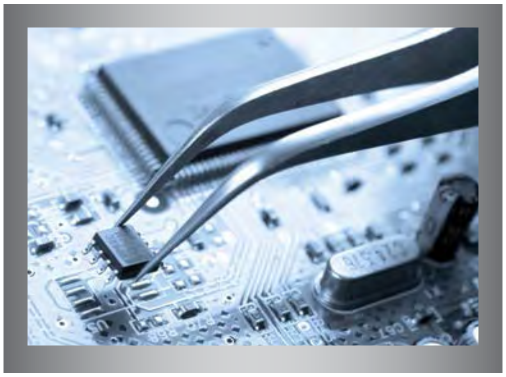
- ***Room construction, size and location.*** Natural heat dissipation through walls, ceilings and doors typically lowers room temperatures. However, if the room size is too small, the racks are densely populated, or surrounding areas aren't cool enough, dissipation may be unable to keep pace with the heat generated. If the data center has a brick exterior wall with direct sun exposure, heat transfer through dissipation is also likely to be insufficient because masonry traps heat much more than drywall, like an oven. On the other hand, if the room has interior surrounding walls heated by the HVAC system in the winter, temperatures can also rise to levels that are not optimal. And obviously, overheating can occur year-round if the computer room happens to be an unvented former closet space in an old facility, and hot air has nowhere to go.

- ***Room connection.*** At first glance, it may seem beneficial to have a computer room connected to the facility's "comfort cooling" HVAC system through air supplies and air returns. However, this situation poses several potential challenges:

  - ***HVAC cost efficiency.*** Adding a room to the HVAC system is typically more expensive, more complicated and less effective than other cooling methods. In addition, the cooling capacity per unit area of an HVAC system is typically not high enough to provide sufficient cooling for a high-density installation.

  - ***Seasonal changes.*** Everything works well during the summer, when the HVAC system is in cooling mode. The heat from the IT equipment rises, exits through the air return, gets cooled and is recirculated through the air supply vent. However, when the system switches to heating mode for the winter, heated air is delivered back to the room, where it may begin to cause problems – especially in a data center already functioning close to maximum heat capacity.

HVAC systems are not ideal for cooling high-density IT equipment.



Rapid temperature changes can stress electronic circuit boards and increase equipment failure rates.

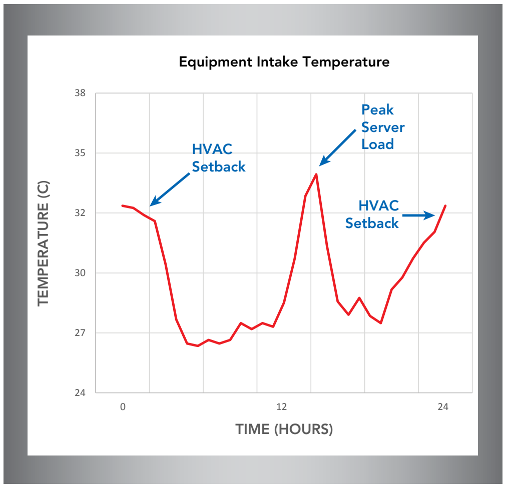
- ***Thermostat placement.*** Chances are, the thermostat for the HVAC system is not located in the data center. Therefore, while the temperature in the area near the thermostat may be kept constant, it may still fluctuate widely in the data center. This problem will be further aggravated if your organization employs HVAC setback on nights and weekends to save energy and reduce costs.

- ***HVAC cycling.*** In commercial buildings, as in homes, chillers and compressors cycle on and off. If the air handling system also cycles off, the temperature can quickly escalate in the data center because both the cool air supply to the room and hot air extraction have ceased temporarily. The IT equipment continues to produce heat, but the room has essentially sealed off all airflow.

  Issues still can occur even if the air handling system does not cycle, particularly if a computer room is already running near its limit. When the cooling compressor cycles off, the hot air from the IT equipment still gets pulled from the room through the air return. However, that air is replaced through the intake vent with air that has not been cooled.

  In either scenario, the cycling may be short enough to avoid creating immediate heat shutdown issues. But large temperature swings can still reduce equipment lifespan, reliability and availability. In fact, rapid temperature changes can actually be more damaging than elevated temperatures because they cause expansion and contraction that stress the soldering and other components of circuit boards, increasing failure rates.

Use environmental sensors to monitor equipment intake temperatures remotely.



Record temperature data over the entire production cycle. Some problems aren't visible until equipment is under load or environmental conditions change.

Smart, Cost-Effective Strategies Increase Cooling Efficiency

A wide range of simple and inexpensive airflow management solutions are available to dramatically improve cooling efficiency, once potential and existing problems have been pinpointed in the environment. Most of these solutions are easily deployable by IT staff, eliminating the need to rely on third-party contractors, incur installation costs and schedule around disruptive construction delays.

Best practice recommendations:

- ***Measure intake temperatures.*** Recirculation of hot air can raise equipment intake air temperatures far above the ambient room temperature. It doesn't matter if the room temperature is 25° C if the intake temperature is 36° C. You should know the temperature of the room, but intake temperatures are the primary data you should use to make decisions about cooling.

  We recommend using environmental sensors to monitor temperature conditions remotely. UPS and PDU accessories, as well as standalone sensors, can report temperature values over the network and record time-stamped logs. They can also provide real-time warnings when temperature exceeds defined thresholds. Servers and other devices also report internal temperature data that you can use to supplement intake measurements.

  Recording temperature data over the entire production cycle is important because some heat-related problems only reveal themselves when equipment is under heavy use or environmental conditions change. Although it may be impractical to measure every equipment intake, a representative sample from locations throughout your data center will help you identify problem areas. At the very least, try to measure the intake of every rack enclosure (nearer the top, where temperature is typically higher).

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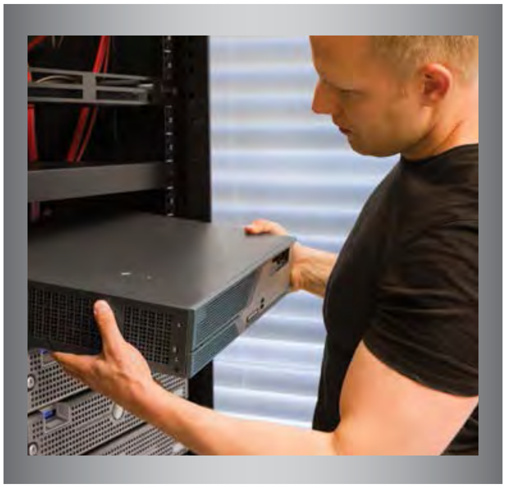
The building's HVAC system can help you remove hot air from the room.

- ***Understand the proper role of HVAC systems.*** Adding your data center to your building's HVAC system might seem like an easy way to cool equipment, but this is a misconception. HVAC systems are designed for the comfort of people in the building. They have many limitations that restrict their use in IT equipment cooling applications. (See **Common Causes of Cooling Inefficiencies** on page 5 for additional information.)

  Although the HVAC system is typically unsuitable as a primary cooling solution, the HVAC return air stream may provide a convenient place to channel hot air that you need to remove from the room. The HVAC system can also provide a source of cooler air outside the data center, but it's important to understand the cycles and limitations of the HVAC system and plan accordingly.

  Dedicated CRAC systems provide precise temperature control suitable for IT equipment, but they are much more expensive to purchase and operate than other solutions. Because of their expense, CRAC systems should only be used when cooling best practices are not sufficient to cool high-density installations on their own.

Incandescent light bulbs can each produce as much heat as several network switches, so replace them with energy-saving CFL or LED bulbs.



Identifying and decommissioning unused equipment will help you cut energy and maintenance costs.

- ***Remove unnecessary heat sources.*** Anything that adds heat to the room will make cooling more difficult and less efficient. Check for baseboard heaters, registers, vents and anything else that radiates heat or introduces warm air to the room. Incandescent light bulbs can each produce as much heat as several network switches, so replace them with energy-saving CFL or LED bulbs. (You can also increase visibility and reduce overall lighting requirements by using light-reflective white rack enclosures instead of light-absorbing black enclosures.) People and office equipment are also substantial heat sources, so locate offices outside the data center. When you have the opportunity, replace older equipment with newer models that use less energy and produce less heat.

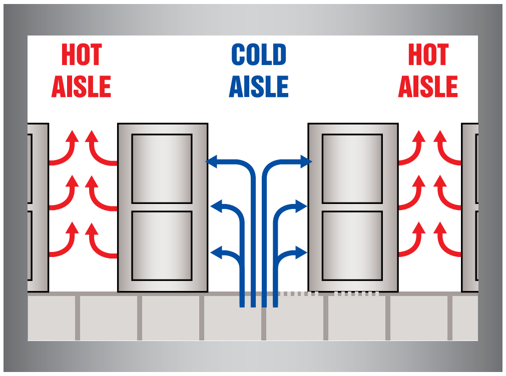
- ***Decommission unused equipment.*** When servers are replaced, they often remain plugged in, drawing power and generating heat. And older servers are typically less efficient, making the problem even worse. Sometimes it seems easier to leave equipment in place than take the risk that you might unplug a device that someone, somewhere might still be using for something. But taking the time to identify unused equipment can really pay off. When a large media company surveyed their data centers and decommissioned their "zombie servers," they reduced the number of servers by 25% and cut energy and maintenance costs by $5 million U.S. dollars per year.

Blade servers and other high-density, high-wattage loads can create problematic hot spots if they're installed too close to each other.

- ***Spread loads to reduce hot spots.*** Blade servers and other high-density, high-wattage loads can create problematic hot spots, especially if they're installed too close to each other. A data center with 20 x 2 kW racks and 4 x 14 kW racks is typically more complex and costly to cool than a data center with 24 x 4 kW racks, even though they both have 96 kW of equipment in 24 rack enclosures.

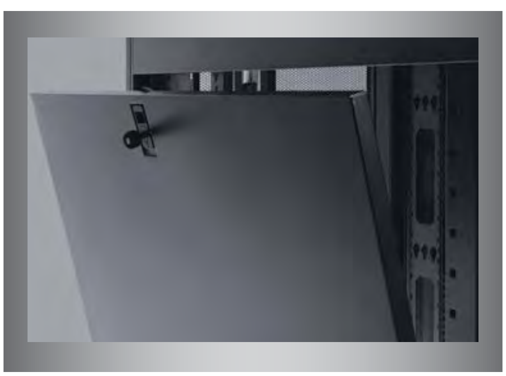
  Virtualization and consolidation projects can also make loads denser and less predictable. Cooling requirements should always be considered in the overall design of these projects. Reducing power and cooling costs typically provides a greater benefit than saving space, so there's a definite advantage to spreading loads when room is available.

- ***Arrange racks in a hot-aisle/cold-aisle layout.*** Separating your cold air supply from the hot air produced by your equipment is the key to cooling efficiency. Arrange racks in rows so the fronts face each other in cold aisles and the backs face each other in hot aisles. That prevents equipment from drawing in hot air from other equipment in the adjacent row. You should also "bay" the rack cabinets by connecting them side-to-side. Baying creates a physical barrier between hot and cold air that discourages recirculation. (You can even seal the ends of the aisles with curtains made of plastic strips – like you'd find in a walk-in freezer. They'll provide basic aisle containment without violating most fire codes.) Arranging racks in a hot-aisle/cold-aisle layout can reduce energy use up to 20%.



Arranging racks front-to-front and back-to-back in a hot-aisle/cold-aisle layout boosts cooling efficiency.

Use enclosures (left) instead of open frame racks (right). Open frame racks are great for some applications, but they offer very little control over airflow.

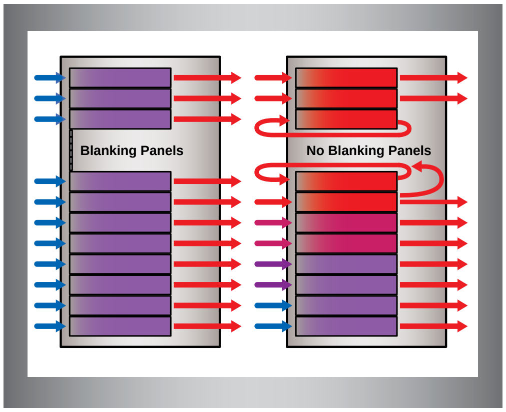


Install solid side panels to prevent hot air from recirculating around the sides of the rack enclosure.

- ***Manage passive airflow inside and outside racks.*** Airflow management provides substantial benefits with little or no expense. Installing simple accessories such as blanking panels – often overlooked during the initial rack purchase – can significantly increase cooling efficiency. Air tends to follow the path of least resistance (such as the path from a server's exhaust back to its intake), so even a modest barrier can make a big difference.

- ***Use enclosures instead of open frame racks.*** Open frame racks are great for some applications, but they offer very little control over airflow. Make sure front-to-rear airflow is unrestricted by using enclosures with fully ventilated front and rear doors. If rack-level security isn't a concern, you can even remove the front and rear doors, or purchase enclosures without them. Some enclosures may use solid doors to seal the airflow path, but they will still maintain front-to-rear airflow through ducting. If you must have a glass door, make sure it permits enough airflow to keep your equipment cool. If you have devices that use side-to-side airflow (common with network switches and routers because of their cabling requirements), install internal rack gaskets to accommodate them.

- ***Install solid side panels.*** They prevent hot air from recirculating around the sides of the enclosure. It may seem like ventilated side panels would improve cooling, but they actually allow hot air to recirculate and cause cooling problems. You also need to make sure that bayed enclosures have solid side panels between them to prevent hot air from traveling from rack to rack inside the row.

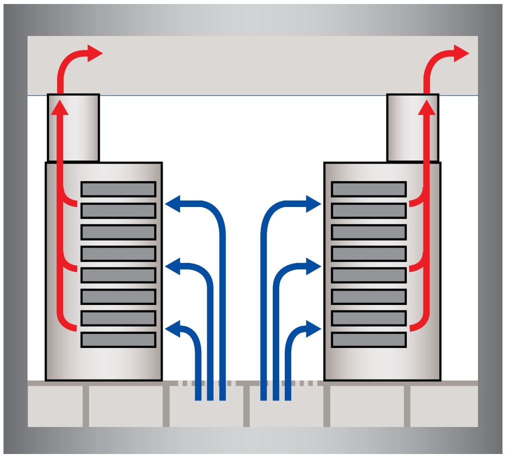


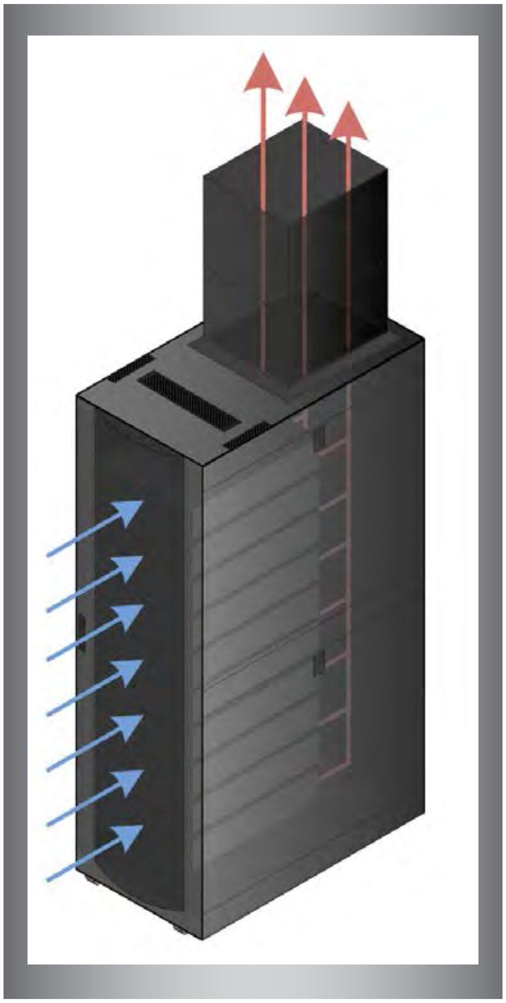
Without blanking panels, hot air will recirculate through the interior of the rack enclosure.

Cable management not only improves cooling efficiency, it also reduces troubleshooting time, repair time and installer errors.

- ***Use blanking panels to fill unused rack spaces.*** This is not a cosmetic procedure – it forces cold air through your equipment and prevents hot air from recirculating through open spaces. Snap-in 1U blanking panels are best. They save significant installation time compared to screw-in models, and the 1U size always fills empty rack spaces evenly. You should also install brush strips, gaskets and grommets to block air leaks around cable channels and other gaps.

- ***Manage cables.*** Unmanaged cabling blocks airflow, preventing efficient cold air distribution under raised floors and causing heat to build up inside enclosures. In raised-floor environments, move under-floor cabling to overhead cable managers (ladders and/or troughs). Inside enclosures, use horizontal and vertical able managers to organize patch cables and power cords. A sound cable management strategy also reduces troubleshooting time, repair time and installer errors. Remember that a standard-width, standard-depth enclosure may not have enough room for all the cables required in a high-density network installation. In that case, consider whether an extra-wide and/or extra-deep enclosure would provide the breathing room you need.



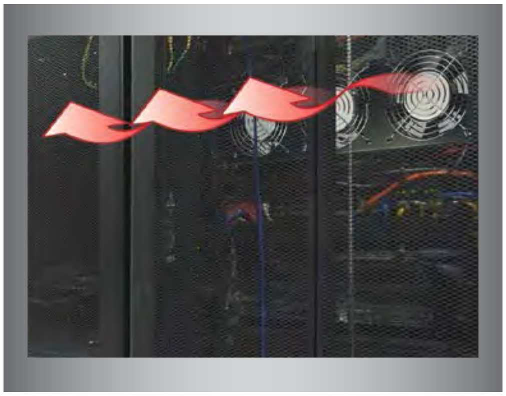


Thermal ducts route equipment exhaust directly to the HVAC/CRAC return air duct or plenum.

- ***Use passive heat removal.*** Passive heat removal solutions help you remove heat from your racks and your data center without introducing additional energy costs. You can use a simple, straightforward version of passive heat removal to cool a closed room. Add two vents by a climate-controlled area: one high on a wall and the other on the wall or door near the floor. Since hot air rises, it will flow out through the upper vent and be replaced with cooler air from the lower vent. (The vents will require a source of sufficiently cool, clean air to draw from.)

- ***Use thermal ducts.*** For even better heat removal, you can connect thermal ducts to your rack enclosures. The overhead ducts – like adjustable chimneys – route equipment exhaust directly to the HVAC/CRAC return air duct or plenum. Hot air is physically isolated, so there's no way for it to recirculate and pollute the cold air supply. Convection and the negative pressure of the return air duct draw heat from the enclosure, while the HVAC/CRAC system pumping air into the room creates positive pressure. The result is a highly efficient airflow path drawing cool air in and pushing hot air out. This approach delivers a bonus by providing air handlers with the hot air that most need to run more efficiently.

  Enclosure-based thermal ducting is also compatible with hot-aisle/cold-aisle configurations and fire codes, so retrofitting an existing installation is relatively painless. It provides a more affordable and practical alternative to aisle containment enclosures, which essentially create a room within a room. Most fire codes require installing or extending expensive fire suppression systems inside these aisle containment enclosures, so costs, delays and disruption mount very quickly.



Active heat removal uses fans attached inside the enclosure to pull heat up and out of the cabinet.

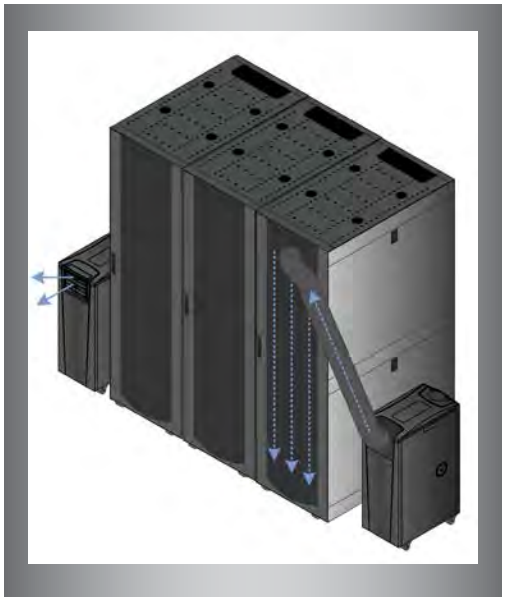
- ***Use active heat removal.*** Active heat removal solutions assists passive heat removal with ventilation fans. Reconsidering the high/low room vent described above, you can assist airflow by adding a fan to the upper vent. Warmer air is lighter than cooler air, so it will rise toward the upper vent, and the fan will accelerate the process.

  Active heat removal can also assist in situations where you cannot connect thermal ducts directly to the return air duct. This solution uses fans attached inside the enclosure to pull the heat up and out of the cabinet, rather than relying on the negative pressure of the return air duct. Fans can be attached to the roof of the enclosure or in any rack space, with or without thermal ducts. Although fans use electricity and generate some heat, the amounts are minimal compared to compressor-driven air conditioners. Using variable-speed fans governed by the ambient temperature may also reduce average power consumption.

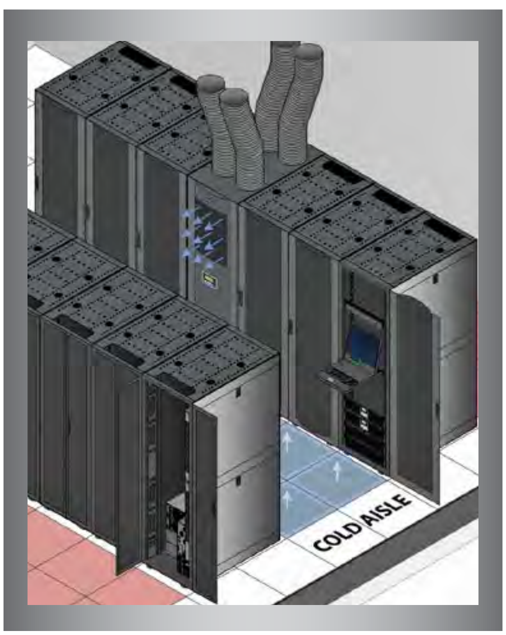
If heat-related problems persist, close-coupled cooling can be a smart and economical choice.

- ***Use close-coupled active cooling.*** If heat-related problems remain after you implement other cooling best practices, a close-coupled cooling system can be a smart and economical choice. For example, it's an ideal solution when masonry exterior walls interfere with effective heat dissipation, when replacement air is unavailable because the room is surrounded by non-climate controlled areas, when inconsistent HVAC operations cause potentially damaging temperature fluctuations or when wattages per rack are simply too high for other methods. (Close-coupled active cooling should supplement – not replace – other best practices. Optimizing data center cooling efficiency requires you to combine all viable and mutually-compatible options.)

  Close-coupled cooling systems deliver precise temperature control suitable for IT equipment, yet they provide better efficiency than traditional perimeter and/or raised floor systems. They can also improve the efficiency of existing CRAC systems by eliminating hot spots without lowering the CRAC's temperature setting.



You can add a portable cooling system at any time with minimal disruption. It can cool a small room, an overheating rack or an equipment hot spot.



A row-based cooling system fits inside a rack row.

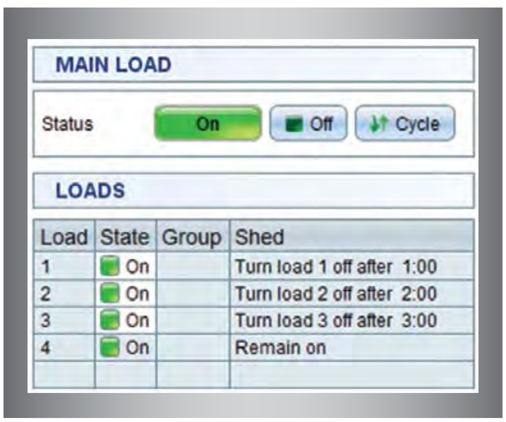
Close-coupled cooling allows you to reduce airflow distance, use less electricity for powering fans and focus cooling where it's needed most. The modular nature of close-coupled cooling also allows data center managers to quickly reconfigure cooling to handle new equipment or overheating racks. Self-contained solutions can be installed by IT staff without requiring costly contractors, plumbing, piping, special ductwork, floor drains, water tanks or extra parts.

Close-coupled cooling systems should incorporate features that allow you to integrate them into your data center's overall management scheme, including remote management capability and automatic restarts after power failures. Although close-coupled cooling solutions require a larger investment than other cooling best practices, they're still a bargain compared to installing or expanding larger HVAC/CRAC systems.

- A portable cooling system rolls into place at any time with minimal disruption. It can either cool a small room or focus cold air on a particular rack or hot spot through a flexible output duct.
- A rack-based cooling system mounts inside a rack enclosure. It provides more cooling than a portable system, with a smaller footprint than a row-based system.
- A row-based cooling system fits inside a rack row, where it is bayed like an enclosure. It provides the most cooling power, but it also requires the most space.

Cooling systems that support remote management allow you to integrate them into your data center's overall management scheme.

Without a plan for cooling during an outage, systems may shut down from thermal overload long before battery power runs out.



Load shedding uses switched UPS or PDU outlets to turn off non-critical loads during an outage.

- ***Consider what happens during an outage.*** If you have long-lasting backup power for your data center equipment, you should consider it for your cooling systems too. During a blackout, servers and other equipment that are backed up by a UPS system will continue to operate and produce heat, but cooling systems may be without power. Without a plan to provide sufficient cooling during an outage, your systems may shut down from thermal overload long before battery power runs out, especially systems like VoIP that require hours of battery backup runtime.

  If the nominal backup runtime is relatively short (30 minutes or less), backup cooling may be unnecessary. The heat dissipation of the room may be enough until power is restored or battery backup is depleted. Intake temperatures will rise, but won't impact system availability as long as they don't exceed 32,2° C.

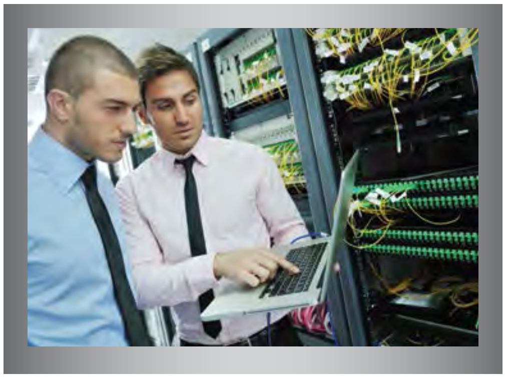
  If the nominal backup runtime is relatively long (more than 30 minutes), you may need to provide backup cooling. This is especially true for high-wattage racks or a data center already close to its heat capacity. If you have some headroom in the heat capacity of your data center, you don't necessarily need to provide backup power for all of your cooling systems. It may be enough to back up a fan-assisted heat removal system. Or you can power a portable cooling system in place of a larger system. You can also use switched UPS or PDU outlets to automatically turn off non-critical loads during an outage – a strategy known as load shedding. This makes it easier to provide extended runtime and reduces heat output while cooling systems are offline.

  Partial air conditioning backup or ventilation-based backup combined with dissipation may keep temperatures at allowable levels long enough to match the nominal runtime. It won't keep the room as cool, but it will keep equipment from reaching the point of thermal failure until power is restored. What is considered an acceptable temperature rise depends on availability goals and budget limitations – you need to balance these considerations to determine the ideal solution for the specific application. (Providing backup power for larger air conditioning systems is possible, but it's likely to be expensive.)

Heat-related issues? Keep cool.

Recommended Plan of Action

1. Do not automatically assume that you need additional air conditioning.
2. Identify the cooling inefficiencies within your data center environment.
3. Determine which issues you can resolve by implementing cooling best practices.
4. Evaluate the broad range of cooling solutions available to find the options that work best for your data center and your budget.
5. Consider working with an experienced professional to help you identify and resolve heat-related problems. Contact Tripp Lite at **+1.773.869.1212** or **salesint@tripplite.com** for a free data center audit.



*Contact Tripp Lite at **+1.773.869.1212** or **salesint@tripplite.com** for a free Data Center Audit. You'll be able to review your cooling needs with an experienced data center specialist and develop a cost-effective cooling strategy that fits your goals and your budget.*

Smarter Cooling, Better Bottom Line

In conclusion, as small and mid-size data centers add racks and increase equipment density to keep pace with growing computing demand, lack of planning often leads to heat problems. Although IT equipment does not require meat-locker temperatures to run properly, too much heat or too many fluctuations can have a negative impact on equipment reliability and system availability.

Users can prevent or mitigate heat-related issues by identifying potential or existing inefficiencies and implementing data center cooling best practices. Cooling best practices provide a low-cost, high-value approach to boosting rack cooling efficiency, reducing operating costs and extending the lifespan of IT equipment. They also eliminate (or at least minimize) the need for more expensive solutions.

Every installation is different, and the ideal solution depends on the site, equipment, application and other factors. Contact Tripp Lite at **+1.773.869.1212** or **salesint@tripplite.com** for a free Data Center Audit. You'll be able to review your cooling needs with an experienced data center specialist and develop a cost-effective cooling strategy that fits your goals and your budget.

About Tripp Lite

Customers in the IT, telecom, industrial, commercial, corporate, healthcare, government and education sectors choose Tripp Lite for complete solutions to power, protect, connect and manage servers, network hardware and other equipment in data centers and related facilities. Tripp Lite makes more than 3,000 products, including UPS systems, battery packs, PDUs, rack enclosures, cooling solutions, surge protectors, KVM switches, cables, power strips and inverters. For more information about Tripp Lite’s full line of data center solutions, visit **www.tripplite.com**.

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