



# HOW COLO DATA CENTERS CAN PREPARE TO INCORPORATE DIRECT LIQUID COOLING

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Colocation (Colo) data centers today are primarily air-cooled and face increasing demands from customers for higher density racks using chips with high Thermal Design Power (TDP) limits from companies such as Intel, NVIDIA, and AMD. But using this technology generates excessive heat and traditional air-cooled data center solutions may not be able to keep up with the needs to reduce energy consumption and maintain infrastructure performance. Liquid cooling has been adopted by High Performance Computing (HPC) for the last decade and is becoming more accessible to Enterprise customers as costs continue to decrease and accessibility increases. Colos are starting to install Direct Liquid Cooling (DLC) infrastructure in parts of their centers to support key customers looking for high-density racks. Solution providers like CoolIT Systems in conjunction with HPE, Dell EMC, Intel, Gigabyte, and others are making DLC viable options for their customers. According to Jason Zeiler, CoolIT Systems, Sr. Marketing Manager, “Similar to Formula 1 racing, the technologies of the high-performance sector are trickling down and becoming the standard for enterprise data center cooling.” This paper explores the challenges faced by Colos in cooling server infrastructure in the data center and introduces the technology and benefits of DLC for Colo data centers.

## Trends in Data Center Energy Usage

Organizations are using Colo data centers with infrastructure that can process and store the massive amounts of data generated by HPC, artificial intelligence (AI), deep learning (DL), and data analytics applications. However, this requires increased energy consumption within the data center. [Data center power usage](#) is projected to double over the next 10 years and is on track to consume 11 percent of worldwide electricity by 2030.

[Data centers in Europe](#) face additional regulations relating to energy usage. The European Union (EU) indicates that the environmental footprint of data centers and telecoms is estimated at 5-9 percent of the world’s total electricity use and more than two percent of all emissions. The EU is driving data centers to “become climate neutral by 2030.”

## Colo Data Center Challenges with HPC Workloads

Colo data centers face the following challenges to efficiently run workloads while reducing heat generated and energy used:

- Colo cloud data center customers require better data center usage with more computing cores per square foot
- Requires increased rack density and efficiency
- Growing power usage and increased heat generated leads to increase in operating costs (OPEX)

**Hardware Performance Considerations:** HPC Central Processing Units (CPUs) and Graphic Processing Units (GPUs) have built-in Thermal Design Power (TDP) temperature thresholds:

- Processing at scale can increase CPU/GPU/memory heat generated making it higher than the allotted TDP rating assigned by the manufacturer
- This may cause performance degradation from heat-related issues which causes the chip to slow down (throttling) to maintain and energy threshold settings

## Traditional Data Center Cooling

Data centers traditionally used air-cooling equipment to cool their facilities and infrastructure including servers. The equipment includes chilling towers, pumps, Computer Room Air Conditioner (CRAC) units and Computer Room Air Handling (CRAH) units. Data centers use various methods for cooling servers such as raised floors with separate hot and cold aisles. A raised floor under the server area is used for cooled air and power cabling. Cold air from CRAC and CRAH units can also be distributed to space in front of servers to cool them. Colo data centers using traditional air-cooling struggle to cool high-density data center racks running HPC workloads. Increasing air cooling units or placing servers in larger enclosures is one solution but this reduces rack density. Colo data centers are increasing use of Direct Liquid Cooling (DLC) to meet the energy and performance challenges.

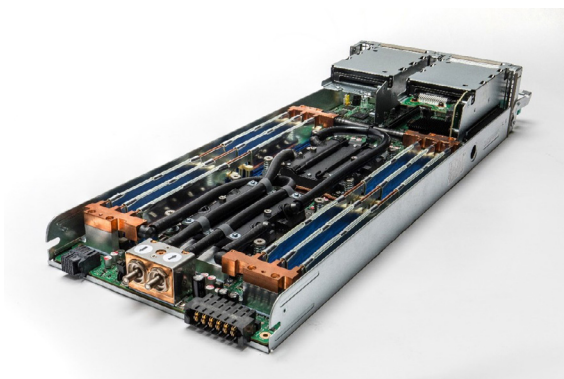
## Direct Liquid Cooling (DLC) Meets Colo Data Center HPC Workload Needs

DLC provides Colo data centers with a method to meet energy regulations, reduce cost, and maintain processing performance of their HPC infrastructure. DLC cools IT equipment separate from building cooling infrastructure by bringing liquid directly to the heat source on the server to cool components on the server such as the CPU, GPU, and memory. The DLC system includes Coolant Distribution Unit (CDU) hardware, Heat Exchangers, and other cooling equipment. DLC provides stable coolant under changing operational loads to maintain the heat threshold of equipment running HPC workloads.

### CoolIT Systems DLC Solutions

[CoolIT Systems \(CoolIT\)](#) was founded in 2001 and is a leading provider of DLC product solutions for the desktop gaming and data center industries. CoolIT products are equipped to support any server, rack configuration and data center environment to enable server technology to perform at its peak. In addition, the products help eliminate the need for Colo data centers to use expensive chiller plants and CRAC units. CoolIT DLC technology can provide a 27 percent reduction in energy usage when using warm water; a 12 percent reduction in energy use when using chilled water; and 10 percent efficiency gains at the server.

CoolIT Systems DLC solutions use liquid cooling to provide modular heat-transfer solutions to cool independent servers for rack-based data centers. Direct Liquid Cooling (DLC) uses the exceptional thermal conductivity of liquid to provide dense, concentrated cooling to targeted areas. By using DLC and warm water, the dependence on fans and expensive air handling systems is drastically reduced. This results in much higher rack density, overall reduced power use and significantly higher performance potential. Figure 1 shows an example of CoolIT DLC equipment placed within an Intel server.



*Figure 1. CoolIT DLC solution placed inside Intel S9200WK server system*



## CoolIT Coolant Distribution Units (CDUs)

Low-pressure CHx Coolant Distribution Units (CDU) are built to meet the increasing demands of today's data centers and demanding HPC requirements. Capable of managing a wide range of heat loads in dense packages, these systems can be configured to provide enough cooling for any deployment.

CoolIT CHx80v2, CHx200, and CHx750 CDUs are specifically suited for installation in Colo data centers. The CHx80v2 manages 80 servers per rack, while the CHx200 can manage 200 servers per rack or cluster as shown in Figure 2. The CHx80v2 and CHx200 CDUs are 4U in height and mount directly into a rack like a server. The CHx750 CDU is the size of a rack and is a standalone product that usually sits at the end of an aisle. Benefits of these CDUs include:

- Compatible with ASHRAE W4 warm water
- Enables 100 percent utilization of rack and data center space
- Facilitates peak performance for higher powered processors
- Significantly reduces data center energy consumed and lowers operating costs
- Quick and easy installation and service
- Can be located anywhere in a rack
- Intelligent control system with remote monitoring



CoolIT CHx80v2 CDU



CoolIT CHx200 CDU

*Figure 2. CoolIT CHx80v2 and CHx200 CDUs.*

## Additional CoolIT DLC Products

CoolIT Systems [DLC products](#) consist of the following additional products:

**Passive Cold Plates:** CoolIT Systems CPU Coldplates are designed to accommodate lower profile footprints, such as 1U blades and other custom chassis. These passive coldplates do not contain any high failure rate components such as internal pumps. Instead, coolant circulation is provided by a rack or row-based Coolant Distribution Unit (CDU).

**Rear Door Heat Exchangers (RDHx):** CoolIT Rear Door Heat Exchangers (RDHx) provide additional cooling capability to direct liquid cooling solutions when 100 percent heat capture and neutralization is required. RDHx Heat Exchangers attach directly to the rack and use the same liquid loop as the CDU, rack manifold and cold plate loops to provide a seamless solution.

**Rack and Chassis Manifolds:** Rack Manifolds are organized for a manual connection at the front or back of the rack. Manifolds are flexible and can be arranged vertically or horizontally within a rack. Combined with dry-break, dripless Quick Disconnects from Staubli, these manifolds are safe and effective building blocks when paired with Rack DLC Passive Coldplate Loops.

**Secondary Fluid Networks (SFN):** Secondary fluid networks (SFN) are custom-designed, partially pre-assembled and installed to meet the needs of the data center. Reliable fusing techniques are used to assemble various modular components to build out the SFN at an off-site location to enable rapid deployment and fusing of the final connections on-site. Each SFN design is completed by performing a series of quality control measures which are considered as leading industry standards.

## CoolIT Systems Command2 Control Software

It is critical that Colo IT staff have an easy-to-use software and management solution. CoolIT's DLC™ Coolant Distribution Units (CDU) come equipped with the Command2™ control system. The software was created by CoolIT and manages the CDU's performance autonomously once the user has provided operating parameters for pressure, flow, and temperature. The software uses a variety of sensors to monitor pressure, temperature, and flow to control pump speeds for secondary side flow. A three-way or two-way valve can be used to regulate flow on the primary side. The software provides Colo data center staff with automated controls that deliver consistent performance across servers without the need for constant adjustments based on a data center's changing needs.

## CoolIT Systems Support and Training

With CoolIT's modular approach, customers work directly with CoolIT's engineering experts to select components specific to their needs. CoolIT provides teams of Solutions, Project Engineers, and Service Specialists to ensure a smooth process from pre-job planning to final commissioning. The teams help ensure customers find the right solution for their liquid cooling needs, it is installed safely and efficiently and provide continued support to guarantee future performance.

CoolIT's network of Approved Service Providers (ASP) help deploy and maintain CoolIT liquid cooling solutions regardless of location. Service is provided by CoolIT and their local Authorized Service Provider partners who cover over 157 countries and better serve the data center industry with forward-thinking designs, solutions, and services.

CoolIT provides multiple levels of on-site and remote training for data center teams around the world. Training can range from Data Center Operators and Server OEM Engineers to Sales Teams and Support Staff, with training topics covering a wide variety of areas and interests.

## CoolIT DLC Technology Cools the Frontera Supercomputer

Located in The University of Texas at Austin, the National Science Foundation (NSF)-supported Frontera supercomputer was the fifth-fastest US university supercomputer in the world as noted in the Top500 list in 2019. Frontera has a theoretical 35-40 PFLOPs peak performance.

The challenge in developing Frontera was cooling this new system with the pre-existing air-cooling infrastructure in the Texas Advanced Computing Center (TACC) facility. Since Frontera would be 3x times denser than the existing Stampede2 supercomputer and air cooling would not be sufficient to cool the high-powered CPUs, the TACC Frontera team worked with CoolIT to deliver a high-density liquid cooling solution. The Frontera Supercomputer liquid cooling technology contains:

- 91x racks with direct liquid-cooled Dell EMC PowerEdge C6420 servers with factory-installed Passive Coldplate Loops
- 91x RD020 Active Rear Door Heat Exchangers, managing heat from all other components
- 9x row based CDU
- 3x custom secondary fluid networks below the racks

According to Zeiler, “DLC enables high-density servers to operate at their highest performance, for indefinite periods of time, without the worry of thermal shutdown due to hotspots created by inefficient air cooling. For example, the TACC Frontera Supercomputer can operate all 91 racks at full performance with their Intel CPUs on Turbo mode for long periods of time for intense simulations. Doing so during their Top 500 run placed them #5 on the Top500 list in 2019. This same technology is now available and being deployed in Colo data centers around the world to increase efficiency and reduce OPEX.”

## Summary

Organizations increasingly use HPC-level processing, artificial intelligence (AI), deep learning (DL), and data analytics applications which generate massive amounts of data. Colo data centers must be able to meet the thermal processing and performance requirements. However, this level of processing generates excessive heat and traditional air-cooled Colo data center solutions may not be able to keep up with the needs to reduce energy consumption and maintain infrastructure performance.

“Colo data centers continue to improve their facilities in order to decrease OPEX while providing the best customer solutions they can. Direct Liquid Cooling is a natural fit to help them reach their goals to fully populate their racks, occupy less physical data center space, and significantly decrease their electricity costs,” states Zeiler.

## About CoolIT Systems

CoolIT Systems specializes in scalable liquid cooling solutions for the world’s most demanding high-performance computing environments. In the desktop enthusiast market, CoolIT provides unparalleled performance for a range of gaming systems utilizing its patented split-flow technologies. Through its modular, rack-based Direct Liquid Cooling technology, Rack DLC, CoolIT enables dramatic increases in rack densities, component performance and power efficiencies. CoolIT partners with the global leaders in OEM server design to provide the most efficient and reliable liquid cooling solutions that provide high-performance cooling for their leading-edge products. Together, CoolIT and its partners are leading the way for widespread adoption of high-performance computing. For more information about CoolIT Systems and its technology, visit <https://www.coolitsystems.com>.