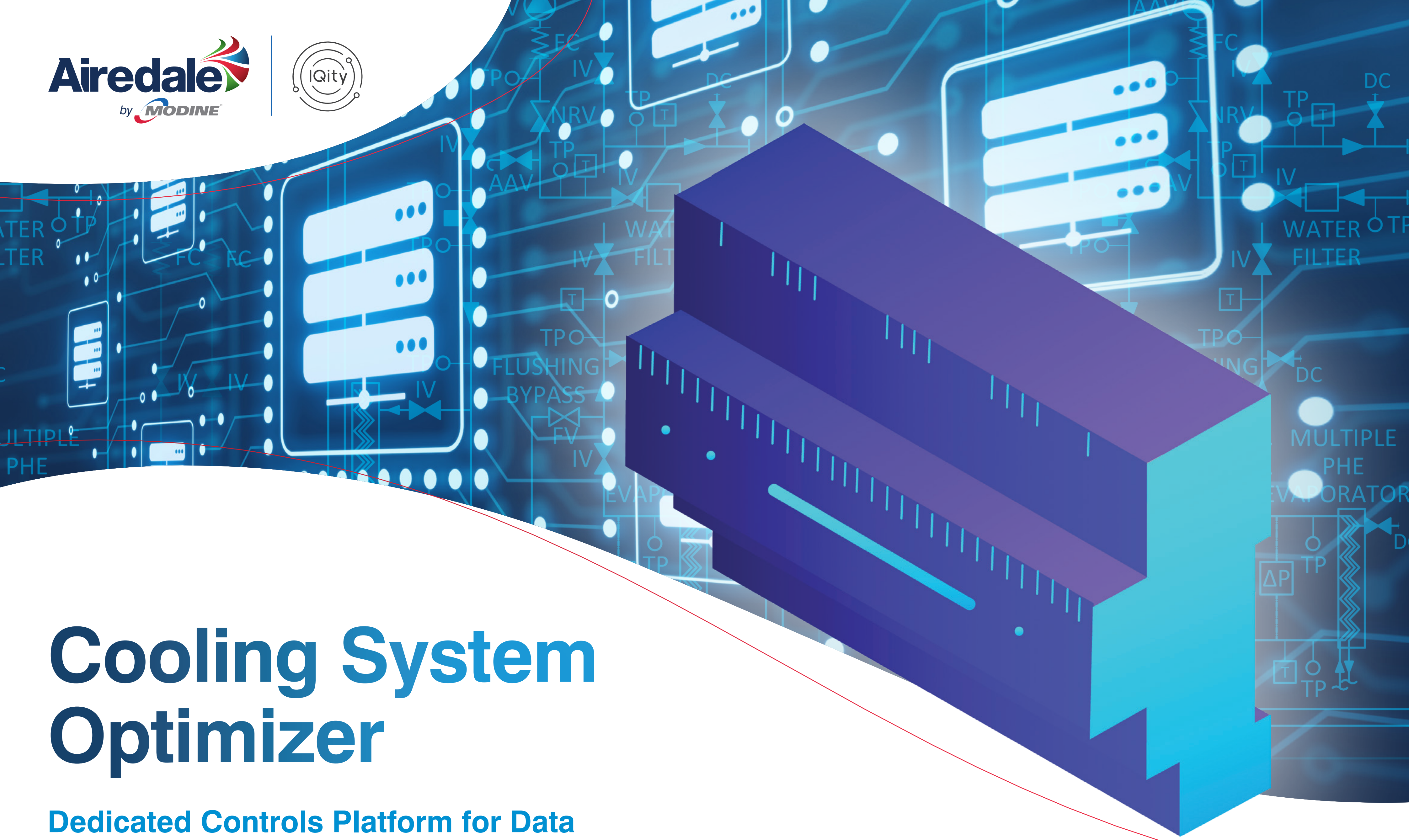
Airedale by MODINE | IQity



Cooling System Optimizer

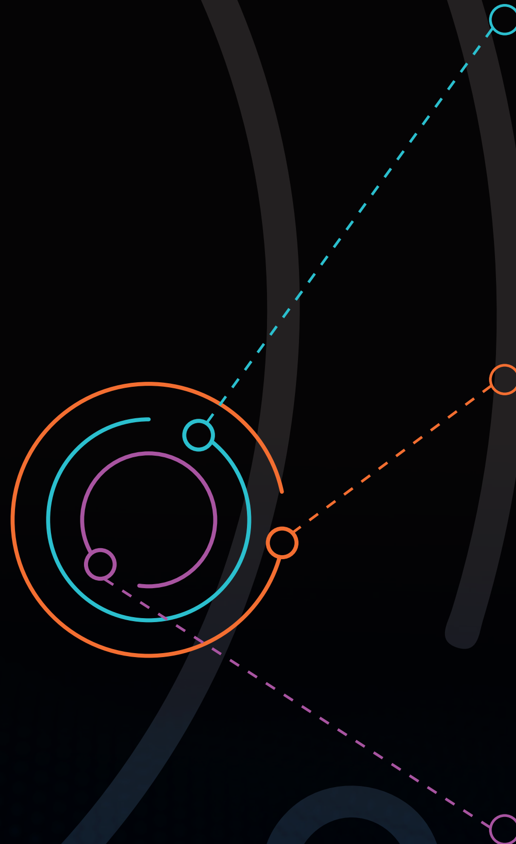
Dedicated Controls Platform for Data Center Chilled Water Systems

Part of Airedale's IQity Data Center Software Framework

IQity

Cooling System Optimizer™ is part of IQity™, Airedale's IoT-enabled technology framework.

Revolutionizing how cooling is connected, controlled and automated at critical facilities at a product, system and site level.



SYSTEM

CW System Optimizer
CRAH Energy Optimizer
Chiller Sequencer
HVAC Controls Suite

Optimizer

SITE

ACIS Facility Management
- BMS
- PMS
- BEMS

ACIS Edge
ACIS Telecoms

ACIS™

PRODUCT

Precision Controls
Chiller Controls
Optimized Head Pressure Control
Chiller Fast Start
Energy Manager
Refrigerant Manager
Compressor Manager

helix™

The Problem…

Data center cooling systems are larger and more complex than ever. Managing all the components and variables using a standard Building Management System (BMS) is no longer viable in an industry that demands resilience and redundancy at the lowest possible energy input.

One core issue is that a BMS, whilst still needed for overall monitoring and reporting, is not designed for precise control of complex systems. A BMS mostly pushes data, and isn't capable of addressing the anomalies that it identifies. It can't make the necessary changes to optimize the system.

With a BMS, redundancy is not built in. As cooling plant gets larger and more numerous, this is key to ensuring that cooling requirements are met, and the load is evenly balanced across the system.

In reality, with data center cooling only three things matter…

Focus on What Matters

1. **Small positive pressure at the front of server rack, so air is drawn through server.**
2. **Correct temperature at the server, according to the Service Level Agreement (SLA).**
3. **Ensuring points 1 and 2 while maintaining resilience and redundancy, at the lowest possible energy input.**

Individual computer room air handlers (CRAHs), chillers, pumps and valves should all be modulated in harmony to deliver the above.

The Solution…

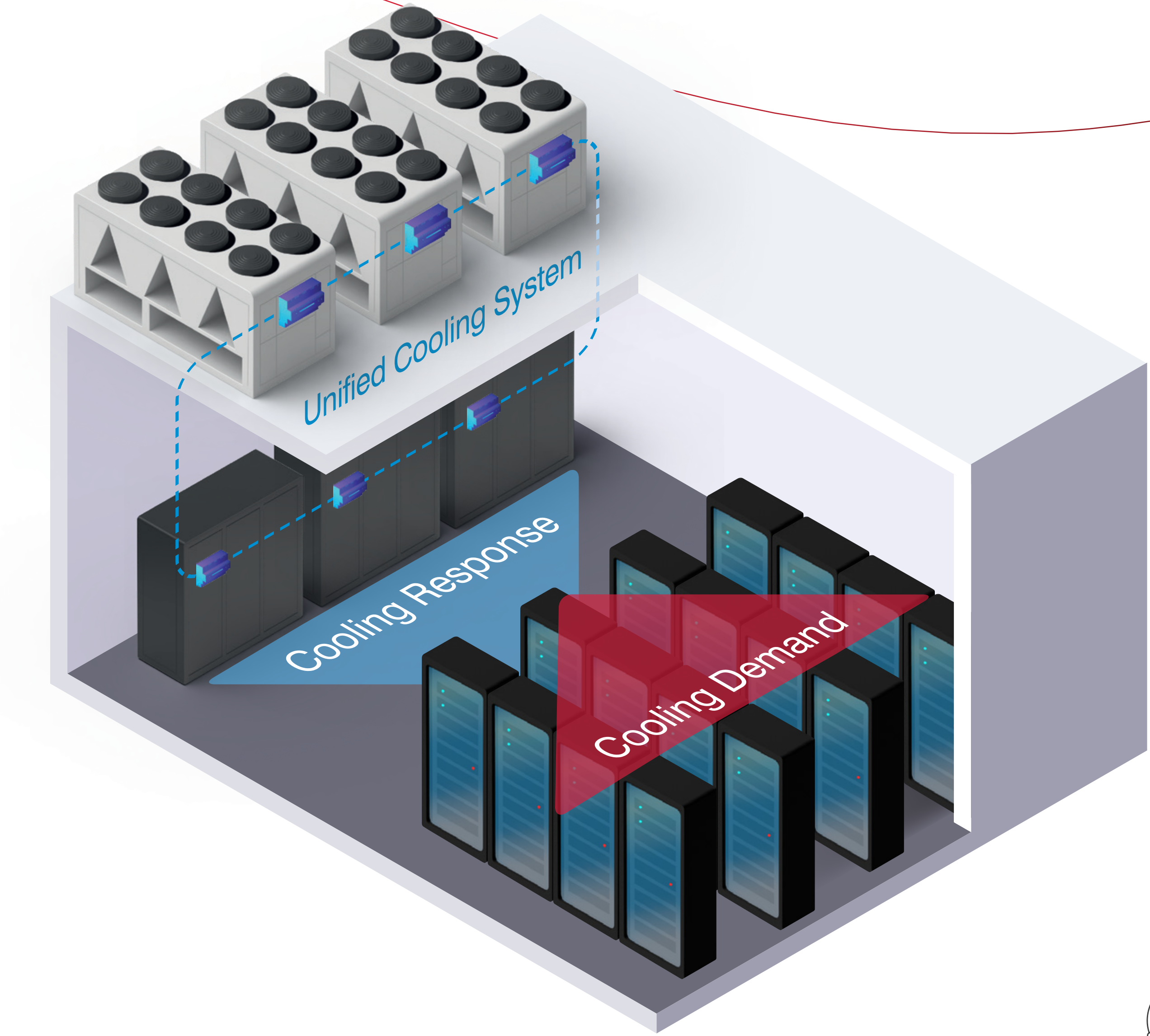
Cooling System Optimizer

Airedale's Cooling System Optimizer™ has been developed to control and optimize data center cooling systems and is built on our 50 years of experience in providing IT thermal management solutions.

The Cooling System Optimizer is an additional controls layer, between the product controls (in chillers and indoor cooling units like CRAHs and fan walls), and the site BMS.

Cooling System Optimizer is a failover master distributed control system, with an Optimizer Controller on each unit offering multiple levels of resilience to failure. With no single point of failure, your facility is in the safe hands of cooling experts.

It is based on PLC-based deterministic controllers – the same hardware that resides in the cooling products. By monitoring the cooling system as a whole, while also being connected to individual product controllers, Cooling System Optimizer can precisely modulate the flow rates through chillers and CRAHs on a unit controls level, to precisely match cooling supply to demand.



Cooling System Optimizer

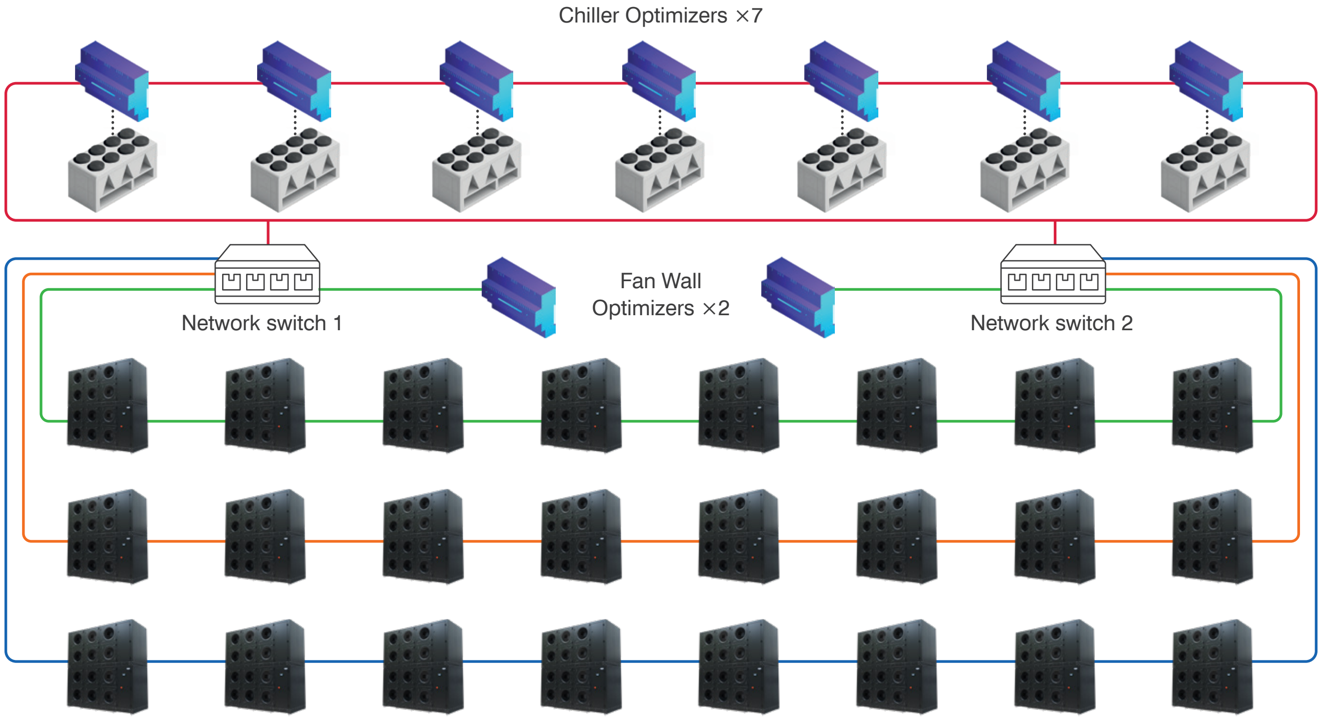
How it Works

An additional PLC-based deterministic controller is placed in each chiller. The Optimizer controllers are connected via a CAT 6 (ethernet) ring topology, or fed directly into the onsite network to maximize resilience.

In the data halls an additional controller is installed (+ one redundant controller) that is connected to the existing controllers in the indoor cooling units.

The Optimizer controls layer is programmed to monitor data from cooling units and field sensors placed at critical points in the system, enabling a whole system response to events like load fluctuations, ambient temperature fluctuations and power outages.

Cooling System Optimizer Controls Topology



Cooling System Optimizer

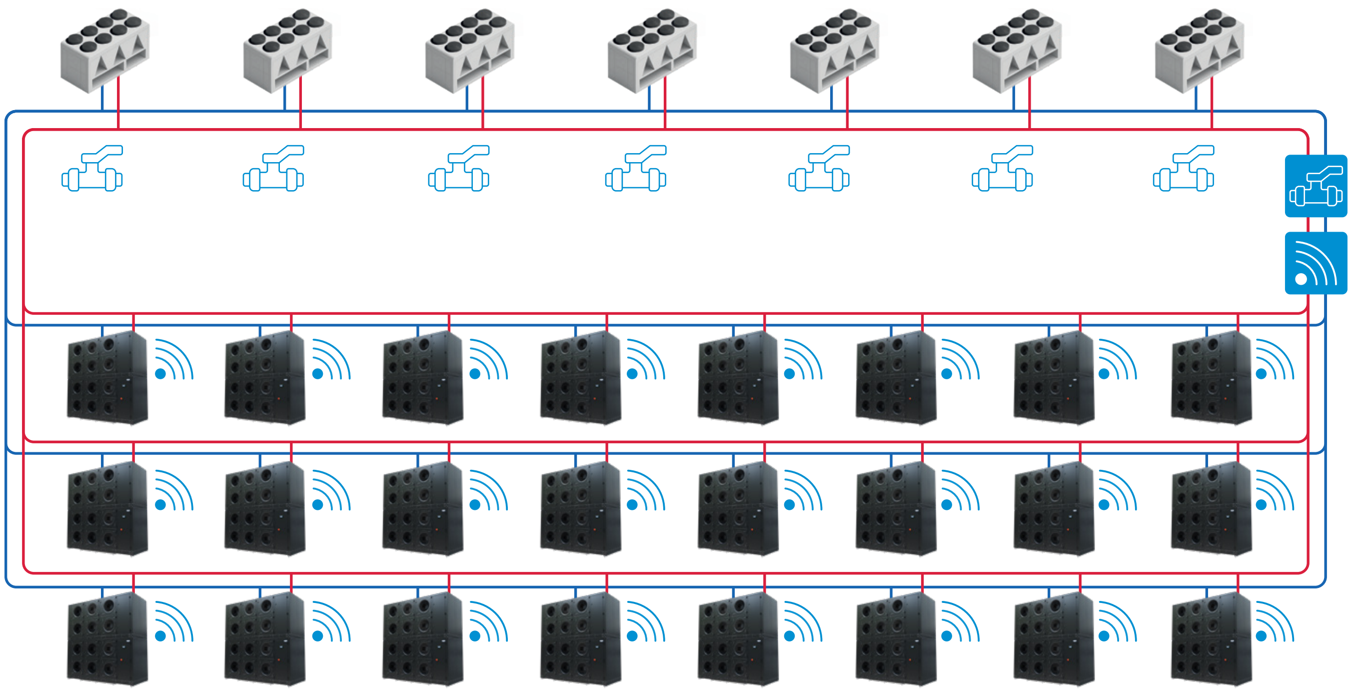
How it Works

Live water volumetric flow requirement from the CRAHs is used to automatically adjust water flow through the chillers, reducing the use of the bypass valves. The Optimizer automatically calculates and adjusts the chiller's pumps speed to achieve the water flow required. Ambient temperature is monitored intelligently, optimizing free cooling.

All mechanical infrastructure (chillers, CRAHs, valves, pumps) are managed / modulated in order to create optimized system pressures, flow rates and system temperatures based on server inlet air temperature and data hall air pressures. All data is then fed back to the BMS for in-depth monitoring, offering a full picture of the system.

Cooling System Optimizer is designed to manage cooling systems from 500kW to 20MW+ and is multi-system configurable, local ICT network compliant and concurrently maintainable.

Cooling System Optimizer Mechanical Topology



Key: Bypass valve Temperature & pressure sensors

Key Benefits

Up to 45% Energy Savings

Lower cost of ownership can be achieved, both in running and maintenance costs thanks to the use of latest technologies and full redundancy. Free cooling is maximized.

Lower Maintenance Costs

Demand is balanced across all chillers and CRAHs with no fixed leading unit, distributing the load evenly and avoiding excessive wear and tear. Full redundancy and the option of remote support leads to fewer call-outs.

Maximum Operating Efficiency

Leveraging the benefits of variable flow chilled water systems, the Optimizer increases cooling efficiency by running components at their most effective and efficient operating points. Chilled water flow through the chillers and CRAHs are constantly modulated.

Full Redundancy

Failover strategy is built into the Optimizer, so each controller can smoothly migrate control to the next one, providing redundancy and eliminating the risk of downtime.

Standardized Solution

Cooling System Optimizer is essentially an off-the-shelf solution, with minimal requirement for tailor-made programming to individual sites. It uses standard PLC-based controllers and works with existing unit controllers in the cooling units.

Future Proof

Fully compatible with IoT (Internet of Things) and machine learning for in-depth analysis.

Free-Cooling

A fully integrated control strategy enables the chillers to operate on a reduced water flow rate during free-cooling operation, sensibly increasing the efficiency of water coils and pumps.

Cooling System Optimizer

Chiller Operation

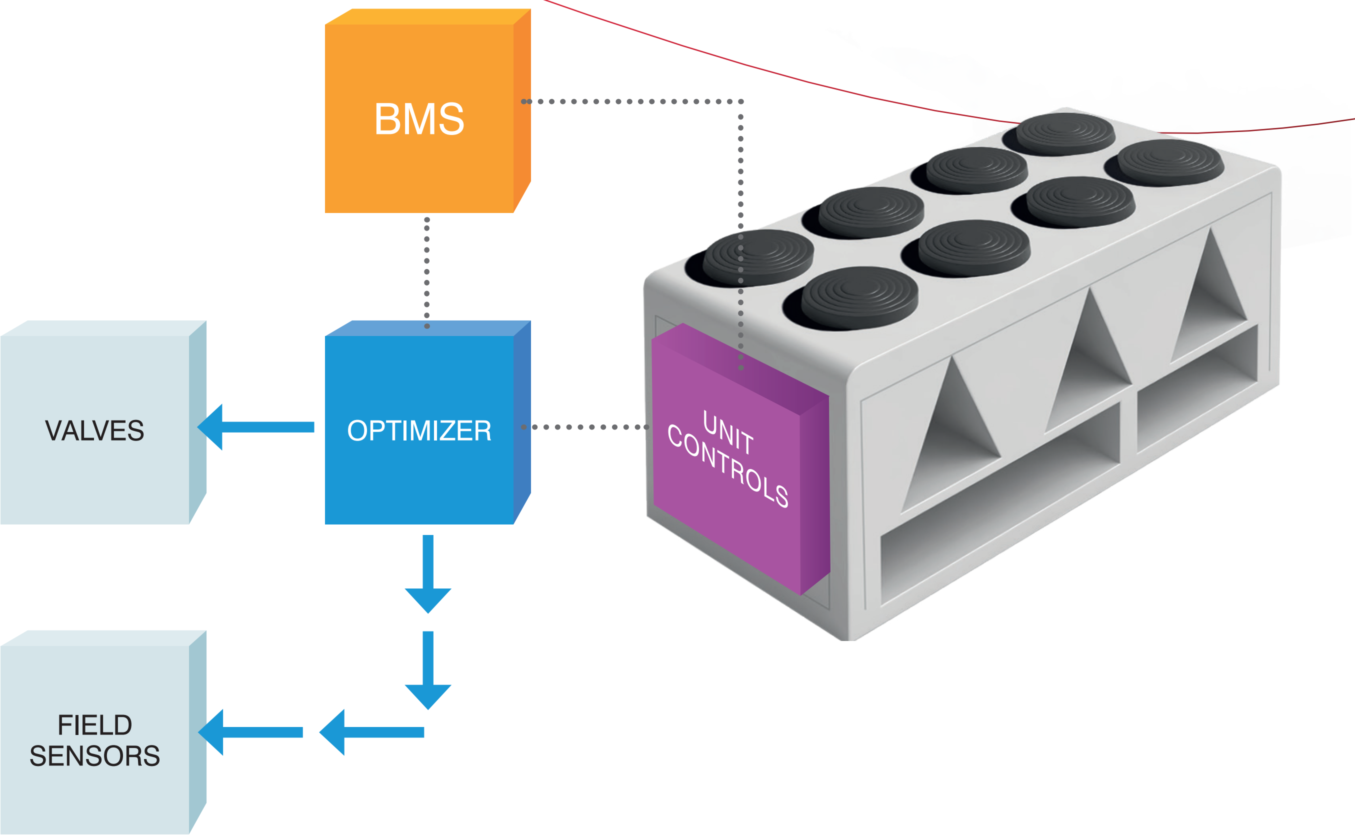
A dedicated Optimizer controller is mounted within each chiller on the system. This is in addition to the chiller's own controller managing the unit itself.

The addition of the Optimizer controllers enables intelligence to be stretched across the entire network, so that chillers become part of a "bank" of cooling potential rather than a series of devices that work in isolation.

The lead Optimizer controller determines the appropriate number of chillers to enable at any one time, based on cooling demand and system pressure.

Cooling System Optimizer enables chillers based on operating run hours and operational status of available units. This logic ensures even mechanical load on the system.

The Cooling System Optimizer also compares the highest water temperature sensor reading across the cooling system with the pre-determined chilled water temperature set-point. Based on this an additional cooling demand is calculated and transferred to all active chillers. This ensures all areas of the chilled water pipework are seeing the correct water temperature.



The Cooling System Optimizer monitors and controls chiller flow rates to ensure that the system operates as efficiently as possible whilst achieving the minimum required flow rates (Chillers have strict requirements for water flow rate, where a minimum flow has to be guaranteed for correct operation when refrigerant-based cooling is active). Flow rate is modulated to ensure a positive pressure differential between the flow and return pipework, measured using a series of remote pressure sensors in the system water pipework individually monitored by each Optimizer controller.

The Optimizer enables the chillers to operate on a reduced water flow rate during free cooling operation, sensibly increasing the efficiency of water coils and pumps.

Cooling System Optimizer

Chiller Scenario 1: Power Dropout

BMS CONTROL

- Power dropout to chiller
- Overall flow reduced
- CRACs react to reduced flow, opening valves in order to maintain supply air temperature
- Pumps react to drop in pressure by ramping up
- System will take time to find new equilibrium – period of “hunting” which could lead to temperature instability in DC
- Redundancy not maintained and additional equipment issues could lead to SLA breaches

LOCAL OPTIMIZER CONTROL

- Power dropout to chiller
- Overall flow reduced
- Optimizer sees power dropout and distributes the flow demand to the remaining chillers

Cooling System Optimizer

Chiller Scenario 2: High Flow Demand

BMS CONTROL

1. High flow demand across chillers
2. BMS initializes additional chiller
3. Chiller's pump will start at same speed as rest of units
4. System will see a large jump in flow
5. Bypass valves will open in order to divert additional flow
6. System instability and inefficiency with "hunting" to recover. BMS may maintain new condition, even though energy wasted.

LOCAL OPTIMIZER CONTROL

1. High flow demand across chillers
2. Optimizer doesn't use flow only as staging input requirement. It sees cooling demand as well.
3. Additional chiller will not start at same pump speed as existing – it balances the system straight away with all pump speeds adjusted to balance flow.

Cooling System Optimizer

CRAH Operation

An additional PLC-based deterministic controller (and one redundant controller) is located in the data hall. This is connected to the controllers in the indoor terminal units via a CAT 6 (ethernet) ring topology or fed directly into the onsite network to maximize resilience.

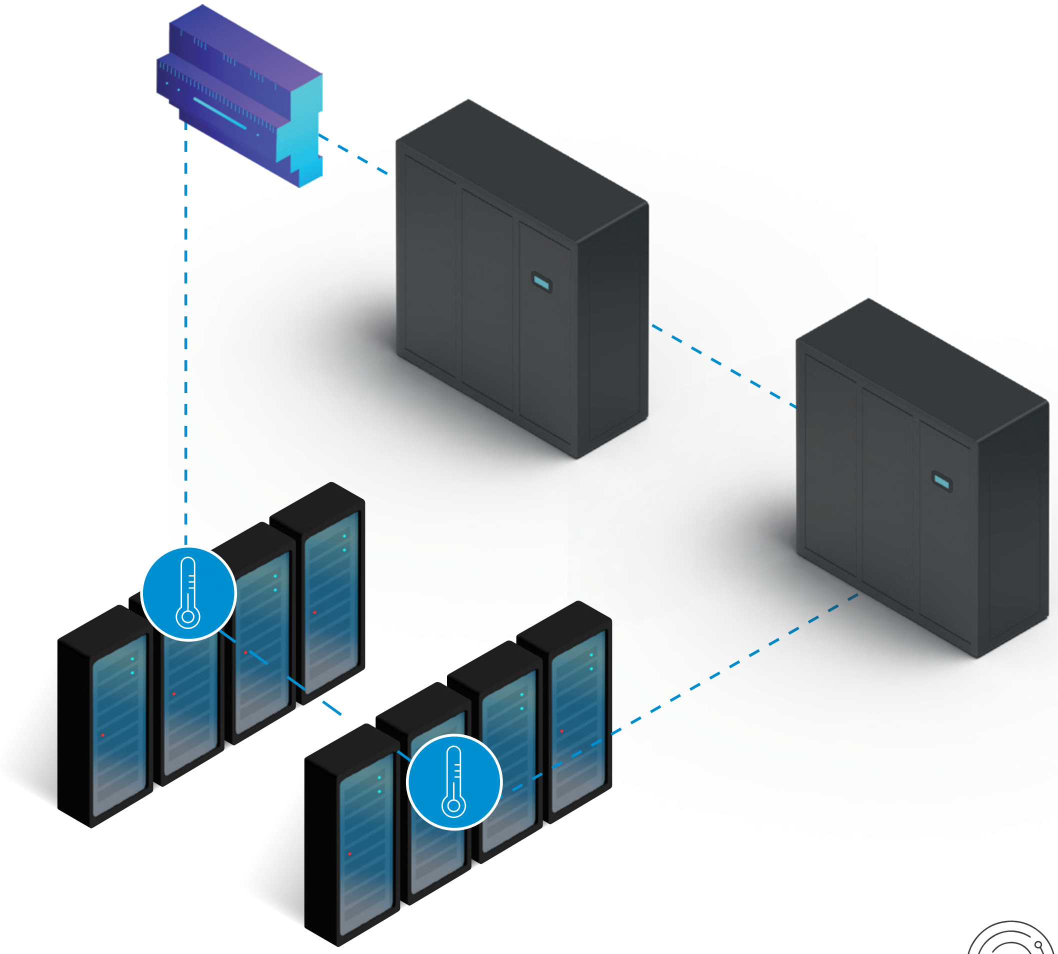
The Cooling System Optimizer takes a holistic view of CRAH operation vs. live conditions at the server air inlet. As with the chillers, such detailed control is only possible with a fully integrated and purpose-built control system using the latest deterministic controller technology.

Traditionally CRAHs are turned on and off manually according to a rotation scheduler, alarms and a manually adjusted setpoint. With the Optimizer, CRAHs are unified and part of a larger cooling system rather than a series of devices that work in isolation.

The Cooling System Optimizer distributes the cooling demand to all CRAHs to achieve the best energy efficiency, automatically enabling units if required and thermally shifting the load to avoid hotspots, whilst reducing the energy consumption in the unused areas of the data halls.

The Cooling System Optimizer manages and modulates the chilled water valve in each CRAH using the supply air temperature setpoint as a reference. Ideally the chilled water temperature is elevated high enough so that the CRAH units have the valve open to 90%. At 90%, there is headroom for any variation in heat load.

Floating the chilled water temperature enables more free cooling by increasing the water temperature so that the ambient temperature is adequately lower than the water setpoint for more time throughout the year.



Cooling System Optimizer

Data Hall Scenario 1: New Customer in DC

BMS CONTROL	New customer moves in and populates a previously empty part of the data center	CRAHs adjacent to the new racks are manually turned on by the FM team in a trial-and-error fashion	CRAHs commence operation with fan speeds and valve positions set according to local control strategy	Cooling becomes unbalanced – prone to hot spots and areas with insufficient or excessive air supply	Potential SLA breach
LOCAL OPTIMIZER CONTROL	New customer moves in and populates a previously empty part of the data center	Zonal control turns on adjacent CRAH units according to temperature and air flow requirements	Network control strategy optimizes the fan speed and cooling demand to integrate the CRAHs into the overall cooling system		

Cooling System Optimizer

Data Hall Scenario 2: Superbowl

BMS CONTROL	Online streaming of the Superbowl increases the load in a specific area of the data center	CRAHs see an increase in return air temperature	CRAHs open valves and adjust fan speeds according to their local strategy	Slow reaction time and uneven load distribution creates instability – may require human intervention to bring situation under control	Hot spots could potentially cause SLA breaches
LOCAL OPTIMIZER CONTROL	Online streaming of the Superbowl increases the load in a specific area of the data center	CRAHs see an increase in return air temperature	CRAHs open valves and adjust fan speeds according to the network strategy, which enables sharing of load to a larger number of CRAHs	Hot spots are taken care of in real time and data center temperature is unaffected	

Cooling System Optimizer

Redundancy

Data centers are considered critical infrastructure and have to be designed to withstand multiple failures. The Cooling System Optimizer has a built-in failover strategy; it doesn't reside on one controller alone. Each controller can smoothly migrate control to the next one in case of failure or maintenance. This guarantees that cooling is always available and minimizes disruption in case of failure.

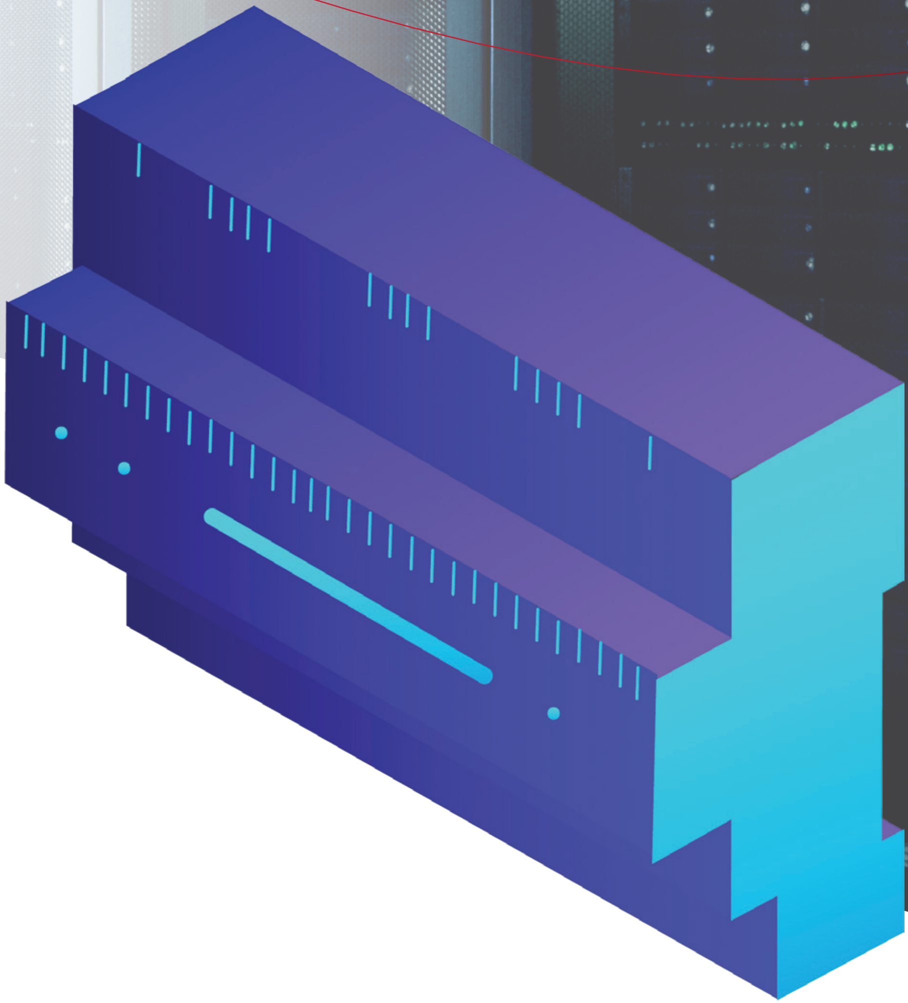
Where communication is lost with a chiller Optimizer controller, the chiller will revert to stand-alone control via the local product controller. The chiller fixes pump speed at this point to achieve the required design flow-rate and cooling demand is managed locally to ensure the design chilled water flow temperature is achieved.

The remaining active Optimizer controllers control the system low-flow bypass valves to the required pre-defined differential pressure setpoint, to ensure design flow-rate is achieved by the chiller.

Cooling System Optimizer

Summary

- System control from 500kW to 20MW+
- Manage large variable primary systems
- Multi-system configurable
- Maintain resilience/ redundancy
- Maximize free-cooling
- Site SLAs determine cooling requirement
- Reduce reliance on BMS for cooling management
- Concurrently maintainable
- Local ICT network compliant



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