ICT TODAY

THE OFFICIAL TRADE JOURNAL OF BICSI

October/November/December 2023
Volume 44, Number 4

EMERGING ICT DESIGN AND CONSTRUCTION PROCESSES

PLUS:

+ Optimizing Data Center Efficiency, Availability, and Planning with Predictive Power Modeling
+ The Human Element of Connectivity

BICSI®

Optimizing Data Center Efficiency, Availability, and Planning with **Predictive Power Modeling**

By Ashish Moondra

Data centers worldwide have come under a magnifying glass for their energy consumption and ability to achieve increasingly aggressive sustainability goals. Now, pending regulations place additional pressure on data centers, making these initiatives even more urgent. In Europe, the Energy Efficiency Directive (EED) expected to be signed into law this year will require data centers with a demand of 100 kilowatts (KW) or more to report their energy performance, including energy reuse factor, renewable energy use, cooling effectiveness ratio, and power and carbon usage effectiveness (PUE and CUE).

Similar initiatives are under way in the U.S., where the Department of Energy (DOE) calculates that data centers account for about 2 percent of the nation's energy consumption.[1] The White House Office of Science and Technology Policy (OSTP) published a report in September 2022 with recommendations for annual electricity usage, greenhouse gas emissions, and electronic waste recycling performance reporting. Proposed data center legislation in Virginia requires site assessment before approval to evaluate a data center's impact on agricultural resources and its effect on carbon emissions and water usage. In Oregon, a proposed bill would require data centers to reduce carbon emissions by 60 percent by 2027, with annual reporting to demonstrate compliance.[2]

At the same time, power consumption in the data center is increasing due to the demand for more digital services and technology advancements that generate more data and require more computing power.[3] As workloads and equipment increase, so does the amount of heat produced and the need for more cooling, which accounts for about 40 percent of a data center's energy consumption.[4] As the most critical asset across every industry and business, data centers also must maintain high availability and prevent costly downtime. Data center managers must, therefore, ensure the right power, overcurrent protection, redundancy, backup, security, and environmental conditions needed to keep the data center operational and maintain optimum performance.

The need to optimize efficiency and availability and strategically plan for the future puts much pressure on data center managers and network operators. Combining the capabilities of intelligent power distribution and backup power with physical security and environmental monitoring into a single, integrated solution via comprehensive data center infrastructure management (DCIM) software can create a predictive power modeling system that significantly eases the burden. Let us look at the elements comprising a predictive power modeling system, how it can optimize the data center, and some essential considerations to help data center managers and network operators better understand how they can leverage this sound power management and monitoring strategy to meet current initiatives while empowering informed decisions that shape a better tomorrow.

WHAT IS INTELLIGENT PREDICTIVE POWER MODELING?

Predictive power modeling utilizes information made available through intelligent power devices within the power chain and monitors, analyzes, and manages that information using advanced DCIM software. Intelligent devices within the power chain include rack-mounted power distribution units (PDUs), remote power panels (RPPs), uninterruptable power supplies (UPSs), and other power equipment, all working together with DCIM software as a single cohesive ecosystem to optimize data center efficiency, availability, and planning (Figure 1).

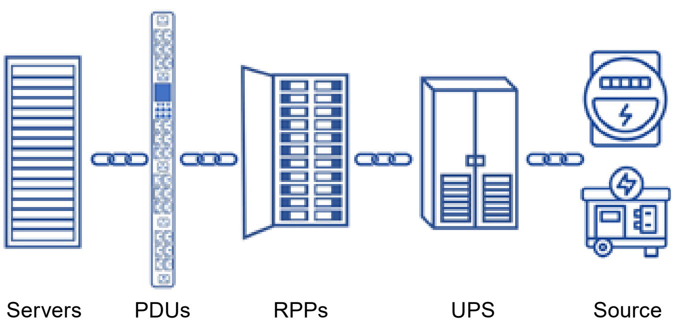

FIGURE 1: Data center power chain.

Valuable Power Information

Within a predictive power modeling ecosystem, intelligent PDUs, RPPs, and other intelligent power distribution solutions at the cabinet, row, and/or floor level have branch overcurrent protection with finite capacities. Intelligent PDUs and RPPs can monitor the current draw for each branch circuit. Intelligent monitored and switched PDUs also provide granular information about their amperage and power usage down to the outlet level. Switched intelligent PDUs even offer the ability to control individual outlets, making it possible to turn the power on or off at each outlet remotely.

Intelligent UPSs within a predictive power modeling ecosystem also report critical information about power quality, including input and output voltage, frequency, and waveform. Intelligent UPSs can even capture information about battery capacity, battery service date, and available run time during battery operation. Intelligent back-end equipment in the gray space, such as chillers and generators, can also be a part of a predictive power modeling ecosystem to report on power quality, usage, airflow, fuel capacity, and other critical information. Even the main utility power source has the potential to be integrated into a predictive power modeling system (Figure 2).

FIGURE 2: Intelligent UPSs report voltage, frequency, waveform, battery capacity, and other critical information.

Environmental and Security Data

Intelligent PDUs can be outfitted with various sensors to monitor environmental conditions such as temperature, humidity, and airflow and detect leaks, smoke, and other hazards. Some advanced PDUs can seamlessly integrate with electronic cabinet door locks via controller modules to enable power, management, and control of cabinet-level security and record access control attempts. Integrating cabinet locks with PDUs can eliminate the need for additional cabling infrastructure to connect and power locks.

Bringing It All into View with DCIM

With all the information from intelligent PDUs, RPPs, and UPSs, powerful DCIM software can provide real-time, remote visibility of the entire network power chain from a single, centralized platform. Data center operators can identify space and power capacity across their facilities via accurate views of available rack power and outlets. They can also monitor amperage and power usage across the entire power chain—from individual equipment to aggregated consumption at the rack, row, floor, or site level. Once thresholds and notifications are set up within the DCIM software, data center operators are notified of any impending issues, allowing for corrective actions before any actual downtime.

Within DCIM software, network operators can actively monitor temperature, humidity, and airflow levels via integrated PDU sensors and set alarm thresholds to quickly detect and prevent hot spots, moisture build-up, low humidity, leaks, and other hazards that can degrade network equipment. With electronic lock integration via PDUs, DCIM software can even monitor and log successful and failed cabinet access control attempts per user for compliance with security regulations such as the Health Insurance Portability and Accountability Act (HIPPA) for healthcare, payment card industry (PCI) standards, and the Federal Information Security Management Act (FISMA) required for the protection of government information and operations.

HOW DOES PREDICTIVE POWER MODELING OPTIMIZE THE DATA CENTER?

While real-time visibility of power, environmental, and security information is critical for maintaining day-to-day data center operations and avoiding catastrophe, trending historical data and extrapolating that into the future with DCIM software is a valuable aspect of predictive power modeling, providing robust business intelligence for long-standing data center energy efficiency, availability, and planning.

Achieves Energy Efficiency

Power consumption information provides the intelligence for predictive power modeling to improve and report on energy efficiency and discover opportunities for future energy savings. Predictive power modeling can identify high-power-consuming equipment or ghost servers (i.e., servers that are physically running but not performing useful functions). It can also calculate, trend, and report PUE and CUE per energy consumption and carbon emissions requirements defined in corporate sustainability initiatives, industry standards, and government regulations. Historical trend data can help data center operators monitor and measure the impact of energy efficiency efforts over time and help predict the impact of future efforts. They can also leverage the information to avoid over-provisioning, find stranded capacity, calculate energy chargebacks, and ensure accountability for internal and external customers.

Maximizes Availability

Based on valuable power information from intelligent PDUs and RPPs, predictive power modeling allows data center operators to keep an eye on the entire power chain and make appropriate decisions needed to avoid unplanned downtime. They can track and monitor downstream and upstream current draw on each circuit to ensure that they never exceed capacity and always maintain adequate redundancy levels to mitigate the risk of any failures. With intelligent switched PDUs, data center operators can power down outlets via the DCIM platform, which is ideal when there are available outlets in a cabinet where equipment is already consuming the branch circuit capacity. They can also view power on each phase of a three-phase PDU to ensure equal load balancing, preventing overloads and achieving the highest possible power headroom (Figure 3).

FIGURE 3: Predictive power modeling tracks and monitors downstream and upstream current draw on each circuit to ensure they never exceed capacity.

Voltage, frequency, and waveform information from intelligent UPS and generators help ensure continuous, clean, uninterruptible, conditioned power to avoid harmful transients from reaching critical loads and prevent voltage fluctuations and harmonic distortions that could result in efficiency losses and damage or degrade or interrupt equipment. DCIM can help avoid downtime during outages by alerting data center operators when UPS battery capacity is low, battery maintenance is due, and when generator fuel levels are low.

With integrated security, predictive power modeling allows data center operators to ensure the proper permissions and user access at the cabinet level to avoid human error and physical security breaches that can reduce availability and uptime.

Optimizes Planning

Predictive power modeling provides visibility of where capacity is available at any given time and enables future analysis for capacity planning and optimizing existing power and cooling infrastructure and space. For example, a data center operator can leverage predictive power modeling to analyze various "what-if" scenarios, such as adding new servers to a rack. This type of modeling lets them effectively plan and budget for future upgrades, potentially preventing unnecessary additional cabinets or physical facility expansion.

CONSIDERATIONS FOR DEPLOYMENT

Before data centers can implement predictive power modeling that combines intelligent power devices and DCIM software into a single solution, they must have a vision of what they need to achieve and the type of information required. When selecting a DCIM platform and intelligent PDUs, RPPs, UPSs, and other devices and equipment, they should look for key features that allow easy, cost-effective deployment, integration, configuration, and manageability while ensuring maximum security.

The first step in selecting intelligent power devices is to determine the level of information granularity and capabilities required. Most monitored PDUs can report on cabinet-level power usage and branch circuit capacity. However, the PDU must provide outlet-level metering to identify specific high-power-consuming equipment. Additionally, only switched intelligent PDUs allow data center operators to power down outlets via the DCIM platform to prevent exceeding capacity. Ideally, any PDU within a predictive power modeling ecosystem should provide both outlet metering and switching.

If it is desirable to integrate cabinet security, the PDU must have an interface for connecting and powering cabinet locks. For environmental monitoring, PDUs need the capability to integrate with various sensor modules. For integration with other systems and the DCIM platform, all intelligent devices in the power chain should support common communications protocols, such as SNMP, command-line interface (CLI), and application programming interfaces (APIs), as well as MODBUS or BACnet for integrating with gray space equipment.

In a data center with hundreds or even thousands of cabinets, having every primary and secondary PDU with an individual IP address and connection to integrate with DCIM can be complex and expensive. In this scenario, one way to ease deployment and integration is to consolidate multiple PDUs under fewer IP addresses. When consolidating PDUs, it is essential to have failover capability and avoid a "daisy chain" deployment, where if one PDU loses connectivity, all downstream PDUs no longer communicate. One way to prevent this is to assign IP addresses to the first and last PDU in the chain. If a PDU loses connectivity, all PDUs upstream of the failure communicate through the first PDU, and all PDUs downstream of the failure communicate through the last PDU (Figure 4).

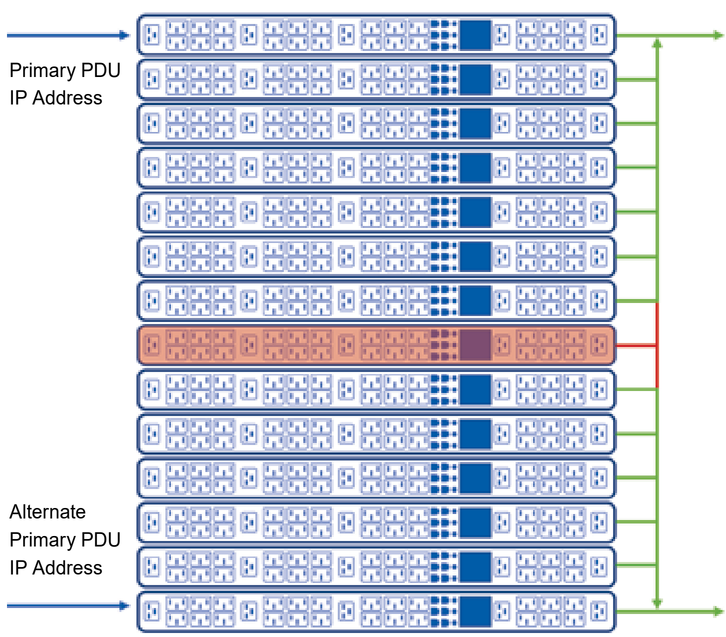

FIGURE 4: When consolidating PDUs, IP addresses should be assigned to the first and last PDU in the chain to ensure that if one PDU loses connectivity, all PDUs upstream and downstream of the failure can still communicate with the DCIM software.

From a DCIM perspective, the software should be easy to use and accessed and viewed via web browsers for remote access. Setting thresholds and alerts for all information should be intuitive and easy with configurable and customizable dashboards. The system should also provide accurate and complete real-time views of capacity, power consumption, environmental status, security events, and other parameters with easy-to-understand floor maps and the ability to drill down to individual rows, cabinets, and devices. DCIM solutions that incorporate 3D can enhance the visualization of information for a better understanding (Figure 5).

DCIM software should offer comprehensive reporting capabilities for calculations like PUE and CUE, access control attempts, and other information by location and timeframe to comply with corporate initiatives and regulations and collect energy rebates and carbon credits. Ideally, the DCIM software should also provide out-of-the-box analytics with key performance indicators, metrics, and "what-if" analyses to forecast and trend power and space capacity. The software should also be highly secure, supporting enterprise-level authentication with multiple permissions levels and all data communications between elements or externally secured with the latest encryption.

ENDLESS POSSIBILITIES

Predictive power modeling will evolve and mature as technology advances and data centers deploy innovative solutions to improve efficiency and availability. In the future, we will likely see predictive power modeling integrated with emerging technologies like liquid cooling technology to monitor information such as pump health and flow rates. Predictive power modeling even has the potential to integrate with onsite renewable energy systems for tracking power generation and onsite battery storage status or even to predict the impact of weather patterns.

A powerful DCIM solution with the ability to accept and analyze any data from any connected system has the potential to provide predictive modeling for all operations and assets across the data center—from power and cooling to security and connectivity. Solutions are available with the right level of intelligence, manageability, integration capability, and protection to comprise the cohesive, synergistic ecosystem needed to deploy a predictive power modeling system that allows data centers to optimize energy efficiency, availability, and planning.

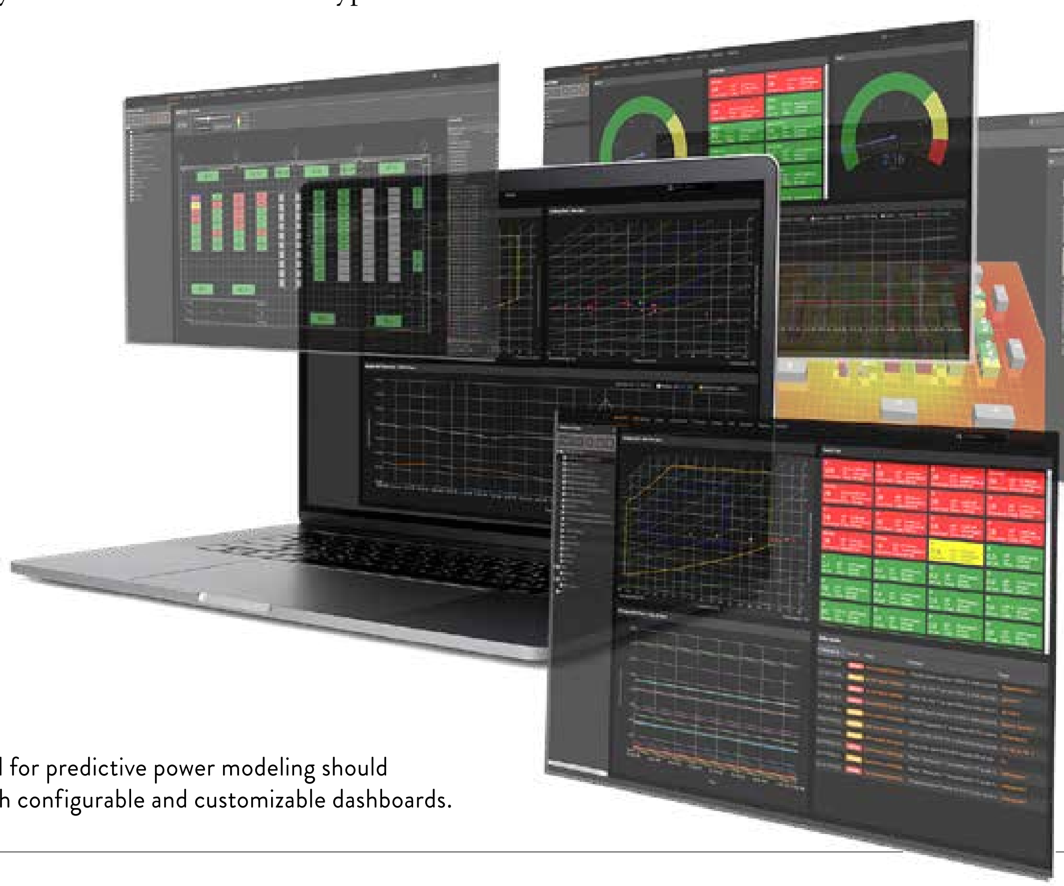

FIGURE 5: DCIM used for predictive power modeling should be intuitive and easy with configurable and customizable dashboards.

AUTHOR BIOGRAPHY:

Ashish Moondra more than 25 years of experience developing, managing, and selling rack power distribution, uninterruptible power supply (UPS), energy storage, and data center infrastructure management (DCIM) solutions. Ashish has previously worked with American Power Conversion, Emerson Network Power, and Active Power, and has been an expert speaker at various data center forums.

REFERENCES:

1. "Data Centers and Servers." *Office of Energy Efficiency & Renewable Energy*, U.S. Department of Energy, www.energy.gov/eere/buildings/data-centers-and-servers.

2. Caballar, Rina Diane. "Tougher Reporting Mandates Ahead for Data Centers." *Data Center Knowledge*, 10 February 2023, www.datacenterknowledge.com/regulation/tougher-reporting-mandates-ahead-data-centers#close-modal.

3. Garcia, Clarissa. "The Real Amount of Energy a Data Center Uses." *AKCP*, February 2022, www.akcp.com/blog/the-real-amount-of-energy-a-data-center-use.

4. "How Much Energy Do Data Centers Use?" *DataSpan*, 15 March 2023, https://dataspan.com/blog/how-much-energy-do-data-centers-use.