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Embracing the Digital Data Center:
How Environmental Monitoring and Visibility Lead to Operational Insights

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Introduction

The reality is simple: data is the lifeblood of many organizations, and the data center has become the heart. With organizations embracing new technologies —from AI to IoT— and generating more data that will get us into the yottabyte* age, data centers are under pressure to do a lot more — and to do it more efficiently and swiftly.

Performance demands on server and storage packed tightly in data center racks — in turn, are creating new demands on data center power and environmental infrastructures.

Consider this: energy use is expected to continue increasing by around 4 percent a year in data centers. U.S. data centers alone are projected to consume about 73 billion kWh in 2020. Many efficiency strategies are already successfully employed in data centers — including emerging technologies, such as predictive analytics and data-driven machine learning. But more needs to be done.

Gartner predicts that by 2020, more than 30 percent of data centers that fail to implement AI and machine learning will cease to be operationally and economically viable. "ITs primary function will be to enable the business to be more agile, to enter new markets more quickly, to deliver services closer to the customer, and to position specific workloads based on business, regulatory and geopolitical impacts," says Gartner's Dave Cappuccio. To survive, data center infrastructures need to become intelligent.

It is more important than ever to have the intelligent data center monitoring solutions to keep an eye on your most critical resources. In other words, advanced tools are needed to monitor a data center's every "heartbeat" with accuracy and in real time. These tools should tell you if there is: enough power, a harmful hotspot, an unauthorized user near an open cabinet, wasteful overcooling, and how new workloads are affecting specific cabinets.

Among the tools used in data centers, environmental monitoring sensors play a big role. Like the proverbial miner's canary, environmental sensors have been helping data centers by monitoring the health around cabinets and providing alerts into potential problems that can jeopardize the performance and life of IT assets.Today, more than ever, data centers of all types — edge, core, and colo's — rely on smarter sensor tools that provide accurate insights to the environmental health in and around IT equipment racks. These tools continue to advance and evolve to meet new data center challenges.

In this paper, we will examine the importance of data center environmental monitoring, explore the variety of monitoring strategies, and how they complement intelligent power monitoring solutions. From there, we'll discuss how to instrument your data center with these tools and provide some real-world use cases.

* Over the last two years alone, 90 percent of the data in the world was generated.



I. Monitoring Tools & Sensors — How They Help Data Centers

Let me share with you a recent call from a customer, in the retail space, who has been reluctant in terms of spending on data center monitoring. This customer's data center wasn't small by any means. They had rows of racks using a few thousand square feet of space. They have about 7,500 users from across the country accessing different systems and resources to conduct business every single day.

One day, they were experiencing power issues impacting several key systems, not knowing what specific rack was giving them these issues.

Occurring randomly, within several racks, it was starting to slow down and impact their sales process. It took a few hours to find a faulty floor PDU that needed to be replaced. However, the real damage was to the business. In today's digital world, slow is the new down. After this event, the customer seriously reevaluated the way they were monitoring their data centers and began to examine deeper, rack and device-level monitoring systems.

There are advanced new solutions helping create smarter racks when it comes to monitoring and power distribution. For example, intelligent rack PDUs offer more than just reliable power distribution. These platforms are a launch pad for real-time remote power metering, environmental monitoring, and even offer deep integration with data center infrastructure management (DCIM) systems. These are the kinds of solutions that deliver the real technology needed to enable a smarter IT infrastructure so that customer can actively stay ahead of problems before they occur.

Let's pause here and focus more on monitoring sensors, and how they specifically help the data center.

Environmental monitoring provides a complete picture of data center conditions at the rack, aisle, and facility level. They reveal trends and alert operators to risks or potential threats in real time.

The idea is simple: you can't effectively manage what you can't monitor and measure. IT managers are tasked with providing a more proactive environment that is better planned, has increased operational efficiency, and maintains to a higher level of service. The ability to achieve actionable, granular visibility into a data center and its operations requires managers to monitor important environmental variables like cooling conditions, temperature, humidity, power, rack conditions, and much more.



Therefore, it's so important to note that there really are sensors for every situation. There are sensors for:

- Keeping Your Humidity in Check
- Maintaining Optimal Temperature
- Detecting Water Leaks
- Maintaining Optimal Air Pressure
- Cabinet and Rack Security
- Monitoring and Managing Airflow
- Many More Applications

Another important point to note — in the past, all this monitoring and management was time consuming and often done manually. Sometimes issues took hours to resolve. And, often, monitoring solutions were difficult and costly to deploy. Most of all, these sensors and systems had little interoperability with existing rack infrastructure — adding another layer of management and complexity.

Raritan's SmartSensors are deployed as plug-and-play options that work with intelligent rack PDUs, inline meters, branch circuit monitors, and other solutions — eliminating the need for a separate controller and underlying networking. The SmartSensor technology uses advanced metering components to provide more accurate and useful data. Furthermore, environment data can be instantly sent to DCIM software solutions to see real-time environment data and trends over time — along with other infrastructure metrics, such as power capacity — on one dashboard. This is key to enabling a proactive environment for your data center operations.

This is the era of the smart and connected IT infrastructure. The beauty here is that you don't have to rip out and replace your existing systems. Many of these sensors and new solutions are designed to work with existing environments.

There are a great number of benefits to creating a proactive data center framework. Consider the eBay use case.

With compute loads and operating costs on the rise, eBay created and began executing on a multi-year data center plan. eBay developed a model — which includes new monitoring tools — for its data centers that makes their IT operations both highly reliable and less expensive to operate than the data centers they are decommissioning. eBay is using smart sensors and rack PDUs as part of this initiative, which has enabled the company to:

- cut power costs in half
- double compute performance
- gain greater operational agility and increased reliability

By implementing IT industry best practices and advanced monitoring tools as exemplified by eBay, data centers of any size can improve their uptime, reduce costs, and become more efficient using readily available equipment and straightforward techniques and processes.

6 Ways Sensors Help Data Centers

- Sensors can help prevent overcooling, under-cooling, electrostatic discharge, corrosion, and short circuits.
- Sensors help organizations to reduce operational costs, defer capital expenditures, improve uptime, and increase capacity for future growth.
- Sensors provide environmental monitoring and alert managers to potential problems like the presence of water, smoke, and open cabinet doors.
- Sensors can save you up to four percent in energy costs for every degree of upward change in the baseline temperature, known as a set point.
- Sensor data helps populate AI, ML, and other future initiatives.
- Collecting and integrating smart sensor data provides valuable information for your multi-dimensional view of your distributed data center operations.

II. Monitoring Basics — How to Effectively Instrument Your Data Center with Sensors

Let's examine a few best practices and recommendations when it comes to environmental monitoring and sensor deployment. Consider these collected best monitoring practices to reduce downtime and improve efficiency:

Temperature. This is where most data centers start monitoring because of the need to maintain a safe equipment operating environment. As we all know, every watt of power consumed by IT equipment is turned into a watt of heat. As compute loads fluctuate, so do temperatures. That's why real-time, accurate monitoring of cabinet temperatures is a top priority.

- Make sure to check ASHRAE T.C. 9.9 for optimal operating temperatures for servers. (Keep in mind that recommendations do change.)
- ASHRAE standards recommend three sensors located at the inlet (front) of the IT equipment. They should be mounted at the top, middle, and bottom of a rack.
- Sensors at the back of the cabinet are not mandatory, however, depending on the air flow containment strategies (hot aisle VS cold aisle) it might be useful to monitor the server outlet temperature as well.
- Administrators should track rack exhaust metrics, internal temperatures, and server temperatures. The more visibility into the temperature control mechanisms in place, the quicker a response engineer can address issues before they become serious problems.

Humidity. Maintaining proper humidity levels helps avoid electrostatic discharge (ESD) problems when humidity is low and condensation problems when humidity is high.

- It is best practice to monitor humidity levels to maintain within ASHRAE acceptable ranges, and therefore avoid uncontrolled temperature rises due to exceeding humidity levels.

Aisle environmental controls. This means temperature, humidity, airflow, and hot/cold aisle monitoring. Depending on the size of the environment, hot/cold aisles will be present. Tracking the temperature ranges in these data center aisles can help administrators' spot problems quickly and improve efficiency.

Vibration. Depending on your data center location, seismic activity could be a serious concern. Look for sensors that can detect vibrations, such as from earthquakes or even damaged fans, along three axes (x, y, z).

Static electricity. Ambient static electricity monitoring sensors help detect if something has entered the facility with large amounts of static around them. Static electricity can be very harmful to a data center environment, so managing with these sensors is important.

Water. Depending on the data center environment, it is recommended to place leak sensors around the outside walls of the server room, as well as beneath the raised floor. To detect wetness coming from cooling units, place water sensors around the unit to monitor possible water and coolant leaks. Take extra precautions if you have liquid-cooled systems.

Data center access and security. From a security perspective, many organizations are deploying data center rack entry, or contact closure, sensors.

- These sensors will alert the security personnel in case of unauthorized access to the cabinet.
- Some solutions will activate a camera system pointing to the exact rack that has been accessed.
- Furthermore, you can even deploy proximity sensors to capture when someone passes nearby a cabinet. (See Raritan's white paper on rack access and control best practices)

Sensor placement. When deploying data center sensors, it's very important to take the environment size into consideration. Since each environment is unique, there aren't too many tools that can "auto" place sensors for you. This is where a good partner can really help. HVAC professionals and data center monitoring/environmental design experts can help an organization plan out the best strategy for sensor deployment.

A final note — you can absolutely **deploy sensors without disrupting operations!** This means leveraging existing IT infrastructure and deploying solutions that can integrate seamlessly. For example, you can easily plug sensors into an intelligent PDU or Smart Rack Controller.

There are several things to consider when selecting a sensor. How well do they scale? Are they durable? Most of all — are they accurate? With that in mind, let's jump into our next section.

Sensor Selection Criteria

There are five key factors to look for when selecting sensors for your data center:

1. Look for solutions that are scalable.
Your data center is an ever-evolving part of your business. In my experience working with data centers, I see a refresh or evolution happen quite frequently. Sometimes as often as every 3-5 years. All of this requires more intelligence around data center management as well the ability to scale. You will deploy more racks, you will have more servers, and you will likely start to look at things like edge. Even smaller data center locations need to be monitored. Sensors that can scale on demand and integrate with management frameworks will help give you your nights and weekends back and help your business become a lot more agile. Most of all, a good sensor and environmental monitoring platform should not introduce complexity or fragmentation. Rather, they'll all integrate with a good management platform to give you visibility and granular control.

2. Look for high metering accuracy.
You absolutely need to work with sensors that are proven and accurate. For example, Raritan's SmartSensors™ deliver the highest metering accuracy at +/- 0.2°C for temperature sensors and +/-1.8% for relative humidity. Accurate environmental data leads to fewer false positive alerts and easier overall data center management.

3. Look for sensors that are easy to install, upgrade, and repair.
Let me give you an example: Removable Sensor Heads can be leveraged to disconnect and reconnect the sensor without having to rewire the rack, saving on maintenance costs. Plus, if sensor accuracy diminishes you don't need to remove the entire sensor; just replace the sensor head to maintain a high degree of accuracy.

4. Cascading and expanding sensors capabilities.
In some situations, you might need to cascade and increase your sensor package. To increase the number of connected sensor packages per sensor port, you can cascade smart sensors using standard network patch cables. And, that cascading can go high. For example, Raritan's sensors cascade up to 32 sensor heads in-a-row, linked with standard CAT5/6 cables.

5. Integration with DCIM to help spot trends and more.
You should consider looking for environmental sensors that are used alongside a DCIM analytic solution to allow you to monitor temperature trends in real-time, calculate potential savings, and generate reports to share with end users and management. From there, these types of solutions help optimize your data center ecosystem to ensure that you are meeting guidelines and setpoints, reducing operational costs, and improving your power usage effectiveness (PUE).

III. More Intelligence with DCIM

Throughout this paper, we've discussed new smart sensors, working with easy-to-install solutions, and making sure that your data center stays proactive. However, another recurring theme has been the integration with DCIM and other data center management systems.

Before we continue, it's important to make this point: Sensors can work without DCIM. There will always be situations where you may not find a need to integrate your smart environmental systems with DCIM. In these situations, your sensors will continue to provide useful information.

However, it's also very important to note that integrating with DCIM can offer a lot of benefits. DCIM software helps visualize data collected and enables operators to monitor the entire data center infrastructure from a dashboard — making it easy to mitigate risks and manage resources. The information provided by DCIM helps data centers pursue energy efficiency initiatives and answer 'what if' questions with predictive analysis planning tools.

DCIM data center health maps, power analytics, cooling charts, and reports are designed to alert you of potential trouble, and help you see real-time power loads, trends, and capacity at all levels of the infrastructure. Users, for example, can easily see temperature data collected from sensors on a psychrometric chart, conformed to latest ASHARE standards, to help ensure that adequate cooling is where it needs to be and proper operating conditions are being maintained. DCIM can also provide 3D thermal floor map visualizations. And with a 3D air pressure floor map overlay with time-lapse video, users can quickly spot trends related to airflow uniformity and efficiency.

IV. What's Next in Intelligent Infrastructures?

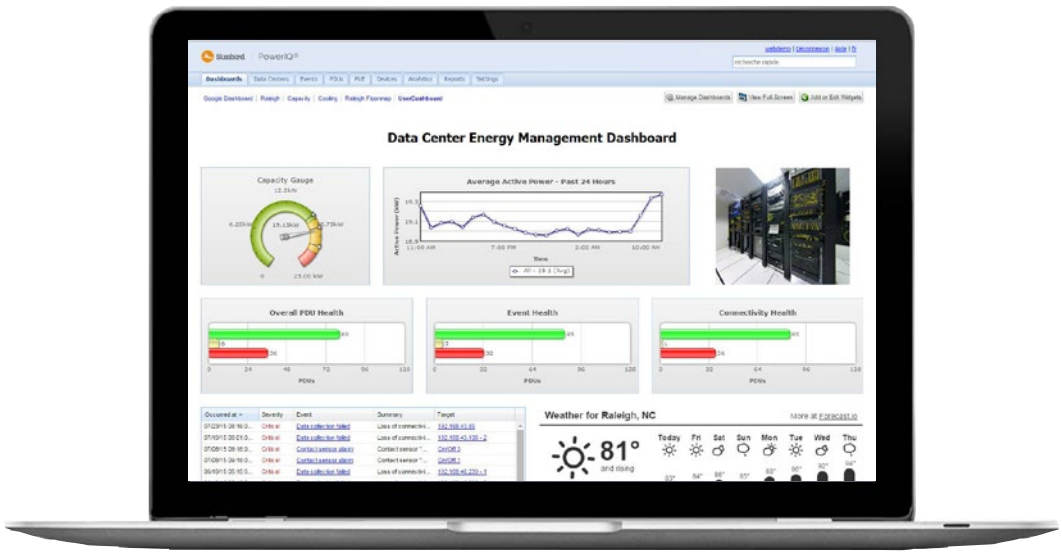
This is just the beginning on how sensor data will be helping data center operators drive efficiencies up and costs down. Intelligent infrastructures that understand a data center's interactions are the frontline of defense for preventing problems and offering remedies, and key to meeting business demands.

Tremendous amounts of sensor data are being gathered and leveraged by AI and machine learning technologies, and other ingenious approaches for automating and optimizing IT infrastructures. An infrastructure's knowledge base perpetually learns and shares — preventing issues discovered in one area from occurring in other areas of the enterprise. As a result, infrastructures are getting continuously more intelligent.

The road to smarter data centers starts with gathering good, accurate sensor data that supports tools to monitor and manage any IT asset or process, anywhere, at any time.

Google, for example, used sensor data and machine learning in its data centers to cut up to 40 percent the amount of energy used for cooling. Thousands of sensors in Google data centers collect data on temperatures, power, pump speeds, setpoints, and other factors. The data is used to train an ensemble of deep neural networks.

According to Google, each data center has a unique architecture and environment. A custom-tuned model for one system may not be applicable to another. That's why data centers need a more efficient and adaptive framework to understand data center dynamics and optimize efficiency.



Conclusion

Your next big step is simply to get started. Whether you have a sensor solution in place or not — you absolutely need to see if your current solution is bringing you value. From there, be sure to understand that there are powerful environmental solutions that can make your everyday life easier and help your data center become healthier. Raritan SmartSensor is the next evolutionary step in creating an intelligent data center infrastructure platform.

When looking at a data center sensor instrumentation project, it is important to optimize total cost of ownership. As well reducing deployment time and overall tasks to manage sensor data, which is crucial to ensure the fastest ROI and highest efficiency. This is why Raritan created Xerus™ technology platform, supporting all peripheral applications and data center products with a single, easy to use application.

To Learn More about what value Xerus™ brings to thousands of end users worldwide, visit here.

About Raritan

Raritan began developing KVM switches for IT professionals to manage servers remotely in 1985. Today, as a brand of Legrand, we are a leading provider of intelligent rack PDUs. Our solutions increase the reliability and intelligence of data centers in 9 of the top 10 Fortune 500 technology companies. Learn more at Raritan.com

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