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WHITE PAPER

OpenData

Optimizing Facility Energy Utilization Using IoT Technology

Modius provides a better solution for maximizing the efficient use of power in your facility

EXECUTIVE SUMMARY

MODIUS' POWER CAPACITY MANAGEMENT MODULE (PCM) FOR OPENDATA "UNLOCKS" TRAPPED POWER CAUSED BY INACCURATE POWER CAPACITY PROVISIONING

Managing power in the data center has never been more important, or more complicated. Data center operators are constantly searching for ways to reduce costs and improve efficiency, while avoiding risk. The cost of power continues to be the focus, as managers look to reduce bottom line expenses, eliminate or optimize underutilized equipment, and extend the life of capital infrastructure. However, data center operators are equally challenged to maintain uptime, ensure business continuity, and expand capacity to accommodate further server growth.

Before the Internet of Things (IoT) became prevalent, data centers provisioned power capacity based on the power requirements published by the manufacturer of each piece of IT equipment. This method often led to gross over-provisioning of power infrastructure and artificial limits on the amount of equipment that could be supported. Using IoT technology to collect and measure actual power usage over time allows operators to fine tune power capacity provisioning to support more IT equipment (i.e. transactions per kW) and free up "trapped" power to avoid or delay a data center build-out costing millions of dollars.

Advanced power capacity management is the key to infrastructure optimization and agile support of business initiatives. Modius helps companies implement operational best practices, by offering a new approach to data center energy management based on the Internet of Things. By measuring more performance indicators, more frequently, in more places, and more easily, Modius gives large companies online visibility to energy consumption and capacity utilization across all their critical computing locations.

TABLE OF CONTENTS

POWER CHALLENGES IN THE DATA CENTER

U.S. data centers consumed about 70 billion kilowatt-hours of electricity in 2014, the most recent year examined, representing 2 percent of the country's total energy consumption, according to a study conducted by the US Department of Energy. While those number seem significantly high, improvements in server power management, virtualization and server performance have played an enormous role in taming the growth rate of the data center industry's energy consumption. Without these improvements, staying at the efficiency levels of 2010, data centers would have consumed close to 40 billion kWh more than they did in 2014 to do the same amount of work, according to the study. Energy efficiency improvements will have saved 620 billion kWh between 2010 and 2020, the study forecasts. The researchers expect total US data center energy consumption to grow by 4 percent between now and 2020.

While reducing energy costs and lowering PUE metrics continue to be important goals for data center operators, and organizations have done a good job slowing the growth of power consumption in the data center, there are still power challenges that need to be resolved.

OVER-PROVISIONING AND POWER CONSTRAINTS

Historically, the most important metric used to measure data center performance was uptime. It is no surprise that data centers were over-designed and over-built to ensure service interruptions based on insufficient power were all but eliminated. During the design phase, data center architects would plan out the number of racks and servers required. Based on power consumption estimates for the servers and supporting infrastructure, they would provide facilities with a "best guess" of the power needed to support the planned IT equipment. Because uptime was considered so important, facilities personnel often would order more power than needed "just to be safe." This power over-provisioning was an expensive decision based on the ripple effect on back-up power systems (i.e. generators, flywheels, UPS etc.) and power redundancy strategies. Having more power than needed isn't always a good thing.

On the flip-side, modern data centers are often power-constrained based on not having enough power capacity. The capital expense of building new data centers is staggering and organizations need to extend the life expectancy of these assets as long as possible. The power capacity assumptions when the data center was built are no longer valid because the power consumption for the servers and supporting infrastructure has increased substantially. In some cases, the data center is capped for power and unable to order more from the grid, and in others, upgrading the backup systems is cost-prohibitive. In either case, higher density servers consuming more power and requiring higher cooling levels are taking data centers rapidly from over-provisioned to under-provisioned.

So, how can a power-constrained (or over-provisioned) data center or facility optimize energy utilization? By using IoT technology to collect real-time and continuous data to support better decisions when calculating power capacity requirements, and by using a power management application to maintain a dynamic "map" of the critical power assets – from grid to IT load.

CURRENT POWER CAPACITY MANAGEMENT OPTIONS

There are a number of ways to determine the amount of power capacity required to safely operate the IT equipment and supporting infrastructure in the data center.

During the planning stages, the total square footage of the data center was defined and the number of racks supported by that square footage was calculated (based on rack size, aisle size, other supporting equipment, etc.)

Once the number of racks and the "U" capacity for the racks is defined, the number of servers per rack based on the server "U" size can be estimated. For example, a 48U rack could contain 24 2U Servers, if filled to capacity. If our sample data center was standardized on the 2U Dell R830 Rack Server, we would be able to calculate the maximum power consumption for the rack based on Dell's "plate value" for this server (i.e. 280W). The plate value for power consumption is the measurement the manufacturer provides for a fully loaded server running its CPU(s) at 100%. In other words, the worst-case scenario.

For power capacity planning purposes, a data center manager would not want to simply use plate value for power consumption calculations. This approach would grossly over-provision the power requirements, although it does represent a very conservative approach to ensuring available power in a worse-case scenario. A more common approach is to use de-rated, or Mean Adjusted Power Factor (MAPF), figures to get a better estimate of the real-world power consumption of the example Dell R830. The de-rated or MPAF power consumption numbers are still estimates, but provide a more realistic estimate than plate values.

A more accurate power consumption number is measured power. This involves bench measurements of the actual power consumption of the Dell R830, configured to purchase specifications, and running the business applications as intended. This measurement will provide the most accurate estimation of power consumption currently available, but still falls short of the accuracy of continuous real-time data collection based on IoT technology.

THE MODIUS APPROACH: IOT-BASED POWER CAPACITY MANAGEMENT (PCM)

By capturing data continuously and in real-time, Modius offers a breakthrough solution that allows data center operators to capture actual power data to achieve energy cost savings and maximize the efficient use of data center capacity in several important ways:

- First, energy costs can be dramatically reduced. OpenData enables optimization adjustments to key data center equipment – CRAC units, HVAC systems, chillers and generators – that can translate into substantial cost savings and rebates. For example, continuously capturing power data from servers can identify non-peak usage patterns that will allow data center personnel to turn down the AC and use less electricity to cool the room. These energy saving initatives are often supported by local utilities in the form of rebates that can be used to offset the cost of purchasing OpenData.

- Second, data center capacity that appears to be maximized is often simply poorly configured. OpenData provides critical information on how power is distributed throughout the data center, helping facilities professionals to reorganize equipment to harmonize the IT load. This prolongs the life of existing data centers and allows companies to defer or eliminate CapEx investments in new data center facilities.

- Third, the holistic view on data center power health and reliability that OpenData provides helps impart peace of mind that facilities management and IT executives alike can appreciate. Modius allows data center teams to take a proactive approach to managing power distribution in the data center by identifying conditions in real-time that have drifted from their original design, instead of perpetually reacting to emergency situations after they occur.

- Fourth, capturing power consumption data for individual assets over time provides data center management with exact measurements rather than estimates. The delta between these exact measurements and available capacity can be used to free up “trapped” power to support adding more equipment.

The real-time analysis provided by OpenData is essential in managing power capacity in today’s ever-changing data center environment. Simply put, Modius OpenData helps to reduce the cost and stress of managing the enterprise’s most volatile environments.

In general, Modius has built its approach to power capacity management from the ground up by creating a highly scalable architecture for real-time IoT data collection across all data center infrastructure. For power capacity management, Modius recommends that the data center operator starts collecting power infrastructure data (from the grid to the servers) continuously throughout the day (i.e. approximately once a minute), until a reliable baseline is established and then increase or decrease the granularity (i.e. frequency, device coverage, and comprehensiveness) over time as power usage patterns are determined.

This recommendation is based on the fact that a continuous sample rate is absolutely necessary to understand the important power fluctuations throughout the day, week or month. Even if only relatively few instrumentation points are being used to record power performance metrics, continuous collection allows more insightful correlation with other factors such as server loads and ambient air temperature. By capturing data continuously, operators increase their ability to make incremental adjustments to their infrastructure that drive increased utilization and improved efficiency.

Once continuous baseline data is established for power consumption on individual assets, power capacity thresholds can be set based on real data, not on theoretical models, or manufacturer’s plate values for normal operation. For example, the manufacturer provided plate value power consumption on the sample Dell R830 Server was 280W, and a derived de-rated value of 224W (at 80% of plate value) to calculate the power demand for the rack. After continuous power monitoring of the Dell R830, we were able to determine that this configuration never exceeded 176W over a 90-day period. That 48W difference was trapped power.

Assuming the total power utilization for the rack is 2.8kW based on ten Dell R830s per rack at plate value to be safe, we have been using 224W to calculate our remaining capacity, so the rack should have 560W remaining. If we use the real data for power consumption (176W x 10), our remaining capacity for this rack jumps to 1040W (2800W - 1760W). Even with a 90% power threshold limit for the rack (2.52kW), the remaining rack capacity would be 760W, or 200W more than before the adjustment, or the capacity to add 4 more Dell R380 servers rather than 3 more Dell R380 Servers. This additional server will improve one of the most significant data metrics for Digital Service Efficiency (DSE): transactions per kW.

Modius OpenData will continuously poll IT and power infrastructure to check for threshold violations, monitor KPIs, and intelligently alert data center personnel of any possible issues. Because OpenData is web-based, any user with access to an internet browser can receive the threshold violation and access the information in OpenData to fix the problem quickly.

PCM MODULE FEATURES AND FUNCTIONS

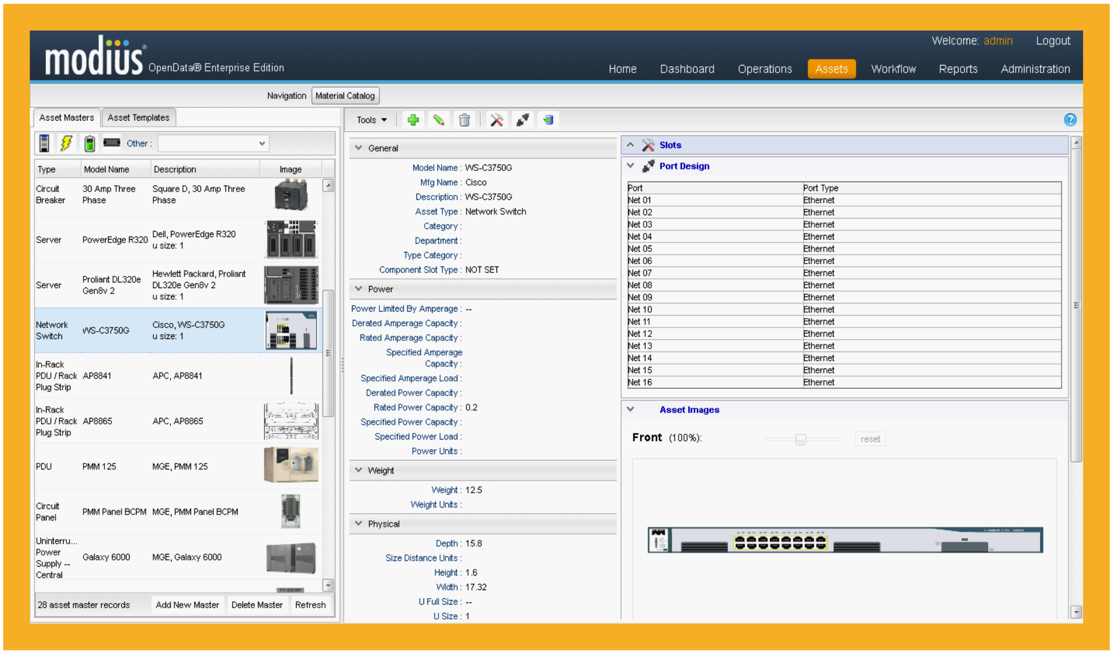
The OpenData Power Capacity Management Module from Modius provides the ability to create an exact representation of the power distribution infrastructure. This representation enables performance monitoring, fail-over and redundancy scenario testing, and power capacity planning to support IT operations in your data center.

BUILDING THE POWER CHAIN

The PCM Module leverages our Asset Management Materials Catalog to select the power infrastructure assets found in your data center. These asset master records make quick work of assembling an accurate model of your power chain.

The PCM Module supports multiple options for documenting the power connections between assets - from simple asset-to-asset connections to more detailed mapping of individual breakers and cable connections. Within PCM you can use the manufacturer’s specifications for power from our materials catalog (for both supply and demand), realtime measured power readings, or derived loads from downstream components - or any combination of these values - to create an accurate map of power flow at every node in the power chain. Some DCIM vendors only use plate or de-rated power values for these calculations because integrating these power devices consistently can be difficult but OpenData can collect real-time IoT data and trend it over time to build power profiles for individual power assets. These profiles provide the data needed to make the most accurate calculations for remaining power capacity.

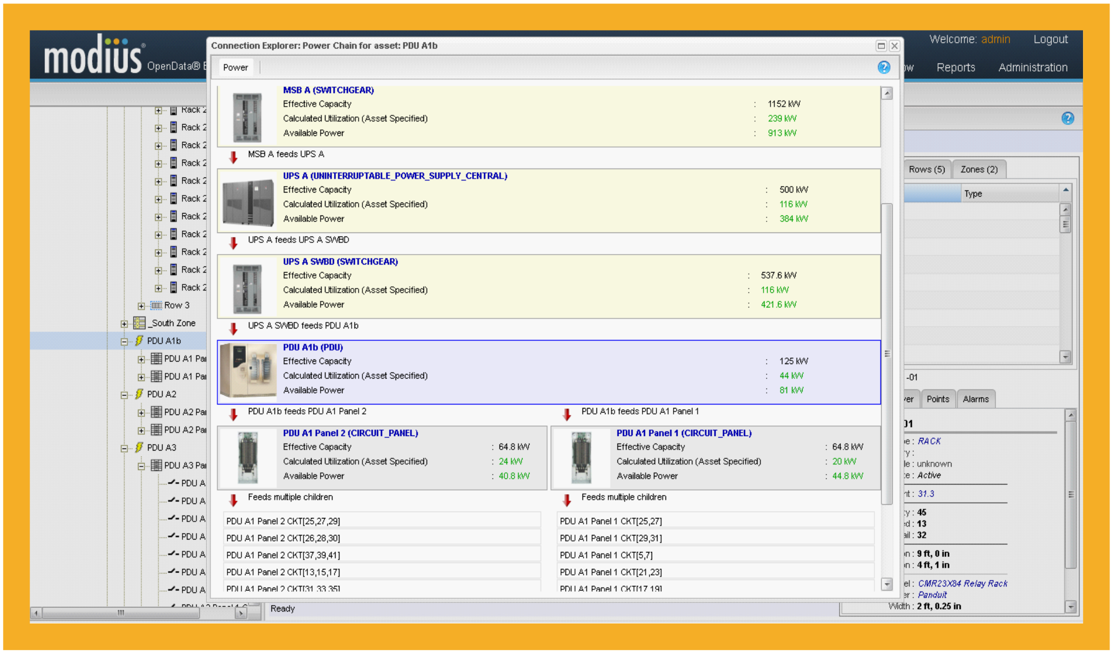
The following screenshot represents the selection of assets in OpenData from the Asset Management Materials Catalog to build out the power chain for a facility. In our example, when a power connection to this new network switch is made, the power load of the switch is subtracted from the remaining power capacity of the supporting power chain.



MANAGING THE POWER CHAIN

Once the Power Chain Map is complete, PCM supports the ability to select any asset in the chain and visually "walk" the chain from that position to verify the supporting infrastructure. This feature can be used in conjunction with the OpenData Monitoring Module to collect and analyze performance metrics to alert data center personnel to possible equipment problems. For example, if a circuit breaker in a panel had tripped, by using the PCM Module, we would know the exact location of the circuit breaker and could virtually walk down the power chain to identify all of the affected equipment on that circuit. This data can drastically improve Mean-time-to-Detect (MTTD) and Mean-time to Repair (MTTR) metrics for equipment failures, by dispatching the right personnel to the right place with the right equipment to fix the problem.

The following screenshot depicts the how the PCM module is used to visualize the power chain for a selected assets (PDUA1b).

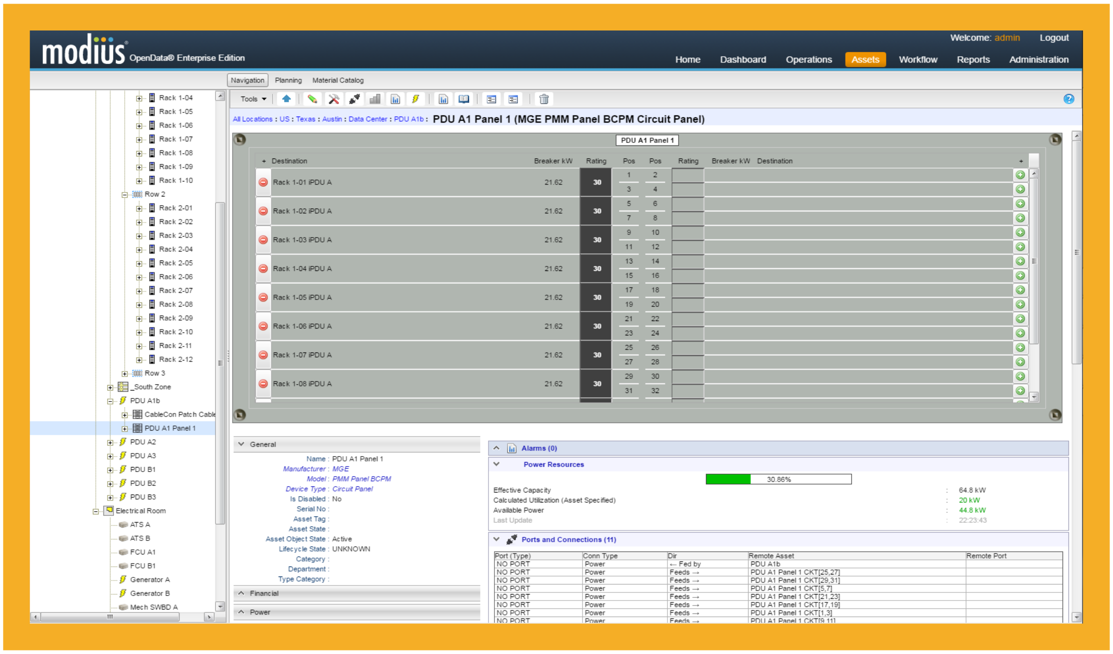


POWER PANEL MANAGEMENT

The PCM Module provides the ability to document the configuration of circuit breakers in a power panel. Panel Assets are selected from our Asset Management Materials Catalog or can be created from scratch. The operator can select attributes for how the cabinet is configured, (number of columns), orientation of the columns, (vertical or horizontal), and the number of poles supported in the panel.

Once the panel is defined, individual circuit breaker assets can be assigned to the pole positions and the power connections to the outbound assets are completed to form the power chain.

The following screen shot depicts a partially loaded power panel asset.



TESTING THE POWER CHAIN

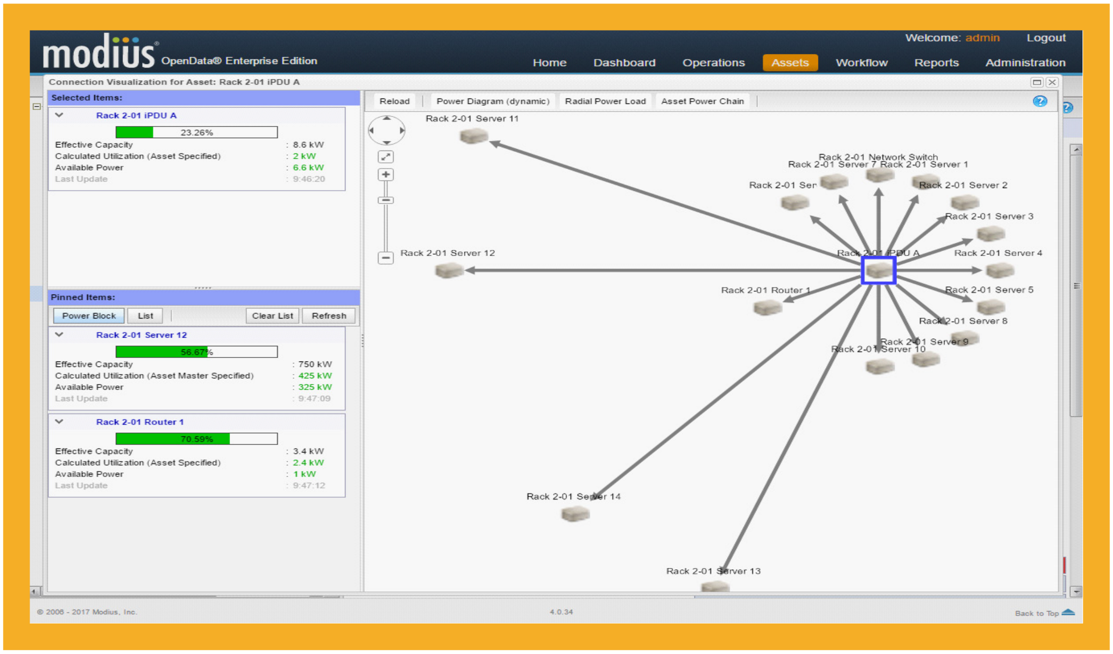
The PCM Module provides the ability to assess fail-over conditions at any node in the chain and test redundancy strategies to insure that all downstream assets have adequate power to continue operation in the case of a failure. To monitor the behavior of power path states or create simulations, the user can set output power states on devices to mimic real-world conditions such as maintenance and equipment failures. Output connection states can be On, Off, Failed (Tripped) and devices with multiple output connections can be inter-locked, (one is On and the other is Off). The PCM Module supports these simulations with interactive power chain diagrams that provide the following test scenarios:

- **Load balancing analysis** - Instantly visualize power load imbalances for electrical panels and rack PDUs.

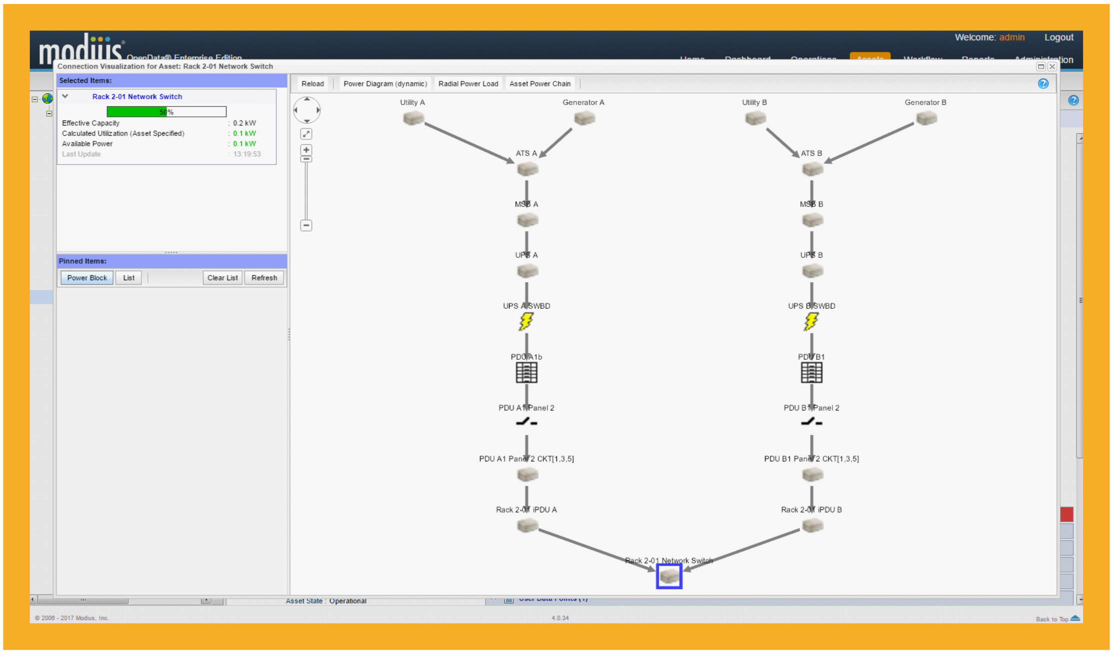
- **Circuit redundancy definitions** - Allows the user to define the correct mapping for power flow in architectures with redundant power paths.

- **Redundancy and load testing** - Interactively test the effect of adding or subtracting equipment load or simulating equipment failures.

The following screenshot depicts a radial power diagram for visualizing the power load between devices on the chain. The four devices on the left with the longer connectors are consuming more power than the devices with the shorter connectors.



The following screenshot depicts a linear power diagram for visualizing and testing redundant power paths for a target device. The application allows the operator to simulate a failure at any point in the chain and observe the effect on the capacity of the redundant circuit.



PROVISIONED CIRCUITS

The PCM Module provides the ability to assign circuits to customers, departments, or individual users so energy usage data can be collected and used for charge-back reporting and SLA compliance.

ASSET MANAGEMENT SUPPORT

When used in conjunction with the OpenData Asset Management Module, PCM provides instant access to power capacity data for supporting Moves, Adds, and Changes (MAC) initiatives in the data center. For example, when planning a server move, the PCM module provides the current available power capacity for the target rack; and will warn the operator if the placement of this server will exceed the power usage threshold, or if there are enough power connections to physically connect this server to the rack PDUs.

WHY ORGANIZATIONS NEED PCM

Power Capacity Management is an essential component of the efficient planning and operation of the data center. The need for PCM is directly correlated with the density, size and complexity of the data center being managed. Having accurate data on both potential and actual supply and demand for power provides the best opportunity for maximizing the efficient use of this valuable resource. Here are the top 5 reasons all organizations can benefit from using PCM.

1: Delay or avoid data center expansion - with PCM, you can get accurate and reliable data for your current power usage and use this data to identify trapped or stranded capacity that can be reclaimed to power additional equipment. In addition, PCM can be used to analyze replacement of older, less-efficient equipment with newer models to assess the impact on power capacity. It is estimated that the typical data center today could hold up to 30% more IT equipment using the same facility power capacity if the capacity was properly managed.

2: Improve MTTD and MTTR metrics for power related problems - PCM uses IoT and other protocols (SNMP, MODBus, BACNet, Wireless HART, etc.) to collect real-time power usage and monitor the performance and health of power infrastructure. This data can be used to recognize abnormal conditions and alert support personnel to issues before they become points of failure. PCM's real-time monitoring capability improves MTTD and MTTR metrics by providing multiple levels of escalation and instant identification and location of equipment experiencing operational issues.

3: Avoid unscheduled downtime - A very high percentage of data center downtime can be directly associated to human error during equipment moves, adds and changes. In many cases, overloaded circuits or inadequate testing of redundant power paths can cause tripped circuit breakers during server installations.

PCM provides a very accurate model of the data center's power infrastructure, so equipment loads can be modeled prior to installation to ensure that adequate redundant power capacity exists. When used in conjunction with the OpenData Asset Management Module, PCM will warn the operator that power thresholds are being violated during the process of moving, adding or changing equipment.

4: Reduce power expense - cooling the data center is one of the largest expenses and if done poorly can exceed the power expense associated with running the IT equipment. Better understanding of the relationship between the power consumed by IT equipment in the rack and the cooling requirements for this equipment can help data center operators reduce the power expense associated with data center cooling.

PCM will collect power metrics for all equipment in the power chain, including the servers in the rack. Increases in server power draw can be correlated with environmental data (server inlet/outlet data, HVAC return air temperature, floor tile vent temperature, etc.) to dynamically adjust CRAC units to provide “just-in-time” cooling to match ASHRAE thermal guidelines for data center equipment. This dynamic cooling approach based on actual equipment loads will reduce power costs associated with cooling the data center.

5: Recover power costs - PCM can help data centers shift from a cost center to a profit center by collecting power related data for supporting the IT equipment of departments or individuals. Because PCM supports circuit provisioning, the power metrics for servers or racks can be assigned to a group and bill-back reports or SLA compliance reporting can be instantly generated for any date range.

PCM can be very beneficial for colocation service providers who want the ability to collect detailed data on the power consumption for individual equipment to support flexible billing options for their customers. Using measured power and custom configurations based on total required U-space and network connections, a colocation provider can offer significantly lower prices while still maintaining healthy profit margins.

SUMMARY OF MODIUS’ RECOMMENDATIONS

Modius offers three guidelines for implementing Power Capacity Management for a Data Center:

1: SOME PCM IS BETTER THAN NO PCM

Modius recommends that data center operators use real-time data collection for power infrastructure, but even using manufacturing specifications for structured power capacity calculations is better than unstructured estimates.

Modius solution: PCM provides the ability to build a software representation of your power infrastructure based on a library of devices from multiple manufacturers. After your power infrastructure model is built, it will accurately calculate remaining power capacity based on manufacturer’s specifications for power usage. Better than most, this level of power capacity management won’t provide enough information to unlock all the trapped power capacity in your data center.

2: BETTER PCM IS IN THE DATA

Collecting real-time data for power equipment over time provides the most accurate information for managing power capacity in your data center. The more accurate the data, the closer you can safely run your data center without fear of power related outages.

Modius solution: PCM actively polls each device multiple times a minute to collect the most up-to-date performance information. The solution then records the data in a centralized database for easy trending and analysis over time.

3: REAL-TIME BENEFITS OF PCM

Finally, and most importantly, Modius believes that operators that implement PCM with real-time continuous data feeds will experience higher levels of efficiency for power infrastructure management.

Modius solution: When a power device is set up for data collection, metrics associated with its health and performance are also collected. This data can be used for alarms and alert monitoring to improve MTTD and MTTR metrics.

ABOUT MODIUS

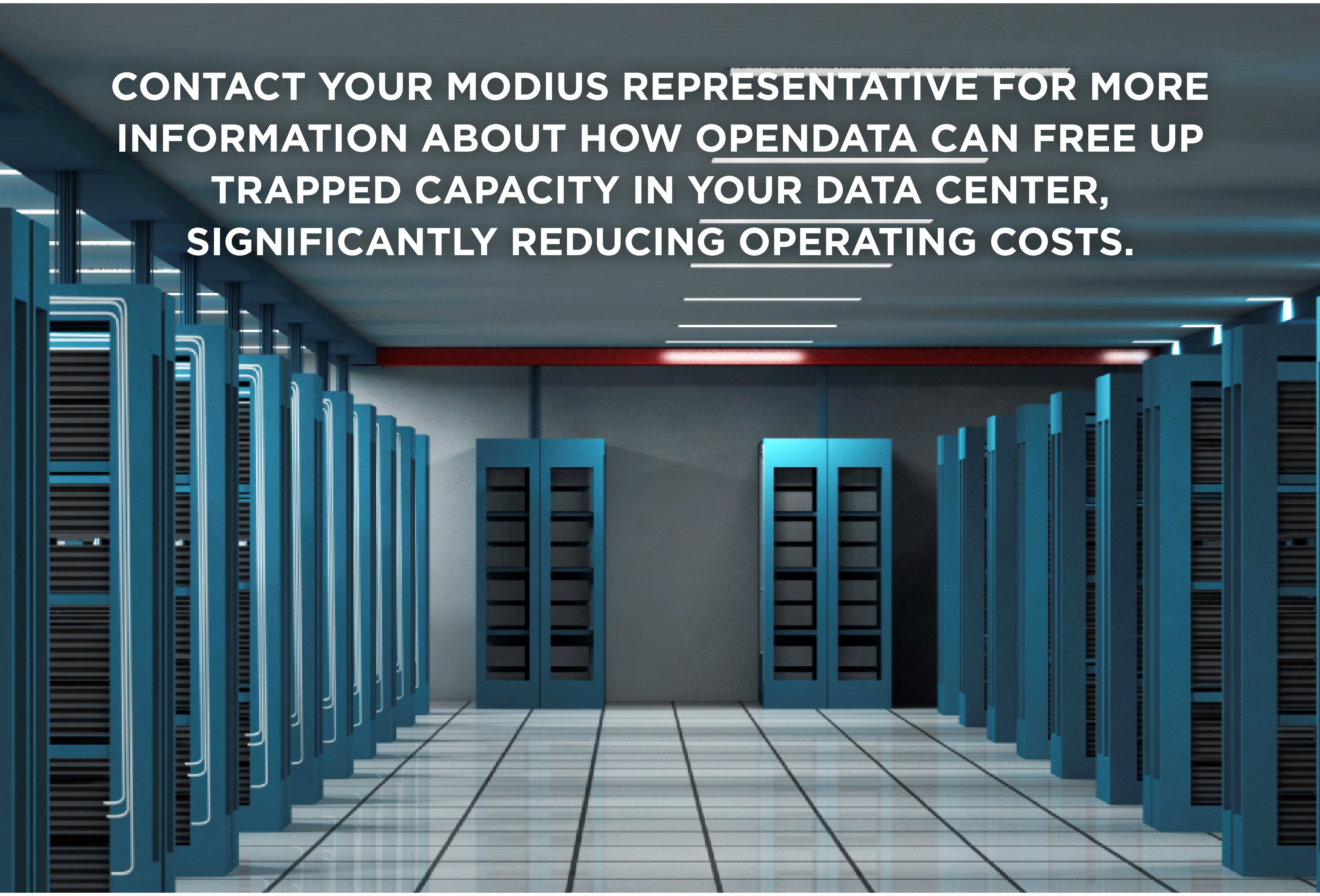
Modius is an independent software vendor based in San Francisco, California. Founded in 2004, Modius develops intelligent measurement systems for mission critical facilities that improve business continuity, energy performance, and carbon management. Modius solves the challenge of integrating both IT and facilities management information into a single, comprehensive measurement system. Modius empowers 'smart' data center management through:

1: Widespread, practical, low-cost collection of all physical-layer performance data

2: Trustworthy and reliable analysis tools based on comprehensive data and rich analytic capabilities

3: Useful and actionable intelligence through highly-configurable business logic

4: Customized workflows, **delivering the right intelligence to the right people at the right time**.



CONTACT YOUR MODIUS REPRESENTATIVE FOR MORE INFORMATION ABOUT HOW OPENDATA CAN FREE UP TRAPPED CAPACITY IN YOUR DATA CENTER, SIGNIFICANTLY REDUCING OPERATING COSTS.

TECHNICAL SPECIFICATIONS

Modius OpenData is a software application that can be installed on-premise or hosted in the cloud. Some customers choose to run the application within VMWare ESX. Software platform requirements are as follows:

- **Windows Server** - 2008, 2008 R2, 2012

- **Database** - Express, Workgroup (Up to 2012) and MS SQL Server 2008 - 2016

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