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

INTRODUCTION

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

Performance demands on data center racks create new demands on power and environmental infrastructures. Faster, hotter chips, larger servers, cluster networks, storage, and rising densities will push the limits of legacy data center infrastructure and designs.

Data centers are one of the most energy-intensive building types, consuming 10 to 50 times the energy per floor space of a typical commercial office building. These spaces account for approximately 2% of the total US electricity use. As the use of information technology grows, data center and server energy use is expected to grow, too.[1] Many efficiency strategies are already successfully employed in data centers, including advanced technologies like predictive analytics and data-driven machine learning. However, more needs to be done, and data center infrastructures need increasing levels of intelligence to survive.

One way to increase a data center's intelligence is to implement intelligent data center monitoring solutions to survey critical resources. In other words, advanced tools are needed to monitor a data center's every "heartbeat" accurately and in real time. These tools should be able to tell you if there is enough power, a harmful hotspot, an unauthorized user near an open cabinet, wasteful overcooling, if there are harmful environmental hazards, and how new workloads are affecting specific cabinets, as some examples.
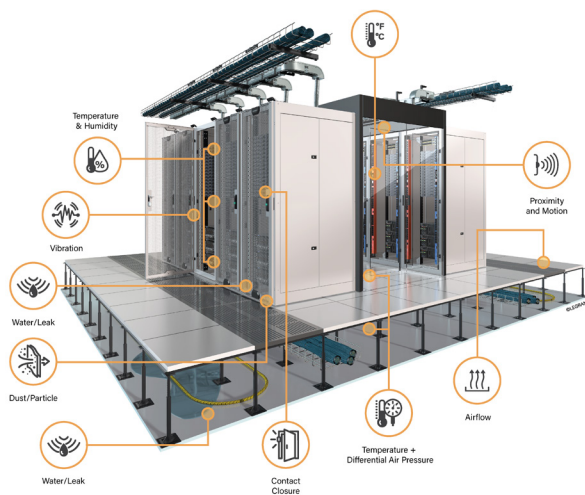
Among the tools used in data centers, intelligent environmental sensors play a significant role in monitoring data centers. Sensors can provide alerts about potential problems that can jeopardize the performance and life of IT assets. Today, more than ever, data centers—edge, core, and colo's—are relying on more intelligent sensor tools to provide accurate insights into the environmental health in and around IT equipment racks. These tools continue to advance and evolve to meet new data center challenges.

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This paper will examine the importance of data center environmental monitoring, explore various monitoring strategies, and discuss 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.

USE CASE: MONITORING TOOLS & SENSORS - HOW THEY HELP DATA CENTERS

A customer in the retail space was reluctant to spend on data center monitoring. This customer's data center had rows of racks using a few thousand square feet of space. Seven thousand five hundred users nationwide are accessing different systems and resources to conduct business daily.

One day, they experienced random power issues impacting several vital systems, not knowing what specific rack was giving them these issues. The problem started to slow down and affect their sales process. It took a few hours to find a faulty floor PDU that needed replacing. 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 how they monitored their data centers and began to examine deeper rack and device-level monitoring systems.

Advanced solutions are helping create smarter racks regarding 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, rack-based power quality monitoring, environmental monitoring, and even offer deep integration with data center infrastructure management (DCIM) systems. These are the kinds of solutions that deliver the technology needed to enable a smarter IT infrastructure so that customers 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 levels. They reveal trends and alert operators to real-time risks or potential threats.

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

This is for illustration only and is not an actual deployment recommendation.

Therefore, it's important to note that there are sensors for every situation, including:
- Keeping the White Space's Humidity in Check
- Maintaining Optimal Temperature
- Detecting Water Leaks
- Maintaining Optimal Air Pressure
- Ensuring Cabinet and Rack Security
- Monitoring and Managing Airflow
- Many More Applications

Another essential point to note—is that in the past, all this monitoring and management was time-consuming and often done manually. Sometimes, issues took hours to resolve. And, frequently, 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.

One intelligent solution, Legrand's SmartSensors, can be deployed as plug-and-play options with intelligent rack PDUs, inline meters, branch circuit monitors, and other rack management solutions— eliminating the need for a separate controller and underlying networking. The SmartSensor technology uses advanced metering components to provide more accurate and valuable data. Furthermore, environmental 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 and power quality— on one dashboard. This is key to enabling a proactive environment for your data center operations.

This is the era of smart and connected IT infrastructure. The beauty here is that you don't need 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 significant number of benefits to creating a proactive data center framework. Consider the eBay use case.

With compute loads and operating costs rising, eBay created and began executing 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, eBay exemplifies that data centers of any size can improve their uptime, reduce costs, and become more efficient using readily available equipment and straightforward techniques and processes.

5 WAYS SENSORS HELP DATA CENTERS

- Sensors can help monitor overcooling, undercooling, electrostatic discharge, and short circuits.
- Sensors help organizations 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 and open cabinet doors.
- Sensor data helps populate AI, ML, and other deep learning initiatives.
- Collecting and integrating smart sensor data provides valuable information for your multi-dimensional view of your distributed data center operations.

USE CASE: MONITORING BASICS - HOW TO EFFECTIVELY INSTRUMENT YOUR DATA CENTER WITH SENSORS

Let's examine a few best practices and recommendations regarding 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 rack's top, middle, and bottom.
- Sensors at the back of the cabinet are not mandatory; however, monitoring the server outlet temperature might be helpful depending on the airflow containment strategies (hot aisle VS cold aisle).
- 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 a severe problem.

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 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 spot problems quickly and improve efficiency.

Vibration. It is recommended to ensure that a sensor installation protects equipment from excessive vibration and shock. Depending on your data center location, seismic activity could be a serious concern. Look for sensors that can detect vibrations, such as earthquakes or damaged fans, along three axes (x, y, z).

Dust/particles. For example, airborne particles and dust deposits—such as organic dust, concrete dust, ferrous metal particles, electrostatic dust, and haze due to forest fires—are an invisible threat to data centers, server rooms, and other areas where IT equipment is installed. Although not naturally harmful to IT equipment, these ultrafine particles may build up over time, interfere with a device's normal functioning levels, and even lead to its short circuit. When deployed, a dust/particle sensor will monitor particle levels flowing through it and help identify whether levels are above or below custom thresholds.

Water. Depending on the data center environment, it is recommended to place water/leak sensors around the outside walls of the server room, as well as beneath the raised floor. To detect wetness 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 sensors for data center rack entry or contact closure.

- 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 near a cabinet. (See our white paper on rack access and control best practices for more information.)

Sensor placement. Sensor placement is a matter of understanding the purpose of the sensor and the use of the resulting data you will receive, both within the context of industry standards and the wisdom of best practices. Temperature and humidity sensors, for example, should be deployed in larger quantities and various locations—since understanding the efficiency

of your mechanical system is a big-picture exercise. Water/leak-detection sensors, on the other hand, should be deployed in a more targeted manner.

When deploying data center sensors, it's imperative to consider the environment's size. Since each environment is unique, there aren't too many tools to "auto" place sensors for you. This is where a good partner can help. Almost by definition, best practices are ever-evolving. As new monitoring challenges arise and sensor technologies are made available, the location and use of sensors at the rack and within the data center will continue to evolve. For example, industry guidelines written by the ASHRAE, Telcordia Network Equipment Building System, the Department of Energy Data Centre Energy Productivity, European Telecommunication Standards Institute, and EU Code of Conduct can help guide you on local and national regulations.

A final note—**you can 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 rack 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 scalable solutions. Your data center is an ever-evolving part of your business. It is paramount to note when refreshments are typically planned or when evolution forces you to make changes. These changes require more intelligence in data center management and the ability to scale. As you deploy more racks, you will have more servers and will likely start looking at edge deployments. Sensors that can scale on demand and integrate with management frameworks will help give you real-time insights and help your business increase its agility. A suitable sensor and environmental monitoring platform should not introduce complexity or fragmentation. Instead, they will integrate into your overall management platform to give you visibility and granular control.

2. Look for high metering accuracy. You need to deploy sensors that are proven and accurate. For example, Legrand's SmartSensors deliver high metering accuracy at ±0.2°C for temperature sensors and ±5% 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. Suppose sensors have removable sensor heads or are designed with dual RJ-45 connectors. In that case, it will ease the installation and servicing of sensor packages without having to rewire the rack, saving time and maintenance costs.

4. Cascading and expanding sensors capabilities. Sometimes, you might need to cascade and increase your sensor package deployment. To increase the number of connected sensor packages per sensor port, you must look for sensor solutions that can be easily cascaded using standard network patch cables. And that cascading can go high. For example, Legrand's SmartSensors cascade up to 32 sensor packages in a row, linked with standard Cat5/6 cables.

5. Integration with DCIM to help spot trends and more. It would help if you considered looking for environment 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 solutions help optimize your data center ecosystem to ensure you meet guidelines and setpoints, reduce operational costs, and improve your power usage effectiveness (PUE).

MORE INTELLIGENCE WITH DCIM

Throughout this paper, we've discussed new smart sensors, working with easy-to-install solutions, and ensuring your data center stays proactive. However, another recurring theme is integrating with DCIM and other data center management systems.

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

However, it's also crucial to note that integrating with DCIM can offer many benefits. DCIM software helps visualize data collected and enables operators to monitor the entire data center infrastructure from a dashboard, making mitigating risks and managing resources easy. The information DCIM provides 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 the latest ASHRAE 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. Users can quickly spot airflow uniformity and efficiency trends with a 3D air pressure floor map overlay with time-lapse video.

WHAT'S NEXT IN INTELLIGENT INFRASTRUCTURES?

This is just the beginning of how sensor data helps data center managers 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 are vital to meeting business demands.

Tremendous amounts of sensor data are being gathered and leveraged by AI, 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 different areas of the enterprise. As a result, infrastructures are continuously becoming more intelligent.

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

CONCLUSION

Your next big step is to get started. Whether you have an environmental monitoring and sensor solution in place or not, you need to see if your current solution brings you value. From there, be sure to understand that there are robust environmental sensor solutions that can make your everyday life easier and help your data center become healthier. Legrand's SmartSensors are the next evolutionary step in creating an intelligent data center infrastructure platform.

When looking at a data center sensor instrumentation project, optimizing the total cost of ownership is essential. As well as reducing deployment time and overall tasks to manage sensor data, which is crucial to ensure the fastest ROI and highest efficiency. Learn more about Legrand's SmartSensors and embrace the intelligent digital data center.

SOURCES CITED

1 https://www.energy.gov/eere/buildings/data-centers-and-servers

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