# White paper

**Cool-safe®**: what is it and why is it good for you?

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Introduction

Cool-safe is a holistic system engineering methodology used in PRIMERGY servers. Cool-safe is right at the heart of our engineering efforts. If you ask a group of our engineers to say what Cool-safe means to them, you would come up with these 3 common denominators:

- Performance
- Efficiency
- Reliability

Our PRIMERGY engineers are putting all their creativity at your service in order to ensure that efficiency, reliability and performance runs right through your PRIMERGY server.

Since the introduction of the PRIMERGY Dual S8 generation in 2013 selected PRIMERGY servers now support Cool-safe Advanced Thermal Design which is an extension of the Cool-safe concept. Selected servers can thus be operated within greater temperature ranges. As can be seen in the diagram, the normal temperature range for server operations is between 10 °C and 35 °C. Cool-safe Advanced Thermal Design extends the range to between 5 °C and 40 °C.

Further information: Cool-safe® Advanced Thermal Design White Paper

So, that’s what Cool-safe is in a nutshell. Oh yeah, Cool-safe is also about keeping your CEO and CFO happy. Now let’s take a look inside and see how this is done in practice…the engineering.

Performance – what your CEO loves best

Your CEO wants to be able to take advantage of every business opportunity out there and PRIMERGY engineers know that. That is why they use the Cool-safe method to get the best performance out of the system, without losing sight of the efficiency and reliability. A particularly important development in this respect is the use of the Intel® Xeon® E5 product family with up to 18 cores. On top of that PRIMERGY M1 systems are capable of using up to 1.5 TB of brand-new DDR4 memory with 2133 MHz, and up to 32 hard disks! Now let us look at how to keep this beast under control.

Efficiency – why your CFO loves PRIMERGY servers

Efficiency is a big word and it can mean many things, but in this context efficiency means not wasting energy. Wasting money is never a good idea. Wasting energy is also bad from an environmental point of view too. Both of these are very important when it comes to data centers where you have many servers running in rack or blade infrastructures.

The best way of measuring energy efficiency is to look at the SPECpower_ssj2008 benchmark (http://www.spec.org/power_ssj2008/results/power_ssj2008.html) which measures server performance/Watt. According to SPEC, “The overall score of the SPECpower_ssj2008 benchmark calculated from the sum of the performance measured at each target load level (in ssj_ops) divided by the sum of the average power (in W) at each target load including active idle.”. See: http://www.spec.org/power/docs/SPECpower_ssj2008-Result_Fields.html. By looking at the SPEC results site, you will see that there are several PRIMERGY systems listed under the top 10 of the most energy-efficient servers. Since the start of the power and performance characteristic measurements 7 years ago the energy efficiency of the PRIMERGY servers improved by factor 30.
Now let’s take a look at what makes PRIMERGY servers efficient.

**Power Supply Unit (PSU) efficiency**

In almost all of our single and dual socket tower and rack server systems we build in power supplies capable of reaching 94% power efficiency. Some selected systems feature even power supplies with 96% efficiency. That means that only 4 or 6% of the energy going through the power supply is lost. This saves costs and minimizes the environmental impact.

**BIOS and processors**

How does the BIOS affect energy consumption? Well there’s no point in the hardware running at full speed all the time. Your local energy supplier doesn’t mind, but your CFO does. That’s why processors have so called “C-states” and “P-states”. C-states are idle states and P-states are operational states. In other words, the C-state decides how far a processor should go into idle mode. The deeper the idle state, the less energy it consumes but the longer it can take to ‘wake up’. The P-state decides at what frequency the processor should be run. By running at a lower speed, the processor generates less heat and consumes less power. In Intel® processors, P-states are known as Enhanced Intel Speed Step® Technology. Still with me? Of course, the processor interacts with the operating system in order to set the right c or p state, but that’s not the whole story. Here’s where the BIOS engineers come in... The BIOS has a table of values which sets the overall limits within which the hardware and software operate. That’s what determines the how low your system is idling or how high it is performing. Not an easy task, but that’s where the PRIMERGY engineering crew can blend in their awesome analytical skills with their fearsome precision. The BIOS know-how is the result of extensive testing and customer feedback.

**Motherboard design – PRIMERGY Dual Socket M1 Servers**

So, what have these PRIMERGY engineers thought about here then? Well, to achieve a high efficient server system you have to look at the power delivery concept as a whole, from AC Power in, down to the components on the motherboard, like processor, memory and chipset. Always keeping energy efficiency as a priority one goal in mind, they first replaced the old power supplies by new ones, optimized for high energy efficiency.

Further, they have also been able to optimize the connection of the power supplies to the motherboard. The highly efficient redundant power supplies are connected to the motherboard via low impedance connectors. This guarantees a highly efficient energy transport from the power supply to the motherboard.

All those small steps lead to a very high energy efficient server system. Besides that, reducing the number of cables improves the serviceability of the server. Have a look. Here’s what the insides of an RX2540 M1 look like when you take the cover off.
Energy efficiency on a new level

The combination of highly-efficient power supplies, the various improvements in the motherboard design and optimized energy and BIOS settings lead to a significantly improved energy efficiency of the new PRIMERGY dual-processor generation. Thus it was possible to increase the results of the important SPECpower.ssj2008 benchmark by more than 30%. What does that mean for you? In comparison to the S8 generation the new M1 PRIMERGY generation has a 30 % higher performance per Watt.

A perfect climate and savings in energy costs

You surely know that power consumption costs for a data center use up an enormous share of a company's overall IT budget. But did you know that expensive cooling in a data center often account for more than 50% of the energy costs?

Here's the good news: there is a simple way to save money! The new generation of servers supports environment temperatures of up to 40 °C / 105 °F. The temperature in a data center can thus be increased by a few degrees without any problems. Each additional degree results in a 5 to 6% drop in air-conditioning costs. Even the "dreaded hot zones" in a data center are now not so frightening. Indeed: a skillfully configured area within the data center with a higher environmental temperature relieves the burden on air-conditioning and your budget in a very simple manner. To be able to offer customers a uniform data center concept it’s not just the servers that support the Cool-safe® Advanced Thermal Design technology, but also selected Fujitsu ETERNUS storage systems and network components. Fujitsu thus offers its customer a complete infrastructure consisting of servers, storage, and network that supports an ambient temperature of up to 40 °C / 105 °F.

Server Management – Fujitsu ServerView Suite

To professionally manage your PRIMERGY server across its lifecycle our Fujitsu ServerView® Suite is delivered with every system. The Fujitsu ServerView® Suite – or short ServerView – provides you with a comprehensive set of tools to install, control, maintain, integrate and automate the server in your IT infrastructure. And of course, ServerView also comes with an easy to use interface to conveniently manage all settings for an effective power management of the server. ServerView's counterpart on the hardware side is the iRMC chip (Integrated Remote Management Controller) integrated on the motherboard (see below). Now let's see what the iRMC chip and ServerView can do together.

Power Control

This money-saving functionality is one your CFO’s favorites. The integrated Power Management controls (remote) power on, power off and shutdown for physical servers as well as on virtual servers.

Power Monitoring

Another CFO favorite. The Power Monitor enables the analysis of the power consumption of a single or multiple servers. The consumption data are logged for settable periods, and displayed as graphs.

Power Consumption Control

Thanks to the iRMC chip, you have a choice between four modes:

- Minimal Power Consumption: you constrain the CPU’s power to lowest minimum used by the CPU type
Best Performance: all of the CPU's performance is available for the operating system
Low Noise: The iRMC controls the server to achieve the lowest possible noise emission
Power Limit: Allows limitation of maximum power consumption (in Watts) and lets you define appropriate actions when the limit is reached

The scheduler function lets you switch between these modes on a planned basis. Last but not least, should the uninterruptible power supply be activated because of a power cut the server reduces the power consumption to a minimum.

You think this is good? It gets better. Fujitsu has a track record of creating power-saving hardware and constantly adds more environmentally sound products to its portfolio. The PRIMERGY BX Blade Servers are no exception: first and foremost, the system design dramatically reduces the use of “excess components” – i.e. networking equipment, PSUs, fans etc. – typical for conventional networks, and hence the general power requirements. But what is more, Fujitsu also equips the system with highly efficient components, advanced cooling technology, and potent power management tools.

The power management in the PRIMERGY Blade Server environment can be differentiated into four main functions: Power Consumption Monitoring, Chassis Power Consumption Control, Server Blade Power Consumption Control and PSU Redundancy Mode. These functions help companies better understand thermal effects and utilize power more efficiently through intelligent monitoring and controls. As a result, the PRIMERGY Blade Server can be set to work in several modes which function similar to driving parameter programs in modern cars:

- The Low Noise Mode reduces power consumption and fan operation so that the unit does not emit more than 45 dB(A) noise. This mode is especially useful in office scenarios where the blade system is to be placed in a corner or under a desk.
- The Enforced Mode on the other hand is designed to make sure that the power consumption will not exceed the defined power consumption by the user during the whole activation time of this mode. In case the enforced mode is active, the server blade power budgeting could be changed by user through any possible interfaces.
- The Minimum Mode ensures that the system works the lowest possible energy consumption. This mode allows for the biggest expense cuts and is recommended for all scenarios where performance is not the top priority.
- Furthermore the “Dynamic Power Mode” of the power supply units automatically shift power load to maximize the efficiency of each power supply needed to power the system.
The ServerView remote management tool (screenshot above) displays the power consumption e.g. over an hour, week or year, and in a multiple-curve graph with e.g. current and average consumption.

**Power Calculator in SystemArchitect**

The end user also has the chance to fine tune their consumption by using the "Power Calculator" in SystemArchitect.

For a given configuration, the Power Calculator will work out the power requirements and heat emissions, vital information when you're planning a data center.

See the "White Paper: PRIMERGY Modular PSU Concept" for more details.

That's why your CFO loves PRIMERGY engineers. Because they do everything possible to minimize waste and save your company the very last cent. And because it makes him feel good that he can help preserve the environment too.
Reliability – don’t make your CFO halve your lifetime!

Air flow – keeping the air cool
This is absolutely key when it comes to reliability. The objective here is to stop the system from overheating by keep cool air coming into the system, and moving the hot air out of the system. In order to simulate the air flow, PRIMERGY engineers use Computational Fluid Dynamics (CFD). CFD is widely used in such high-tech fields as aeronautics. The picture below gives an example of a CFD applied to a PRIMERGY RX2540 M1. In the blue and turquoise areas the air is slow moving and the yellow and red areas show faster air speed. This demonstrates that the optimized Cool-safe® design needs only slow moving air to keep the system cool.

The air flows through the system from right to left. As it comes in, the air is channeled into the system via the fans distributed along the width of the chassis. The most critical components are strategically placed directly behind the fans, guaranteeing optimum cooling. The power supplies have their own fans (look at the red area at the top left of the picture), which is not really surprising. After all, by converting the power necessary to keep your system up and running, this also generates heat which has to be removed from the system.

This effort is necessary on the one hand in order to cool a free standing system, such as a tower, and also when the system is in a rack in a data center. The picture below shows the air flow in a traditionally designed data center.

As you can see from the picture, the systems have to be engineered in such a way that:
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- A single rack or blade infrastructure is cooled appropriately and
- that it does not affect the reliability of other racks or blades

The other key point from the drawing is that the large amounts of heat mean that a lot of effort is spent in keeping the data center cool. This of course relates closely to the topic of efficiency and saving money.

So, on the one hand the PRIMERGY engineers look at the system as a single unit and also as part of a bigger picture. In order to do that, the engineers have to keep one basic principle in mind: a clean design. And this is how they do it...The secrets of a cool system.

The picture below of a PRIMERGY RX2540 M1 rack system gives an idea of how it is setup in order to guarantee a cool system.

1. There is an unobstructed airflow, with large enough ‘corridors’ for the air to pass through. Notice also that the engineers have done their best in order to keep the design nearly cable-less. This minimizes any possible obstructions.
2. Heat is quickly moved away from hot spots. The CPUs are placed in parallel so that each CPU gets its own stream of fresh air.
3. The air flow is conducted to where it is needed most. Look at how the fans are setup across the width of the system. The cooling channels are kept separate in order to prevent shortcuts and loops in the airflow.

Another great example is given by the TX2540 M1. The air speed is kept as low as possible by using large fans turning slowly.

In this case, the 3 standard fans plus 1 fan for redundancy are blowing the air directly towards the processors and memory slots. The housing and the fans are optimized to allow a maximum of air to circulate through the system, making the system cooler. Including many small fans, would mean that they would have to turn very fast in order to help keep the system cool. These small fans would make the system power-hungry and noisy. That is why the TX2540 M1 uses 3 big fans instead. These turn slower, making the system more energy efficient and more silent.

A large diameter fan produces good air flow even at low number of revolutions per minute. Of course, the PRIMERGY servers feature the ServerView Management Suite, which also controls the fan speed. The fan speed can be set to vary between the following speeds:

- Full speed specification: 3000 rpm (+/- 10 %)
- Low speed specification: 1000 rpm (+/- 10 %)

The fan speed is controlled in relation to the ambient temperature and the server power consumption. This can be viewed in graphical form in ServerView.
Conclusion

So, now the engineering lesson is over and now you know what makes up the Cool-safe methodology, what do you make of all this?

Performance: Cool-safe lets you take full advantage of the performance at your fingertips. A system which is already overheating at a low performance load, just won’t be able to perform any more. It has hit a brick wall. A system which is cooled appropriately will be able to perform at higher performance loads.

Efficiency and Green IT: Cool-safe saves money and contributes to the environment. By keeping the system running at a low temperature range you avoid inefficient use of resources, both financial and natural.

Reliability: Cool-safe saves headaches. By keeping the system cool and preventing it from over-heating it preserves the life of your components. One of the main reasons why components fail is simply that they overheat. Cool-safe works against this, which means that your system lifetime (and that of your investment!) is enhanced.

Pure innovation: that is the engineering lifeblood running through Cool-safe.

Of particular importance for tower systems is the honeycomb design of the front bezel. While this may not seem like a great innovation at first sight, the hexagonal holes let in more cool air than circular ones. This increases the system's reliability. It also increases the performance as it allows the system to run at higher speeds. It’s a small but effective improvement.