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IT white paper – Rittal door automation for server racks

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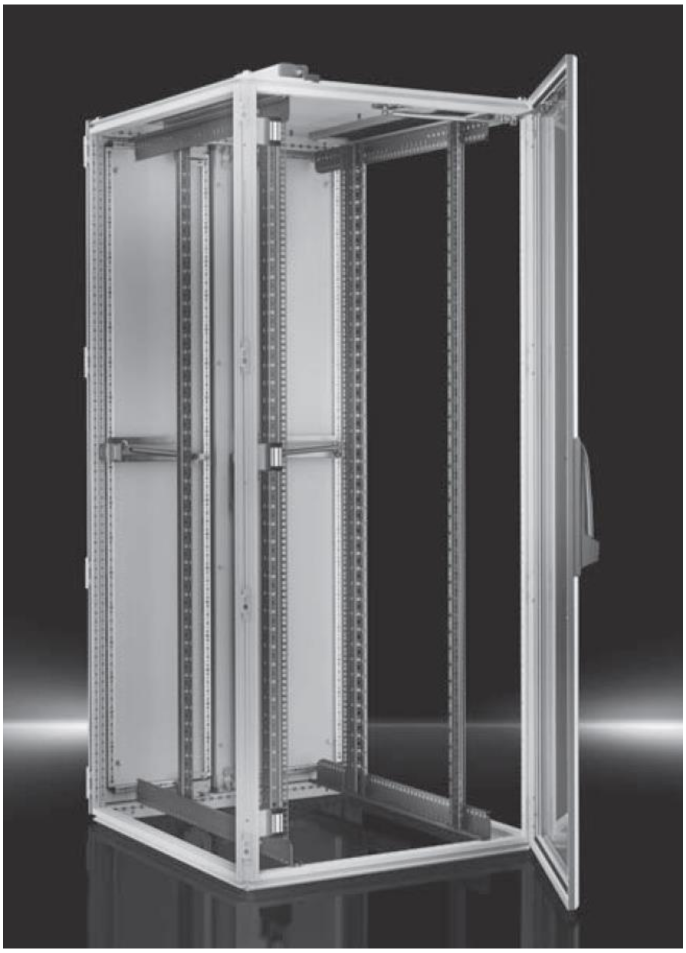
Executive summary

Server-rack power densities are increasing as IT space is used more and more efficiently. Higher demand leads to a greater build-up of heat in the racks, requiring extremely effective cooling systems. These can be directly mounted on enclosed server racks.

This configuration requires a backup solution in case the primary cooling system fails. To maintain server availability in all circumstances, a redundant cooling strategy is essential.

One method of ensuring the availability of backup cooling is to exploit room air conditioning, i.e. the cooling energy stored in the server-room air.

This white paper describes a solution that combines an automatic door-opening system with the use of room air conditioning. Door automation can also assist fire extinguisher systems by allowing the extinguisher gas to flow from the room to the IT components through the opened rack doors.



Introduction

In today's IT facilities, servers are housed in racks. The machines can range from 1U servers – 47 of which fit into a rack – to high-performance systems such as blade servers. What they all have in common is that they are becoming increasingly powerful, which creates the need for more and more effective cooling.

There is often a direct correlation between a server's performance and its power loss. Technical solutions are being developed to address the associated heat build-up. However, the power loss from these systems and racks has been rising steadily over the years. In response, increasingly effective cooling solutions are being employed inside the servers (heat sinks and fans) to dissipate the heat energy from the server casings.

A maximum operating temperature is defined for each server. Servers rely on cool air being supplied to their front air intakes to cool their internal components (processors, storage media, power supply units, etc.). This in turn makes demands on the air inside the rack and directly in front of the servers. A constant volume of air at the right temperature and humidity must be supplied while the servers are in operation.

Two server-rack cooling strategies are currently employed:

- Racks are equipped with vented doors at the front and rear for row or room cooling. This strategy is suitable when power outputs are relatively low.

- Racks are enclosed and cooled by rack-mounted cooling systems. This is suitable for higher outputs.

Both strategies are widely used in IT infrastructures. And in both cases, their dependence on the primary cooling system poses a significant risk.

Today's IT users demand very high server availabilities, as outages can bring entire business processes to a standstill. Redundant cooling strategies are essential to ensure that servers are not impacted by cooling-system failures.

The following sections will discuss a solution featuring door automation, enclosed server racks, and the use of a room air conditioning system as an emergency backup.

Background

Enclosed racks are typically equipped with high-performance cooling systems. An example is Rittal's Liquid Cooling Package (LCP) solution, which produces cold air by means of heat exchangers, expels it directly in front of the servers, and draws in the warm air at the rear.

These high-performance systems can provide cooling outputs of up to 55 kW, and dissipate correspondingly high thermal loads within racks. However, the high power consumption means that if the air conditioning fails, rack temperatures rapidly rise beyond permissible limits.

A tried-and-trusted solution is to configure cooling systems with redundancy, or even multiple redundancies.

System availability is defined as follows:

$$\text{Availability} = \frac{\text{Total time – total downtime}}{\text{Total time}}$$

However, providing one to three backups for each server system would incur excessive effort and expense.

An alternative is to consider the availability of the air conditioning system by itself. Cooling systems can be designed to provide complete or partial redundancy. To give an example with LCPs, cooling systems can be installed on the right and the left of the rack. In addition, a redundant water piping and pumping system can be employed. The same applies to the chillers.

Requirements

Server racks are typically housed in server rooms (see Figure 1). In addition to high-performance servers in enclosed cabinets, server or network racks with lower power consumption and vented doors are often found in these rooms.

It is therefore worth exploiting existing room air conditioning systems to provide backup cooling for enclosed racks.

<u>Description of requirements:</u>

To increase the availability of cooling systems, high-performance server applications housed in enclosed server racks must utilize existing room air conditioning systems (the cool air in the room) as a backup solution.

This is only feasible if the room is large enough and the air conditioning system has sufficient capacity.

Figure 1: Rack cooling with LCPs

Meeting requirements

At first glance, meeting this requirement appears to be a straightforward matter – simply opening the front and rear doors of the enclosed server racks. However, the automation required to do this introduces a range of technical dependencies that must be carefully examined and assessed.

Similarly, the application must be more clearly defined. For example, is it necessary for the doors to open automatically if the air conditioning system fails, enabling the servers to take advantage of the cool server-room air? Or must the doors open if a server room fire extinguisher system starts to discharge extinguisher gas into the room, and the server racks need to be flooded with the agent, too? Or must both scenarios be considered simultaneously – and other applications as well?

The server room and its air conditioning system must also be assessed. The expected delay before the room becomes overheated will depend on various technical factors. Should this period of time be used solely to perform a controlled shutdown of the servers? An alternative would be to switch off only some of the servers, so that critical applications can keep running on the others. Automation is required to handle this option, too.

Figure 2: Rack and row cooling in a contained aisle

If fire extinguisher systems are installed in the server racks, or if extinguisher gas is fed into the racks via pipes, the automation system's normal response must be counteracted. If a fire activates these systems, then automatic door-opening must be disabled to ensure that the doors remain closed and the extinguisher gas cannot escape.

Door automation system

The door automation system comprises three basic components:

- Door Control Module (DCM)

Figure 3: The CMC III system’s Door Control Module

This controller automates the opening and closing of a rack’s front and rear doors. It can be connected to the LCP cooling system or the Computer Multi Control (CMC) III rack-monitoring system. The CMC III monitors the physical environment around the IT equipment and automates appropriate action in response to problems.

The system differentiates between emergency opening and routine opening by users. It can open the doors using a transponder card, combination lock, a latch in the handle, or a switch. The Door Control Module (DCM) features a built-in temperature sensor. This can be placed in the air stream to the servers and cause the doors to open.

In addition, a digital input is provided to connect with a server-room fire extinguisher system. A link can then be established so that the door opens automatically in the event of a fire, allowing the extinguisher gas to reach the servers.

Connection to the CMC III/LCP opens up a host of other possibilities, too. Like a PLC, users can create associations and rules that define the circumstances in which the doors are opened automatically.

- Door kit (spring dampers with magnets – see Figure 4)


Figure 4: Door kit for the door automation system

Normally, the door is kept open with a spring damper. The spring forces are kept small, ensuring that the system closes easily and eliminating the risk of injury to users.


Figure 5: The system's magnetic catches

When the door is closed, 3 to 4 magnets (depending on the model) keep it closed. The magnets are mounted on the enclosure frame (see Figure 5), while the counterplates are mounted on the door. The advantage of this method is that if a cable breaks or the mains power/supply voltage fails, the magnets are released and the doors open.

- Door kit extension (spindle motor)


Figure 6: Door kit extension

Servers with powerful fans can exert such a large inward force on the front doors that they cannot open automatically. This very strong partial vacuum can be overcome with a spindle motor (see Figure 6, Figure 7). The spindle is slowly extended outwards by about 20 cm and pushes open the door at the side until the pressure is equalised. The door starts to open and is pushed wider open by the spring dampers described earlier. The same mechanism can be fitted on the rear door if the cooling system draws in the air at the rear. As a partial vacuum can be expected in practically all server applications, the door kit extension is always recommended for these applications. As the motor requires power, it must be connected to the server voltage supply or to a UPS unit.

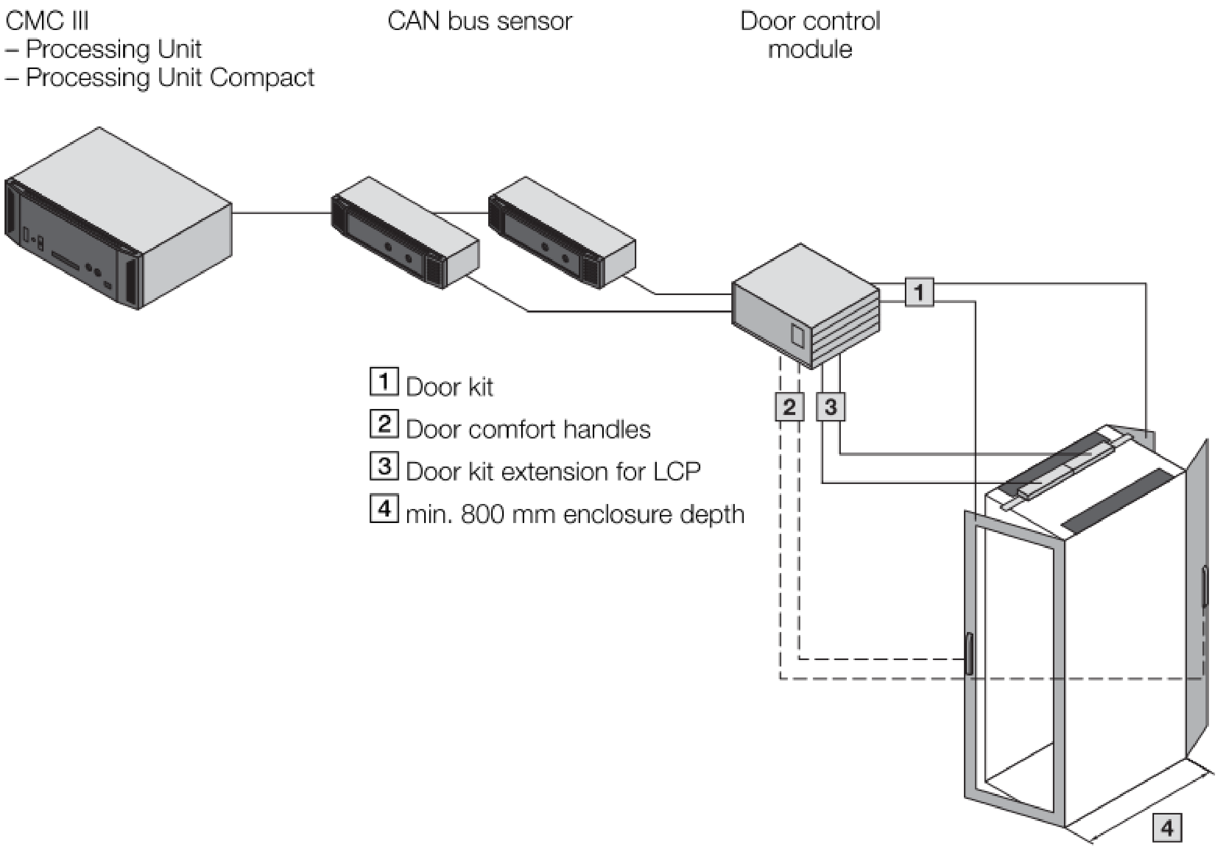


Figure 7: System diagram (see Catalogue 2014/2015, page 459)

Conditions and purpose

Before integrating the door automation solution for server racks, it is essential to consider the environmental conditions and define the purpose of the solution.

<u>Environmental conditions:</u>

- Is the rack located in a small storage room or in a spacious server room?
- What is the room's volume?
- What additional performance can the room air conditioning system provide?
- Does the cooling system have optimum air routing?

Normally, high-performance server applications are located in racks equipped with high-performance cooling systems because conventional room cooling systems cannot provide adequate air conditioning.

The door automation solution cannot be more than a compromise in emergencies where backup cooling is required to prevent the temperature rising rapidly in a rack with closed doors.

Considering that the air throughput of an LCP is up to 133 m^3/min, small rooms clearly cannot offer significant reserves. Given a room height of 3.5 m, the air over a 38 m^2 area (=133 m^3) will be fully cycled in one minute per LCP.

The additional cooling required in a room is simple to calculate: the cooling output of each LCP is shown on the CMC III's web-based remote monitoring screen. The calculation is based on this total. It is not efficient to equip the room with an extra-high-performance air conditioning system. However, it does make sense for it to have reserve capacity. The sizing depends on how long the server system needs to be operational in an emergency.

The positioning rules for vented racks also apply to enclosed racks with door automation. In an emergency, these will be operated with the same cooling system (separate cold and hot zones).

Purpose:

As previously defined, the purpose of the solution is to use the room air conditioning system as an emergency backup if the cooling system in the enclosed racks fails.

The facility operator needs to determine whether the time period covered by the backup should be exploited solely to shut down the servers, or whether the backup solution should be used for a specific length of time, or continuously for an extended period. The operator can also decide to shut down only some of the servers and keep mission-critical machines online.

Server shutdown can be activated by the CMC III monitoring system or by the LCP. Each CMC III can switch off up to 40 servers. One option is to set a specific temperature threshold at which the servers must be powered down. This is also necessary if the room becomes too hot once the doors have been opened. Alternatively, a fixed length of time can be defined, after which the servers have to be shut down.

Longer time periods can be chosen if not all of the LCP systems are working at full capacity and a room air conditioning system with sufficient capacity is available. However, if an automatic shutdown has not been specified, close monitoring by service employees is vital during these periods.

In normal circumstances, it makes little sense to operate the servers for extended periods with the rack doors open. If an extended backup is required, we recommend equipping the enclosed server racks with redundant cooling systems.

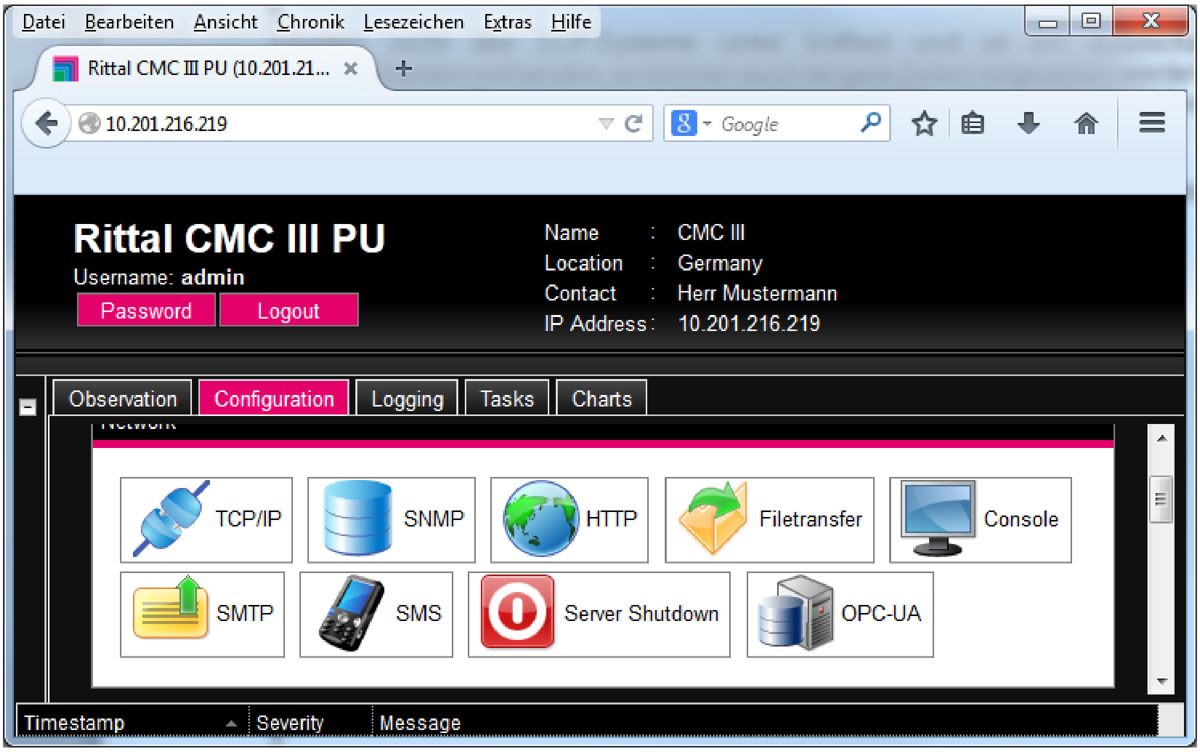


Figure 8: Configuration screen of the CMC III

Rack extinguisher systems

For servers running highly sensitive applications, extinguisher systems are integrated into the racks themselves, or extinguisher gas is fed to the racks through a system of pipes. In both cases, the door automation system's normal response must be counteracted.

The extinguisher system requires the rack doors to be closed so that it can function effectively. It is vital to keep the extinguisher gas in the rack for as long as possible to quench the fire – so the doors must be prevented from opening. For the same reason, one-piece, closed doors must be employed, with door seals that can be pressed firmly against the rack frame.

<u>Solution:</u>

The extinguisher system (e.g. DET-AC III – see Figure 9) and the controller of the door automation system are connected to a CMC III system. The logic settings are configured to determine whether the extinguisher system has issued a fire alarm. The doors may only open automatically if no fire alarm has been activated. This rule can easily be linked to the CMC III task settings.

Figure 9: the DET-AC III rack extinguisher system

In a fire, the servers must also be powered down immediately, as the likely rapid rise in temperature could damage the servers. If the extinguisher system has not issued an alarm, the doors can be automatically opened.

Furthermore, if a fire inside a rack needs to be extinguished, the servers must be fully disconnected from the power supply. They can either be switched off manually by the operator, or automatically via PSM or PDU socket systems connected to the CMC III.

When the servers have been disconnected, a fire caused by a technical fault in a server cannot re-ignite as the extinguisher-gas concentration decreases. The source of the fault is thus starved of power.

Abbreviations

CMC: Computer Multi Control – rack monitoring system
DCM: Door control module – controller for the door automation system
LCP: Liquid Cooling Package – high-performance cooling system with air/water heat exchangers
PDU: Power Distribution Unit – socket system for distributing power
PLC: Programmable logic controller – used to control machines
PSM: Power system module – a modular socket system for distributing power
U: Height unit in a 19-inch rack system
UPS: Uninterruptible power supply

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