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white paper – The Efficiency Package of the RiMatrix S Data Centre

ENCLOSURES | POWER DISTRIBUTION | CLIMATE CONTROL | IT INFRASTRUCTURE | SOFTWARE & SERVICES

FRIEDHELM LOH GROUP

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Executive summary

A globally operating company must dispose of powerful and efficient information and communications technology. A prerequisite is that the data centre – as the company's heart – copes with the increasing requirements with regard to flexibility, scalability, efficiency and security.

In particular for medium-sized companies but also for branches of major corporations, a modular and standardised data centre provides added value at several levels. For example, the planning effort is considerably reduced due to the predefined data centre modules. The delivery and commissioning time is significantly shortened due to the prefabricated modules available from stock. Guaranteed efficiency of the data centre forms the basis for a transparent calculation of the investment costs as well as the operating costs.

The electrical power consumption in the data centre is captured completely in order to determine the efficiency. Coming within that is the entire power supply chain (infeed, distribution and protection) and climate control (cold air generation, transport, distribution) as well as installation systems (lighting, etc.).

Rittal offers several option packages for the RiMatrix S data centre (Ref. 1), including the efficiency package. It allows the determination of all relevant performance data by means of measurements. For this purpose, the required measuring instruments are each installed in the subdistribution or in the bayed enclosure suites. The representation of the measurement results, their processing and application in closed control loops and alarm scenarios is realised by the Data Centre Infrastructure Management (DCIM) software. Thus, the efficiency package provides a high level of comfort in the determination and representation of the energy consumption. This results in a basis for the optimisation of efficiency and energy demand in the data centre, which paves the customer's way to maximum cost savings.

Introduction

IT technology is still becoming more and more important, as is also indicated by the topic "Industry 4.0 – the fourth industrial revolution". Internet technology, cloud computing, big data and efficient IT are important key technologies. "Industry 4.0" can only take place if IT and production technology grow together, as data centres ensure the control of all business and production processes.

For medium-sized companies, great challenges result from that already in the conception of a data centre, which must satisfy essential aspects such as flexibility, scalability, efficiency and security, as shown in the following Figure 1.

Figure 1: Field of tension of a data centre operator

In the case of a predefined investment framework, aspects of security and flexibility are to be traded off carefully against the other performance parameters of a data centre such as costs and efficiency. For companies in which IT is no core business but is "just" needed to control the business and production processes, already the conception of a data centre is extremely

demanding. In principle, operators want to concentrate on their own core business and rise to challenges such as "Industry 4.0".

A standardised data centre which is based on an elaborate data centre modular system considerably facilitates the planning phase and creates the needed transparency so that managerial investment decisions can be made on a solid basis (Ref. 1).

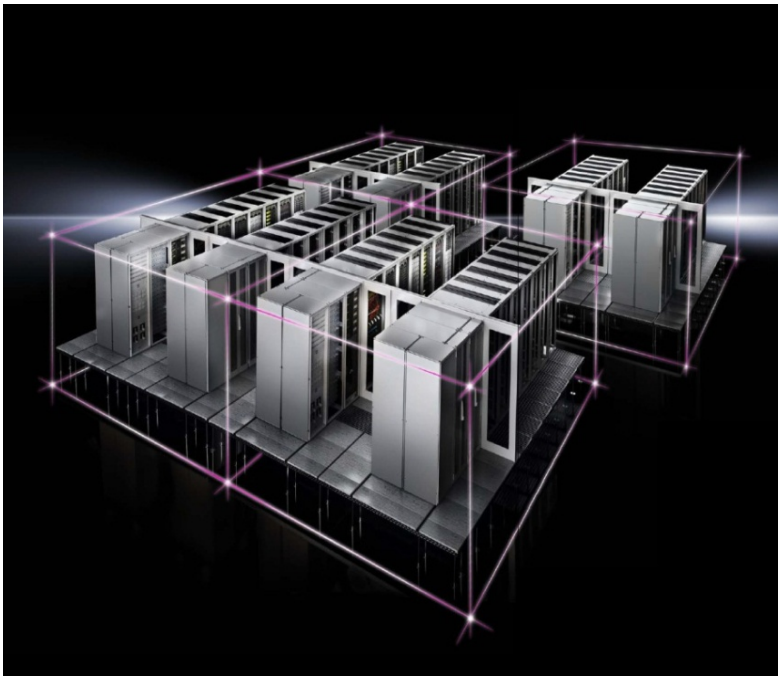

Figure 2: Data centre modules of the RiMatrix S modular system

A complete ROI consideration includes not only the investment sum but also a detailed analysis of the operating costs to be expected. Apart from the personnel expenditure, in particular the electricity costs are to be analysed here, which also attract great social and political interest, as IT and thus the data centres contribute significantly to the CO_2 emission (Ref. 2).

The political parties have already established a "Green Agenda" in their programs, which demands a reduction of the CO_2 emissions. Equally, society develops an increasing ecological awareness; for example, the readiness to accept higher prices for environmentally friendly products and production processes is increasing.

Efficiency metrics for components, systems and thus also for entire data centres are decisive for reducing these emissions.

Efficiency metrics

A primary feature of the RiMatrix S modules is the guaranteed, calculable efficiency. This is based on the fact that the data centre modules are regarded as one complete unit. These data centre modules are completely measured and include a data sheet which renders all relevant parameters. This is the basis for efficiency and operating costs calculation.

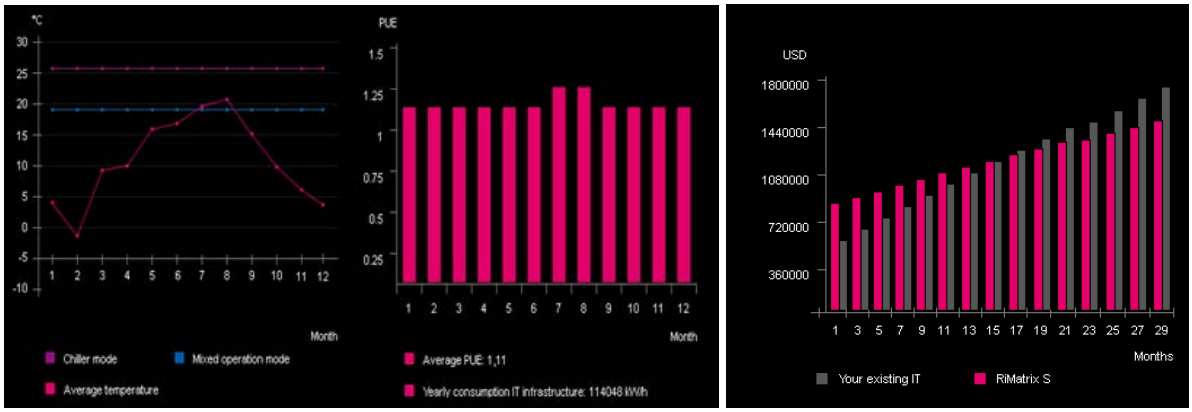

Figure 3: Efficiency analysis and ROI calculation

The data required for that must be captured by means of measurements in the power distribution systems (see Figure 4) and made available to the DCIM software.

Figure 4: Infeed, protection and distribution

The important components within power distribution are:

- Infeed and subdistribution
- Power protection – UPS
- Outlet systems – PDU

The measurement granularity depends on the customer application case and the selection of suitable metrics. Therefore, the most important metrics will be explained first:

A) Energy consumption [kWh]

Every data centre operator's primary objective is to keep the energy consumption of the data centre as low as possible. From the energy consumption you can directly derive the electricity costs and thus a part of the operating costs.

Likewise, it is possible to calculate the CO_2 emission from the energy consumption. In particular for a "Green IT Policy", this value – and particularly its sustainable reduction – is a cost and marketing advantage. The conversion factor for kWh into CO_2 depends on the power mixture (coal, electricity generated by nuclear power, renewable energies, etc.) of the respective country and can be enquired at the corresponding environment department (see, for example, Ref. 3).
To determine the energy consumption of a data centre, it is essential to measure the central infeed.

If consumer-related accounting is required, it is inevitable to take measurements at enclosure level (server, switch, storage system). Intelligent socket systems (PDU) are used for that, which can measure either each multiple socket strip or each socket.

B) PUE / DCiE

The two best known metrics are the **P**ower **U**sage **E**ffectiveness (PUE) and its reciprocal, the **D**ata **C**entre **I**nfrastructure **E**fficiency (DCiE). These metrics were defined by Green Grid (Ref. 4).

"PUE = Total Facility Energy divided by the IT Equipment Energy
• This takes into account energy use within a facility

• Partial PUE is for energy use within a boundary

pPUE = Total Energy within a boundary divided by the IT Equipment Energy within that boundary"

With regard to RiMatrix S this means that the division is to be considered as follows:

IT Equipment	=	server load
Total Facility Energy	=	losses of UPS and power distribution + cold air generation + cold air transport + cold air distribution + IT equipment + lighting + other consumers

The DCiE is the reciprocal of the PUE. The PUE or DCiE alone are no suitable variables to optimise a data centre, as they just represent the ratio of two values but no absolute numbers. However, the PUE in the course of the year shows the sustainability or improvement due to optimisation measures.

To determine the PUE or DCiE of a data centre, it is essential to measure the central infeed as well as the subdistribution branches. Here, it must be paid attention that the measurements of the IT equipment and infrastructure are separated.

C) EER / COP

To optimise a data centre with regard to efficiency, it is necessary to view individual subsections in detail, in particular the cold air generation. For this, special metrics such as EER and COP are available.

The EER (**E**nergy **E**fficiency **R**atio) is used to specify the efficiency of cooling systems. The EER is defined as the ratio of cooling capacity (in BTU/h) to absorbed electric power (W).
BTU is an old English unit (British Thermal Units). It corresponds to 1.055 joules, which are required to heat "1 Pound" of water (0.454 kg) from 3.8 to 4.4° C.

The COP (**C**oefficient **o**f **P**erformance) of a refrigerating system is the ratio of the heat change to the energy spent for that. Therefore, the following applies to a cooling system:

$$COP = Q_C / W$$

where Q_C is the cooling capacity (reduced heat) and W the energy spent for that.

To determine the EER or COP of the refrigerating systems, it is essential to measure the subdistribution branches in order to capture their electrical power consumption.
The cooling capacity of the refrigerating system can be requested via a management interface. However, this can also be derived from the flow volume and water temperatures.

Moreover, the efficiency of a UPS can be determined, although this is a factor which should just be considered in a detailed analysis of the current path. Phase utilisation and cos(Phi), for example, should also be considered for an optimisation.

The efficiency package

Together with the individual modules of the standardised RiMatrix S data centre, various option packages are offered (Figure 5).

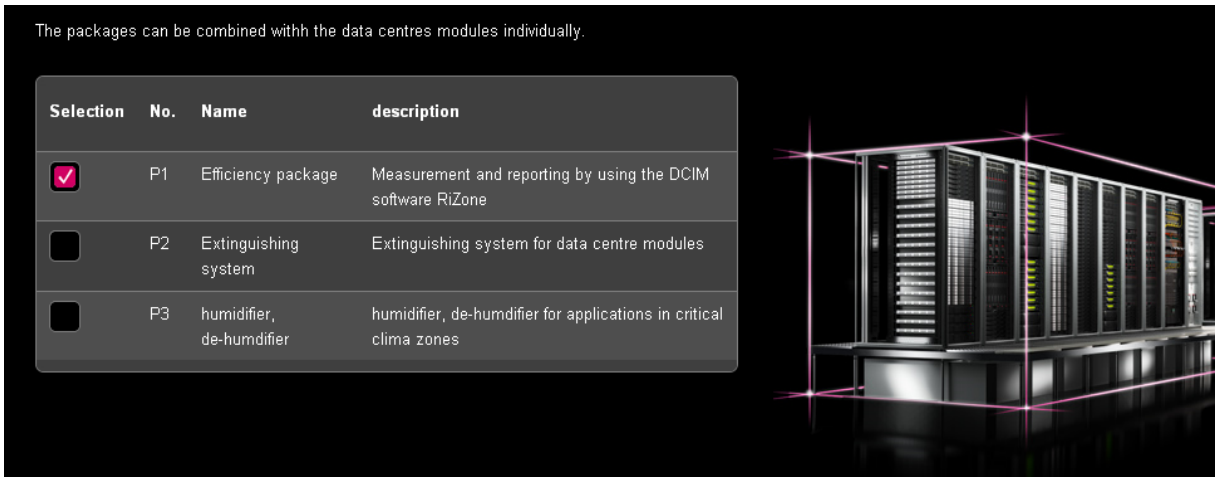

Figure 5: Selection of the RiMatrix S options

One of these options is the efficiency package, which consists basically of the following components:

- Intelligent socket systems – PDU
- Measuring instruments in infeed and subdistribution – UMG
- DCIM software – RiZone

The flexible use of these three components allows adaptation to the respective customer requirements to optimally support the metrics described before and to form a basis for data centre optimisation.

The individual components will be described in detail in the following.

Power Distribution Unit (PDU)

The Power Distribution Unit (PDU) allows real-time power monitoring at enclosure level. Assembly is effected without any tools in the zero-U space of the server and network enclosures. For each enclosure, two PDUs are provided for the separated A and B paths of the power supply.

Connection to the superordinate DCIM software RiZone is realised via the integrated SNMP (Simple Network Management Protocol) interface (version v1 and v3). Thus, all settings can be made remotely via remote access and all parameters and measured values can be captured and displayed centrally.

Figure 6: Power Distribution Unit (PDU)

Within the scope of the efficiency package, the PDU metered is applied as network-capable, 3-phase power distribution. The PDU metered supports phase currents up to 16 A. The integrated measuring system allows phase-wise energy measurement, which means that it is possible to determine the power requirements of an entire IT rack. The measuring accuracy is 1% (active energy measurement). The measured values can be visualised either locally on the display or via RiZone. The values include: voltage, current, frequency, active power, active energy, apparent power and apparent energy. Added to that is a determination of the power factor and neutral conductor measurement for unbalanced load determination. Moreover, there exists an operating hours counter which counts cyclically as well as the total hours.

The intrinsic consumption of the PDU is just 15 W, which means that the PDUs require only 30 W of additional power for each rack. The compact design and low electrical power requirements due to the efficient power supply unit and the OLED display with background lighting as well as the power saving function emphasize its belonging to the efficiency package.

The power LED lights green when the PDU is switched on. A green status LED means that there is no fault. The yellow colour initiates a warning and the PDU sends a message via SNMP to the DCIM software RiZone. In the event of warning or alarm messages, RiZone can react in different ways, for example, with an e-mail to the responsible personnel. The limit values when an alarm or warning is to be triggered can be set individually.

Universal measuring instrument (UMG)

To determine the total current but also its distribution to the respective branches, the universal measuring instrument UMG from Janitza (Ref. 5) is used in the power distribution rack (PDR).

The prerequisite for a multi-function measuring instrument is that it precisely detects all energy data and electrical parameters, thus ensuring transparency in the power supply and distribution. It must be possible to characterise essential power quality values such as high voltages per phase with direction recognition and short-term interruptions. An integrated counter measures the reactive energy and the energy actually spent.

Figure 7: The universal measuring instrument UMG © Janitza electronics GmbH

With a digital 500 MHz signal processor, the UMG 604 is a fast as well as powerful network analyser. It identifies rapid transistors (> 50 µs) and displays minimum and maximum values.

The DCIM software RiZone features an integrated driver so that the UMG is integrated via the SNMP interface. RiZone can thus transparently display all values of the UMG and serve as a basis for energy management in the data centre.

DCIM software (RiZone)

RiZone is a **D**ata **C**entre **I**nfrastructure **M**anagement (DCIM) software for all components of the physical infrastructure of a data centre and thus serves for the monitoring of the critical supply paths (power protection and distribution, cold air generation and distribution) as well as the continuous monitoring of all relevant security parameters (temperature, humidity, smoke, access, etc.).
For the RiMatrix S modules (Single6, Double6, Single9, Double9), preconfigured projects are available, which can be adapted to the particular customer situation without any problems. Via an auto-discovery function, the current IP addresses of all physical devices and sensors can thus be transmitted to the predefined projects using drag and drop. Figure 8 shows a RiZone installation for the RiMatrix S module Single6.

Figure 8: RiZone – RiMatrix S – Single6 installation

RiZone is available as hardware or software appliance. In the hardware appliance, RiZone is preinstalled and executable on an HP Proliant server. In the software appliance, RiZone runs in a virtual environment on any customer server. All common virtualisation platforms are supported.

The following Figure 9 outlines the RiZone architecture. Communication with the sensors and physical components of the infrastructure (PDUs, UMG, climate control, etc.) is realised by means of the communication modules via an SNMP interface.

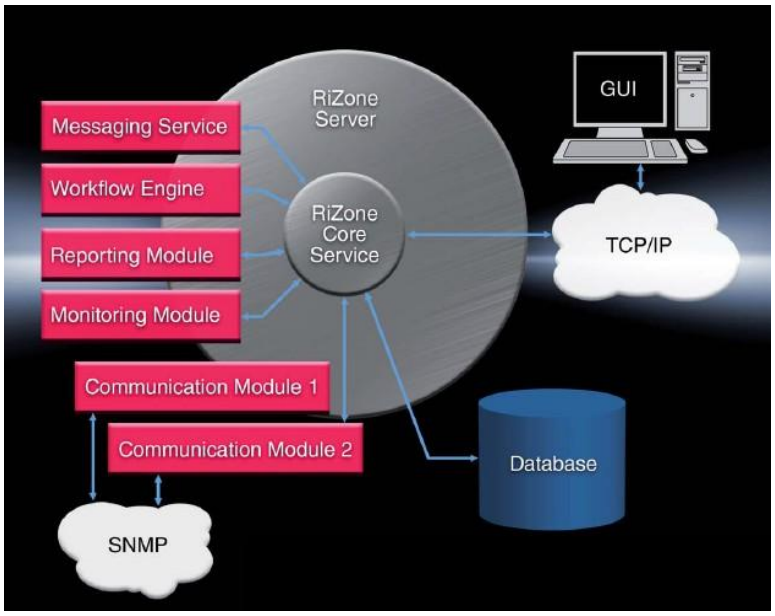

Figure 9: RiZone architecture

RiZone assigns all measured values to the physical objects and creates on their basis the graphics for evaluation in the monitoring module. A powerful workflow engine supports customer-specific evaluations, hierarchical alarm scenarios up to open-loop control and closed-loop control of external components.

Important for the data centre administrator is the reporting module. Automatic reports can be generated in predefined intervals to continuously monitor the utilisation, operating costs and efficiency of the data centre. Via the data captured and stored in an SQL database, the current, monthly and annual energy consumption can be visualised so that conclusions can be drawn about the efficiency of the data centre.

RiZone features a bidirectional SNMP interface which allows connection to management systems and via protocol converters even to building services management systems.

Summary

A standardised data centre which is based on a flexible modular system of individual data centre modules provides a number of customer benefits:

- The aforethought, preconfigured data centre modules considerably shorten the planning phase.

- The individual data centre modules are completely measured, include a data sheet and allow a PUE statement and thus a transparent ROI calculation already in the planning phase.

- The complete documentation including an operating manual, which also includes the DCIM software, allows secure working right from the start.

- The short delivery and commissioning time as well as the available certificates represent another important customer benefit.

- The flexible adaption to the customer situation is possible due to the option packages, one of them being the efficiency package.

With the efficiency package, a flexible, powerful solution is available in the prefactured scope of the RiMatrix S data centre, to implement all aspects of monitoring and logging. This forms the basis for an optimisation of the data centre as well as the subsections such as climate control and power protection. Continuous, transparent monitoring is the guarantee for sustainable efficiency improvement and thus reduction of the operating costs.

The efficiency package provides all components and mechanisms for that.

List of references

Ref. 1: Technical Report – RiMatrix S – A Concept for Standardised Data Centre Construction

Ref. 2: Borderstep Institute, http://www.borderstep.de

Ref. 3: Umweltbundesamt (German Federal Environment Agency), /www.umweltbundesamt.de

Ref. 4: The Green Grid, http://www.thegreengrid.org/

Ref. 5: Janitza UMG, http://www.janitza.de/produkte/energie-messtechnik/umg-604/uebersicht/ and http://www.janitza.com/products/energy-measurement/umg-604/overview/

List of abbreviations

COP	-	Coefficient of Performance
DCiE	-	Data Centre Infrastructure Efficiency
DCIM	-	Data Centre Infrastructure Management
EER	-	Energy Efficiency Ratio
GUI	-	Graphical User Interface
IP	-	Internet Protocol
LED	-	Light-Emitting Diode
MIB	-	Management Information Base
OLED	-	Organic LED
PDU	-	Power Distribution Unit
PDR	-	Power Distribution Rack
PUE	-	Power Usage Effectiveness
pPUE	-	partial Power Usage Effectiveness
ROI	-	Return on Investment
SNMP	-	Simple Network Management Protocol
SQL	-	Structured Query Language
TCP/IP	-	Transmission Control Protocol / Internet Protocol
UMG	-	Universal measuring instrument
UPS	-	Uninterruptible Power Supply

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