WHITE PAPER

Choosing Close-Coupled IT Cooling Solutions

Smart Strategies for Small to Mid-Size Data Centers

Executive Summary

As high-density IT equipment becomes the new normal, the amount of heat generated continues to grow substantially – as does the challenge of efficiently cooling data centers. Traditional perimeter and/or raised floor computer room air conditioning systems increasingly struggle to remove concentrated heat loads. In many small to mid-size data centers, implementing close-coupled cooling solutions can be a highly effective and efficient strategy for supplementing cooling capacity. Located in or near server racks, close-coupled air conditioning units focus cooling where it is needed most without lowering the temperature of the entire data center. In addition, these modular solutions make it easy to reconfigure cooling to handle new equipment or eliminate hot spots. As a result, using close-coupled portable, rack-mounted or row-based air conditioning units tailored to your specific data center needs can boost cooling efficiency and add valuable flexibility.

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The Growing Cooling Challenge

As equipment density and wattage in small to mid-size data centers continue to climb, so does the amount of heat generated. This makes it much more difficult for conventional air conditioning systems to deliver enough cool air, maintain a uniform room temperature and adequately remove heat exhaust.

High-density loads like blade servers and PoE switches can create hot spots that traditional perimeter cooling systems have trouble addressing.

For the last 40 years, the primary method of data center cooling has been to use a perimeter computer room air conditioner (CRAC) to cool the entire room. The cool air supplied in this room-based approach may be unrestricted by ducts, vents or dampers. Or, it may be partially constrained by having CRAC units distribute cold air under a raised floor with perforated tiles or vents and removing warmer exhaust air through an overhead return plenum.

However, at higher power densities, perimeter systems operate far less effectively for two key reasons. First of all, perimeter systems provide bulk cooling and distribute that cooled air to the IT loads. Airflow varies substantially and is heavily influenced by floor depth, obstructions, air leakage and room dimensions (particularly ceiling height). This makes cooling performance difficult to predict and difficult to scale.

Second, the greater the distance between the CRAC units and the heat load, the harder it is to remove heat generated by the equipment in the racks and prevent it from recirculating. In fact, efficient data center cooling depends even more heavily on separating hot air from cold air to prevent recirculation than it does on supplying cold air.

First Line of Defense: Cooling Best Practices

Numerous low-cost and no-cost best practices can optimize airflow, boost efficiency and solve heat-related data center problems such as hot spots. These practices range from spreading out the heat loads, arranging racks in a hot-aisle/cold-aisle layout and installing blanking panels, to managing cables, managing passive airflow inside and outside racks and using passive heat removal. (See Tripp Lite white paper ***Increase Rack Cooling Efficiency and Solve Heat-Related Problems*** for more information.)

Simple steps like installing blanking panels in unused rack spaces can help prevent warm air from recirculating and improve cooling efficiency.

If you continue to have heat-related issues after implementing these best practices, it's time to consider close-coupled cooling solutions. Based on the premise that one of the most effective ways to increase cooling efficiency is to move the air conditioner as close as possible to the heat source, close-coupled air conditioning units are mounted near, between or inside racks.

Close-coupled air conditioning units can be used as stand-alone solutions in small data centers or provide supplementary cooling in larger ones. They can effectively and economically address several common issues:

- Masonry exterior walls interfere with heat dissipation
- Replacement air is unavailable because the data center is surrounded by non-climate-controlled areas or sealed so tightly that make-up air is hard to capture
- Inconsistent HVAC operations create potentially damaging temperature fluctuations, or seasonal settings send heated air back into the data center
- Wattages per rack are too high for other cooling methods
- Hot spots are created by high-density racks or virtualization
- There are too few racks to do aisle containment
- Cooling needs to be quickly reconfigured to handle new equipment

Close-coupled cooling solutions increase cooling efficiency and performance by moving air conditioning closer to your equipment.

Next Step: Close-Coupled Cooling Solutions

Close-coupled air conditioning units offer several advantages compared to conventional perimeter systems. These include:

- **Targeted temperature control.** With close-coupled cooling, you can focus cooling exactly where it is needed most without wasting energy and money lowering the temperature of the entire room.
- **No need for a raised floor.** Using close-coupled solutions eliminates the cost of building a raised floor in new data centers. Close-coupled air conditioning units are also are practical options for existing data centers with cluttered or restricted under-floor air distribution paths.
- **Lower operating costs.** Targeted cooling can reduce operating costs by reducing the amount of fan power required to move air around either above or below the floor in order to cool the data center.
- **Flexibility.** Modular, scalable close-coupled cooling solutions allow you to quickly and easily reconfigure cooling as you install new equipment or identify overheating racks.

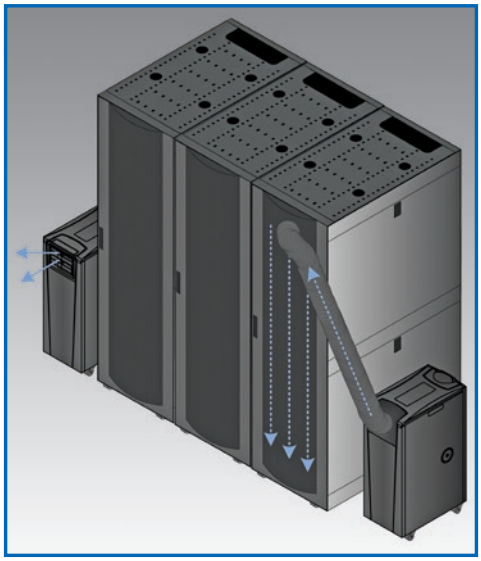
There are three types of close-coupled air conditioning units: portable, rack-mounted and row-based. Several factors should be considered to determine the option that will be most effective for your data center. These include room size, location, number of racks, rack density and arrangement, heat load and budget.

1. Portable Close-Coupled Cooling

Portable air conditioning units are ideal for cooling a small server room, up to five racks or a hot spot, which could be an entire rack enclosure or a particular device within the enclosure. These compact units can be rolled into place at any time with minimal disruption. For best performance and most economical operation, portable units should meet these criteria:

- **Ease of installation.** Self-contained models support plug-and-play installation, eliminating the need for a disruptive construction project or the cost of hiring an electrician, plumber or HVAC specialist. Models should include an exhaust hose to remove hot air from the room through a dropped ceiling, window or return duct. They should also have a built-in evaporator to expel condensation, so that they do not require an external condenser, refrigerant piping, floor drain or water collection tank.

- **Precise cooling control.** Portable units with flexible output ducts and adjustable louvers can direct cool air to specific locations. When the duct is connected near the top of a rack enclosure, the cool air naturally sinks and provides even temperature distribution. In addition, connecting units with environmental sensors provides the ability to monitor temperature and humidity several feet away from the unit so that you can accurately adjust its cooling settings or adjust air conditioning cycling at the remote temperature location.



Portable air conditioning units can direct cold air through directional louvers or a flexible output duct.

- **Automated restart.** Some units require manual restart and configuration after a power failure. Others automatically restart with the most recent settings, ensuring data center equipment runs with proper cooling as soon as possible without user intervention.

- **Remote management capability.** With centralized management via Web browser, SNMP, SSH or telnet, you can monitor and adjust temperatures from any location as well as remotely change settings and automated adjustments. You can also receive alerts via email or text message and access detailed condition and event logs so that you can identify and address potential issues before they cause downtime.

2. Rack-Mounted Close-Coupled Cooling

Rack-mounted air conditioning units mount inside a rack enclosure. The short, defined airflow path dramatically reduces the amount of work the unit's fans need to do, and therefore the amount of electricity required to run it.

These flexible, easy-to-implement systems work best in server rooms or data centers with one or two racks, as long as the power density remains under 2 kW per rack. It is easy to tailor cooling capacity to actual power density, and hot spots and vertical temperature gradients are eliminated. Rack-mounted cooling also reduces the problem of performance predictability because airflow can be focused on the target load.

Rack-mounted cooling can also be combined with thermal ducts for better heat removal. Like adjustable chimneys, the ducts route equipment exhaust directly to the room's HVAC/CRAC return air duct or plenum. Because the hot air is physically isolated, it cannot recirculate and pollute the cold air supply.

A hybrid rack-mounted cooling and ducted rack solution is recommended when the data center has a dropped ceiling, scattered high density racks or an uneven number of rack rows. It can also be effective when rack rows are not equal in length, making hot aisle/cold aisle arrangements impractical. Like portable options, rack-mounted air conditioning units should provide remote management capability.

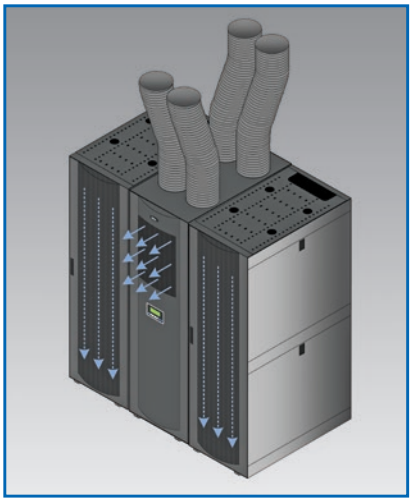
A rack-mounted air conditioning unit operates from the top or bottom of a rack enclosure.

3. Row-Based Close-Coupled Cooling

Row-based air conditioning units fit inside rack rows. The airflow paths are short, clearly defined and predictable, reducing the fan power needed and increasing cooling efficiency. Although they provide the most cooling power of the close-coupled cooling options, they also require the most space.

Row-based cooling provides an advantage over a room-based approach because the solution can be tailored to the density needs of specific rows. Row-based air conditioning units should be sufficiently sized and placed to maximize performance, which means avoiding locating them at the ends of rows. If you need to add new rows – particularly higher-density ones – to your data center, row-based products are the logical choice for increasing localized cooling.

Row-based cooling also improves the efficiency of hot-aisle/cold-aisle rack layouts. It removes hot air from the hot aisle and supplies cold air high in the cold aisle, promoting top to bottom temperature uniformity.



A row-based air conditioning unit resides in the rack row, supplying cold air high in the cold aisle.

Top-performing row-based air conditioning units are characterized by:

- **Simple installation.** Self-contained units with built-in condensers require no plumbing, piping, floor drain, water collection tank or complicated wiring. They can easily be installed by IT staff rather than an electrician or HVAC contractor.

- **Energy savings.** Units with variable-speed cooling allow precise adjustments, making operation much more energy-efficient than those with typical "on/off" cycles. A soft-start feature prevents inrush current spikes from wasting energy and reduces line noise, voltage fluctuations and potential circuit overloads. Once the temperature set point is reached, the unit automatically scales back to operate in temperature maintenance mode.

- **Operating convenience.** The ability to monitor and control temperature, humidity, fan speed, logging and alarms locally or remotely saves valuable time while also enhancing the system's effectiveness. Units that restart automatically after power outages avoid the need to have someone manually reconfigure and start them, saving time and ensuring proper cooling is restored as soon as possible.

Recommended Plan of Action

1. Identify the cooling issues and inefficiencies in your data center environment.

2. Implement as many low-cost cooling best practices as feasible.

3. If issues remain, determine whether close-coupled air conditioning units can help you efficiently supplement your existing cooling system.

4. Evaluate portable, rack-mounted and row-based solutions to find the option – or combination of options – which works best for your data center and budget.

5. Consider working with an experienced professional to help you identify and resolve heat-related problems. Contact your sales representative to arrange a free Tripp Lite data center audit.

Higher Densities, Smarter Cooling Options

As equipment density continues to grow, cooling effectively and efficiently becomes even more challenging for small and mid-size data centers. Initial efforts should focus on identifying potential or existing inefficiencies and implementing low or no-cost cooling best practices. But if hot spots remain or additional cooling is still required, close-coupled air conditioning units can be a smart solution for replacing or supplementing conventional perimeter systems.

Portable, rack-mounted and row-based options – used either individually or in combination – provide highly flexible, scalable, modular cooling that increases predictability, reduces power consumption and lowers operating costs.

Every data center has specific needs, and the best solution depends on a variety of factors including density, rack arrangement, budget and data center dimensions. Contact your sales representative to arrange a free Tripp Lite data center audit. You'll be able to review your cooling needs and options with an experienced data center specialist.

Tripp Lite Close-Coupled Air Conditioning Units

Tripp Lite manufactures portable, rack-mounted and row-based air conditioning units ideal for close-coupled cooling in data centers and other IT environments. All units are self-contained for easier installation and support remote management via SNMP, Web, SSH or telnet.

SRCOOL12K Portable Air Conditioning Unit

SRCOOL7KRM Rack-Mounted Air Conditioning Unit

SRCOOL33K Row-Based Air Conditioning Unit

Portable Air Conditioning Units

SRCOOL12K	12,000 BTU self-contained air conditioning unit. 120 V input (5-15P plug).
SRXCOOL12K	12,000 BTU self-contained air conditioning unit. 230 V input (CEE 7/7 "Schuko" plug).
SRCOOLNET	Optional remote management module for SRCOOL12K or SRXCOOL12K.

Rack-Mounted Air Conditioning Unit

SRCOOL7KRM	7,000 BTU self-contained air conditioning unit. 8U rack cabinet. 120 V input (5-15P plug).
SRCOOLNET2	Optional remote management card for SRCOOL7KRM.

Row-Based Air Conditioning Units

SRCOOL33K	33,000 BTU self-contained air conditioning unit. 200-240 V input (L6-30P plug).
SRXCOOL33K	33,000 BTU self-contained air conditioning unit. 200-240 V input (hardwire).
SNMPWEBCARD	Optional remote management card for SRCOOL33K or SRXCOOL33K.

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 Tripp Lite's website.

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