October 2013

A Zone Approach for Energy and Physical Infrastructure Management

Introduction: The Importance of a Zone Approach

As data centers continue to grow in scale, density and complexity, many data center professionals struggle to understand how to effectively manage their energy expenses and evolve their physical infrastructure. Within budget and corporate requirements for lower operational expenses (OpEx) and total cost of ownership (TCO), the list of critical operational management challenges facing data center and facilities professionals is considerable:

- Ensuring resilience and uptime
- Optimizing capacity and tracking IT assets
- Balancing increasing power requirements with rising energy costs
- Maintaining compliance with tougher environmental regulations
- Improving Power Usage Effectiveness (PUE)

Unfortunately, a lack of relevant and accurate information and performance metrics on cooling and power capacity, energy performance, and asset tracking (underutilized, lost, or obsolete assets) has proven to be an additional challenge, making the interdepartmental team decision making needed to effectively manage these challenges seemingly impossible.

Fragmentation within the data center is another cause for concern. Data centers are designed with the intent of providing long-term efficiency and sustained growth. However, as moves, adds, and changes (MACs) happen over time, data centers become increasingly less optimized due to the impact of power consumption, heat dissipation and network connectivity changes. The imbalance created by moving or introducing new equipment can seriously compromise the data center's overall resilience and in turn, its stability and uptime.

Each unmanaged obstacle can cause another set of inefficiencies that moves optimal capacity usage goals further from your reach (see Figure 1). Eventually, this can lead to lost capacity in the data center, and the requirement for you to invest considerable amounts of capital in retrofits or the construction of a new data center.

Figure 1. A fragmented data center results in inefficiencies that can lead to ineffective IT operations.

To overcome these risks, organizations need to monitor and manage data center energy and the physical infrastructure by adopting an integrated zone-by-zone approach, in combination with data center infrastructure management (DCIM) intelligent software, hardware and services. The result is accurate and timely management information that enables IT and facility managers to develop cohesive strategies that realize sustainable energy, operational and capacity efficiencies.

This white paper focuses on the interdependencies between distinct operational "zones" within facilities, data centers and enterprise operations using DCIM solutions. It also identifies how the 6 Zone™ methodology, a new concept introduced to the marketplace by Panduit, allows you to gain a holistic view of energy, environmental parameters, assets, and connectivity with its SmartZone™ Solutions to optimize operational efficiencies and performance.
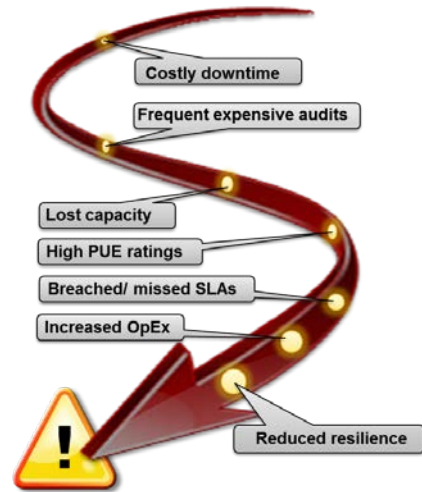
Defining the Zone Approach

The zone approach is a logical step-by-step process that provides a detailed and granular understanding of the energy flow within the entire facility. Using DCIM solutions, such as power and environmental monitoring equipment, intelligent patch panels, and software reporting, IT and facility managers can monitor, measure, and document data to get a true understanding of energy use against specific payloads and supporting services.

This approach allows for assessment, discovery and understanding of power and energy consumption, cooling and thermal factors, and asset and connectivity tracking through a facility from the building's point-of-entry, through distribution systems, to individual devices or assets within racks and cabinets. The result is information that is consolidated, accurate, and provides the granular visibility required to clearly identify and address major challenges, such as achieving performance optimization, while facing rising energy costs and capacity constraints.
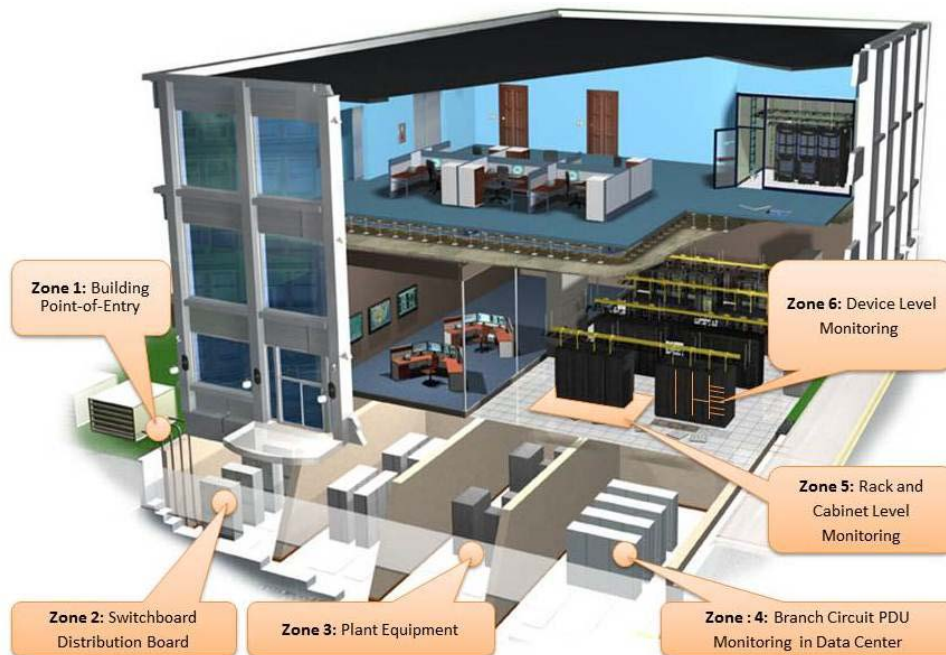

Figure 2. The six areas associated with the Zone Approach.

As shown in Figure 2, a zone approach typically includes the following distinct areas to be monitored via intelligent instrumentation to gather comprehensive performance data:

- Zone 1 - Building point-of-entry
- Zone 2 - Main switchboard distribution circuits
- Zone 3 - Plant equipment
- Zone 4 - Branch circuits in the data center
- Zone 5 - Rack and cabinets in a data center
- Zone 6 - Individual devices or assets within rack or cabinets

Addressing Your Data Center Challenges

With an unprecedented growth in high density IT loads to support technologies such as data analytics and virtual desktop infrastructure (VDI), the demand for power, cooling, and capacity is stretching many facilities and data centers to their operational limits.

The zone approach provides the ability to spot trends and highlight events occurring within the infrastructure, helping both IT and facility managers to jointly understand how and where a building's power is actually being consumed and how much available capacity remains; or to gain insight into other critical performance resilience issues.

The structured zone approach also provides visibility and granular-level detail to assist with addressing the pitfalls that arise as a result of poor operational visibility, which helps IT facilities and data center managers tackle the challenges they face on a daily basis.

Increase Resiliency and Business Continuity

Uptime is one the biggest challenges for the data center, overall facilities and enterprise operations. Power and capacity needs continue to increase, and the ability to support this demand puts a strain on all facility systems - from utility metering and facility equipment, to individual data center cabinets and devices. This creates potential risk for failures that could affect business continuity and/or service level agreements (SLAs).

While risk is inherent in all systems, it is magnified by poor visibility of operational performance. One system failure at any stage of operation could affect the dependability of other systems within a facility or data center. Whether the source of this failure begins in the cooling stage of plant equipment, or is caused by an overloaded outlet in a data center cabinet, or phase imbalance issues, the end result is risk to business performance.

SmartZone™ Solutions deliver invaluable insight into critical management parameters around energy consumption, environmental conditions, and connectivity status, helping to identify potential service-impacting problems and ensure that all systems are operating at optimal levels.

Optimize Physical Capacity and IT Assets

The demand for data and the need for greater capacity (i.e. more space, more power, more cooling, etc.) continue to grow. Some facility managers and data center operators make the choice to continue building out additional square footage on an existing facility, or to build a new data center. These decisions may have costly consequences. Oversized data centers result in the creation of wasted space, inefficient cooling, higher PUE and underutilized or lost IT assets - all of which strain supporting facility systems.

When combined with comprehensive DCIM solutions and services, the zone approach allows IT and facility managers to jointly and fully assess power, cooling, and space capacity utilization and thresholds in each zone. This helps to identify available or stranded capacity that can be capitalized on to install additional equipment, decommission inefficient devices, and retrofit or consolidate existing equipment at no additional cost or risk.

This visibility into the infrastructure delivers the knowledge necessary to take actionable steps to extend the life of a data center or facility systems and possibly avoid the cost of new builds. It also establishes the supporting foundation for optimal operational efficiencies in new data centers and facilities.

SmartZone™ Solutions enable highly effective capacity management by providing visibility of all IT assets, their locations, and their attributes to maximize current utilization while supporting views into present and future capacity allocations, and providing estimations on remaining capacity. Through analytics, consolidated and automated documentation, IT and facility managers are empowered to reclaim lost or stranded capacity, repurpose existing space, and/or deploy assets more effectively with "best-fit" capabilities that locate optimal space for new device installation requirements.

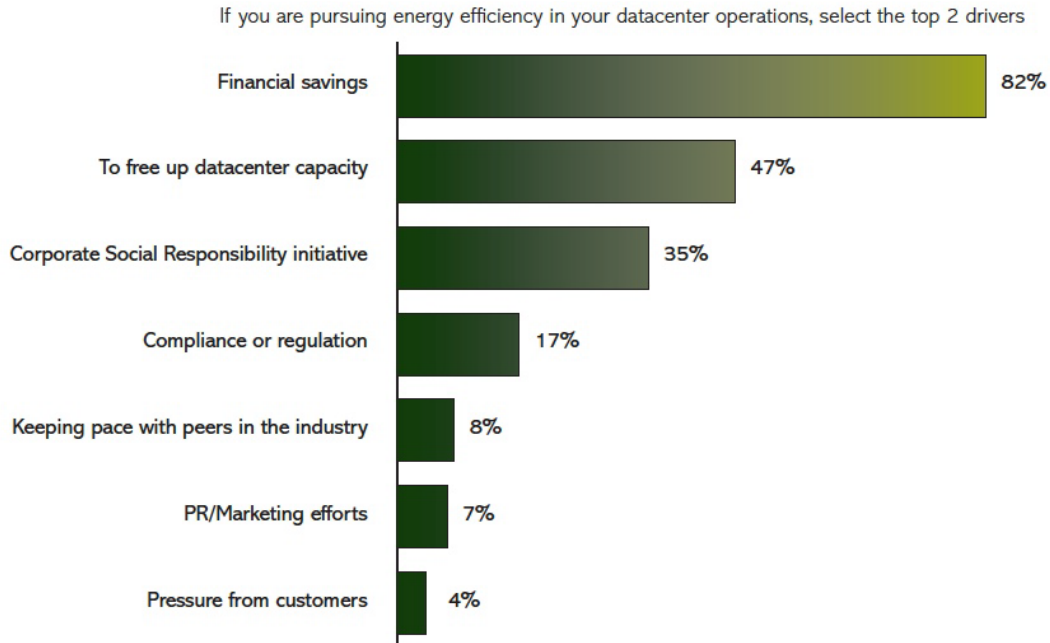## Balance Increasing Power Requirements with Rising Costs

The exploding demand for data is pushing the consumption of power upwards, increasing operational costs, and putting serious strains on the budgets of IT and facility managers. According to the U.S. Environmental Protection Agency (EPA), data center space accounts for as much as 20 times more energy consumption per square foot than a typical office building. However, to effectively control energy costs and balance them with rising demand, inefficiencies need to be identified and acted upon throughout all areas of a facility.

By integrating DCIM solutions in each zone of a facility, IT and facilities managers can broadly explore all areas, removing traditionally "siloed" areas labeled as either an IT or facilities domain. By monitoring and assessing each zone through a DCIM dashboard, there is an opportunity to identify stranded power and cooling inefficiencies, helping to avoid additional equipment purchases and unnecessary energy usage. Also, monitoring at a granular level identifies specific supporting services or assets that demonstrate operational inefficiencies that could be resolved, consolidated, or decommissioned to reduce costs.

With significant costs originating from data center cooling, there may be opportunities to operate data centers and other facility zones at higher temperatures to bring down escalating cooling costs. In doing so, however, it is critical to manage this process with visibility of the temperature thresholds of sensitive systems and equipment to identify any potential operational concerns before they occur and ensure resilience during any optimization process. The 6 Zone™ methodology helps to monitor and assess these systems in real-time to ensure their stability and identify service impacting issues.

Examining power consumption across different zones of a multi-purpose facility provides a detailed view of the energy flow within the data center, which allows IT and facility managers to more easily identify areas of power consumption outside of the data center that may be consuming power inefficiently. For example, the discovery of large power consumption from an area that houses the work space highlights an opportunity to add automated circuits to turn off lighting and save energy outside working hours.

Regardless of the method taken, the key to balancing increasing power demands with costs is to become much more energy efficient in all facets of building operations, from the plant to the office space, to the data center (See Figure 3). This requires visibility of how, where, and when power consumption is occurring and delivers the knowledge necessary to take measured steps towards reducing operational efficiencies, and limiting growing expenses.

If you are pursuing energy efficiency in your datacenter operations, select the top 2 drivers

Driver	Percentage
Financial savings	82%
To free up datacenter capacity	47%
Corporate Social Responsibility initiative	35%
Compliance or regulation	17%
Keeping pace with peers in the industry	8%
PR/Marketing efforts	7%
Pressure from customers	4%

Source: Uptime Institute 2012 Data Center Industry Survey

Figure 3: Energy-efficiency drivers for data center operations.

SmartZone™ Solutions deliver visibility into the energy consumption and environmental conditions from each monitored zone. This visibility allows you to identify opportunities for greater operational efficiencies, resulting in a reduction of costs, or maximization of current power allocation levels.

Comply with Tougher Environmental Regulations

The ability to deliver increased compute and storage for growing virtualization and cloud computing business initiatives is often threatened by an inadequate power and cooling infrastructure, ultimately putting resilience and business continuity at risk. Further complicating facilities and data center management's ability to deliver on these initiatives is the growing movement of government regulations regarding an organization's energy usage and related carbon footprints.

Governments are campaigning and mandating that enterprises and their data centers become more energy efficient. The U.S. Department of Energy estimates that data centers consume up to 100 times more energy than a standard office building and often less than 15% of original source energy is used for the information technology equipment within a data center. As a result, data center energy consumption is becoming a major government regulatory focus with energy reduction and greenhouse gas emissions reduction targets, commitments to disclose emissions, and goals for performance improvements.

Europe leads the emergence of new energy and carbon reduction initiatives and technologies to continuously lower energy consumption. However, the regulatory issues are global and include current and forthcoming legislation, many of which will demand energy monitoring and management initiatives to lower power consumption with carbon reduction initiatives, and requirements that reductions must be proven through energy management reporting. For example, the UK government established an Enhanced Capital Allowance (ECA) scheme to help businesses reduce carbon emissions by encouraging the purchase of approved energy saving equipment specified on the Energy Technology List (ETL).

As governments and corporations intensify their focus on reducing energy demands and carbon dioxide emissions, the challenge for both IT and facility managers is to demonstrate through energy management reporting that energy reduction initiatives are meeting these regulations.

One solution for legacy data centers and enterprise facilities is to perform a comprehensive energy audit to assess the current energy footprint of the existing data center or facility and to discover potential opportunities for monitoring and energy reduction. This can include an inventory of current monitored and unmonitored systems, baseline power usage, and cooling plant inefficiencies. Performing this audit can also encourage you to consider any established goals for reducing the company's energy use and associated carbon footprint.

To build a business case, the audit provides recommendations, savings calculations, risk assessments and suggested deployment initiatives on power and cooling efficiency improvement programs to justify an energy management program.

Delivering a consolidated view of the data center and/or facility provides the knowledge and necessary data to prove the impact of energy reduction initiatives in easy to understand, customized reports that can be used as part of regulatory filings or social responsibility programs.

SmartZone™ Solutions collect and analyze comprehensive data on energy usage, environmental conditions and ambient temperatures to assist energy efficiency audits, savings calculations, risk assessments and deployment initiatives on power and cooling efficiency improvement programs. Automated reporting and documentation can also demonstrate the performance of efficiency programs, and support regulatory filings. SmartZone™ Services provide energy efficiency resources including audits, evaluations, power and cooling assessments, implementation, and custom reporting.

Improve Power Usage Effectiveness (PUE)

In an effort to enable data center operators to estimate the energy efficiency of their data centers, compare the results against other data centers, and determine if any energy efficiency improvements need to be made, an association of IT professionals, the Green Grid, proposed the use of two metrics - Power Usage Effectiveness (PUE) and its reciprocal, Data Center Infrastructure Efficiency (DCIE) metrics.

PUE is a measure of how efficiently a data center uses its power, or more specifically, how much of the power supplied to the data center is actually used by the computing equipment to perform business (in contrast to cooling and other overheads). It is the ratio of total amount of power used by a facility or building, to the power delivered to IT equipment, and is calculated as such:

$$\text{PUE} = \frac{\text{Total facility power}}{\text{IT equipment power}}$$

A perfect (no supporting services needed) PUE is 1.0. Any equipment that is not considered a computing device in a data center (e.g. lighting, cooling, etc.) falls into the category of facility power usage.

Providing merely a PUE value against the above calculation will produce a number only. It does not show you how or where to improve efficiencies. Care must be taken when calculating PUE because it can be open to misinterpretation. In addition, PUE values should not be used to compare one data center with another due to climate conditions, size, design, and purpose. Ideally, PUE should be tracked over time and used as a gauge to validate if operational changes have improved efficiency for a single data center.

As IT and facility managers seek ways to improve their PUE, understanding the actual efficiencies and performance of their infrastructure becomes critical. The zone monitoring process provides detailed information on the energy flow from the point-of-entry into the facility or data center, down to individual servers, identifying inefficiencies and optimization opportunities.

This insight provides the knowledge necessary to take steps towards refinement of energy and thermal operations and development of management strategies to improve overall PUE. Those steps might include keeping hot and cold air separate utilizing hot aisle containment, increasing data center temperatures while monitoring hot spots through measuring the temperature, or giving chillers a rest by leveraging cooling towers, fresh air, etc. to avoid turning on the air conditioning. SmartZone™ Services provide a number of energy efficiency audit, evaluations, and assessments to improve PUE.

SmartZone™ PUE Calculations

Consider a facility consuming 500kW for IT equipment, another 350kW for cooling and 150kW for power distribution, UPS loads, etc. The sum of the entire load is 500kW + 350kW + 150kW or 1000kW. The PUE in this scenario would be 2.0 because the ratio of the entire load (1000kW) to the IT load (500kW) is 2. At $0.10/kWh, a 31 day monthly bill would be $74,400 and the annual power bill would be $876,000.

Interpreting the data derived from SmartZone™ Solutions real-time monitoring and taking the necessary remedial action, a reduction to a PUE of 1.8 (as a goal to reduce power consumption by 20%[1]) should be achievable. This would result in savings of $175,200 per year.

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[1] Typically, the 20% reduction in costs for supporting services will come from cooling (70%), UPS losses (27%) and lighting (2-3%).

SmartZone™ Solutions not only support operational PUE calculations, but also help meet the requirements for PUE Categories 2 and 3, which stipulate and differentiate between additional methods for more accurately calculating PUE ratings. Using SmartZone™ Solutions, data is captured from intelligent power strips at the cabinet level to accurately measure cumulative IT energy loads over 12 month periods from the power inputs of each IT device (allowing calculation of PUE Category 3, the most advanced and accurate variation of the PUE metric). Together with sub metering and shared load allocation data, a granular level of data is converted into energy metrics for pinpointing exactly where and how energy is being consumed.

Zone-By-Zone Optimization

Each zone maintains unique systems or functions that hold the key to helping IT and facilities managers overcome today's operational challenges. This section discusses the various zones that are part of the monitoring and management model as well as the unique properties, data available and key stakeholders involved with each zone.

Fiscal/Utility Meters

This zone captures all utilities data (power, oil, water, gas) via central monitoring at the point of building entry in either single or multiple sites. The purpose is to enable a high level overview of total facility energy consumption and power draw which can be used to facilitate billing reconciliation, variance analysis and predictive forecasting, and yield useful information about emissions performance, including CO_2 tonnage, for compliance with regulatory reporting requirements.

Trend and spot data for all incoming energy types is available and collected in a number of ways depending upon the existing meters and their features (e.g., smart meters, pulsed outputs etc.). Typically these will be non-invasive solutions and the reporting will allow comparative analysis and change analysis across multiple timeframes (e.g., day, week, month, quarter and year).

Finance directors, head of facilities or energy managers are key stakeholders of this information because it provides a detailed breakdown of actual utility usage and allows for accurate calculation of costs based on the utility suppliers' charged utility rates.

Main Switchboard Distribution Circuits

This zone monitors the power distribution circuits on the main switchboard to capture the total power consumption of all supporting data center related plant equipment, including Uninterruptible Power Supplies (UPS), Computer Room Air Conditioner (CRAC), chillers, Air Handling Units (AHU) and lighting circuits.

Intelligent instrumentation can collect trend and spot data for all outgoing circuits to enable detailed reporting on capacitive and change analysis across multiple

timeframes whether daily, weekly, monthly, quarterly or annually, providing a granular analysis of historic and actual consumption of individual circuits. Data would also be provided on the status of the back-up generators including availability, capacity and fuel levels.

Facilities and energy management teams are key stakeholders of this information because it provides a breakdown of the entire power infrastructure. Overlaying all of this information into consolidated reports provides holistic views and accurate information to assist with ongoing initiatives to continuously improve Power Usage Effectiveness/Data Center Infrastructure Efficiency (PUE/DCIE).

Plant Equipment

Using data collected from the plant's own external monitoring system, typically Modbus or Simple Network Management Protocol (SNMP) technologies, or through a Building Management System (BMS), this area allows facilities and energy professionals to accurately monitor the efficiency of the plant hardware. By drilling down to view and analyze individual equipment they will be able to report on a range of parameters including set points, run time, pressure, feed and return temperatures, power draw and capacity.

Branch Circuit PDU Monitoring in the Data Center

Monitoring total rack/cabinet IT loads in this zone is performed by polling real-time data from the Power Distribution Unit (PDU) branch circuits. While it is possible to attribute actual power consumption of specific racks at this level, more granular and actionable information is provided by monitoring the individual cabinets or racks in the rack and cabinet level monitoring zone. If environmental metrics on racks are required, custom data 'containers' can be created which attribute these readings to individual racks located in the Racks and Cabinet Level Monitoring zone. Monitoring also ensures more reliable circuit protection by proactively highlighting/alerting on any faulty, over-rated or tripped circuits.

Monitoring this zone provides IT and energy managers with the breakdown of the power infrastructure, feeding the cabinets and free standing equipment within the data center. Trend and spot data for phase balancing and power draw by circuit is collected via a Modbus or SNMP. As in the previous zones, granular reporting enables detailed capacitive and change analysis across multiple timeframes.

Rack and Cabinet Level Monitoring

Rack power monitoring in this zone, including free-standing IT equipment using intelligent PDUs, sensors and security access control, provides granular reporting, auditing and trend analysis. This information greatly assists in measuring and controlling power usage and infrastructure efficiency (e.g. capacity, power, environmental and connectivity status) throughout the data center, allowing for more informed decision making regarding cooling and power capacity planning. A broad range of metrics is included from power usage, humidity, temperature and airflow, to leak detection, security, and rack-level assets.

The IT cabinets offer the potential for supplying detailed information to IT and facility managers about power, environmental and physical security. Intelligent power strips collect true Root Mean Square (RMS) volts, amps, kW. kVA, kWh, Power Factor (PF) and Frequency (Hz) to deliver trend and spot data for all cabinets at either a cabinet or individual power strip level. Capacity reports offer the opportunity to identify power, temperature and space capacity on a cabinet, aisle containment, row, or room basis.

Device Level Monitoring

Device level monitoring and reporting on individual IT assets within the cabinet is performed using intelligent per outlet control PDUs. Extensive "drill-down" reporting on asset and characteristics is provided, including network connectivity and power/energy consumption by location/department/customer and the server hardware/manufacturer. This enables detailed information on cost/total cost of ownership (TCO) per asset as well as highly accurate billing data on a per outlet basis. Automated connectivity patch field management also streamlines remote site network management by facilitating guided moves, adds, and changes without a trained operator.

Monitoring this zone allows IT managers to understand and manage the availability and performance of individual IT assets and devices. Monitoring the power draw of all active equipment at a socket level provides trend and spot data to enable IT management to calculate TCO as well as compare the performance of different manufacturers on an energy cost and performance basis.

Bridging the Gap Between IT and Facilities

Building on accepted DCIM best practices and following a unique, process driven method, the zone approach bridges the traditional IT and facilities management disciplines by providing centralized visibility of energy, cooling, capacity and assets via networked DCIM instrumentation and "single pane of glass" views, from building point-of-entry to individual pieces of supporting plant and IT equipment.

A "single pane of glass" view requires a highly flexible and functional software platform linked to intelligent sensors, power strips, gateways, and networked monitoring devices. These must be capable of providing all

stakeholders with holistic real-time views across all zones being monitored to produce granular reporting on the required parameters including those for measuring power, energy, cooling, assets, connectivity and capacity.

The zone approach provides an opportunity for IT and facility managers to assess, discover and articulate all existing and potential power/energy, capacity, cooling, and asset/network infrastructure issues. This allows them to develop a framework for a collaborative energy and physical infrastructure management strategy encompassing:

- Existing facilities design constraints and monitoring requirements
- Integration of energy and infrastructure systems including IT assets and connectivity
- Operational steps necessary for ensuring and sustaining improved efficiencies and cost savings

Going Beyond the Data Center

Energy and physical infrastructure challenges also extend beyond the data center environment embedded within an enterprise. As organizations strive to improve operational efficiencies, realize energy savings, and reduce their carbon footprint throughout entire buildings, including remotely located sites, the previously discussed practices and strategies are still applicable. Facility managers and building services professionals are realizing that greater operational efficiencies can be made by proactively measuring, managing and optimizing energy and asset utilization.

From office buildings, universities, and hospital campuses, to multi-site retail operations, warehouses and factories, implementing more sophisticated instrumentation enables a clearer understanding of utility consumption, air temperature (external and internal), and specific electrical circuits, such as those for heating, heating, ventilation, and air conditioning (HVAC), telecoms and IT equipment.

Mapping sub-metering circuits and their location (by country, city, street, floor and department, and cabinet) and classifying each type of circuit according to load type enables reporting parameters and targets, including energy usage, cost and emissions, to be set.

In addition, monitoring network patching connections in the telecommunications closet provides live documentation for troubleshooting, and detects unauthorized patch changes as they occur. Guided patch cord tracing as well as guided moves, adds, and changes also removes the need for skilled workers to complete every connection modification required. This is especially important when managing connectivity in enterprise organizations with multiple remote locations.

Panduit 6 Zone™ Methodology

Panduit brings its infrastructure proficiency into the realm of DCIM for data centers and enterprise operations with a 6 Zone™ methodology supported by a comprehensive SmartZone™ Solutions portfolio.

Following the defined zone approach, Panduit has adopted a logical, step-by-step 6 Zone™ methodology that segments local and remote buildings into six clearly defined "zones". This practiced and proven methodology assesses simplified, divided views of these distinct enterprise, data center, and facility zones to holistically monitor, manage, and optimize power/energy, asset/connectivity, and thermal management within each zone with greater visibility.

Panduit SmartZone™ Solutions

Based upon findings from the 6 Zone™ methodology, SmartZone™ solutions deliver the holistic and granular insight, along with available energy efficiency services, to help you develop comprehensive energy and physical infrastructure efficiency strategies in data centers, building facilities, and remote enterprise sites. SmartZone™ Solutions include:

- **SmartZone™ gateways and appliances** that are deployed across the entire facility and within racks and cabinets to monitor and capture real-time data in each zone
- **SmartZone™ infrastructure management** software that collects, filters, and processes the data to provide infrastructure visibility and management through rich Graphic User Interface (GUI) dashboards, administrator controls, and automated reports and documentation
- **SmartZone™ Services** that can *chart* the current state of a physical infrastructure, make recommendations to *optimize* the environment in support of logical network requirements, and help *map a* clear and actionable path forward

Conclusion

It is essential for IT and facilities management to collaborate closely to ensure maximum data center resilience and uptime while tackling the operational challenges caused by financial and capacity constraints, rising energy costs, and tougher regulatory landscapes.

Combining our pioneering 6 Zone™ methodology for assessment, plan/design, integration, and operation, with a set of appropriate Panduit SmartZone™ Solutions provides a holistic view of connectivity, energy, and environmental parameters which can help you address both new and legacy data center optimization challenges now and in the future.

About Panduit

Panduit is a world-class developer and provider of leading-edge solutions that help customers optimize the physical infrastructure through simplification, increased agility and operational efficiency. Panduit's Unified Physical Infrastructure℠ (UPI) based solutions give enterprises the capabilities to connect, manage and automate communications, computing, power, control and security systems for a smarter, unified business foundation. Panduit provides flexible, end-to-end solutions tailored by application and industry to drive performance, operational and financial advantages. Panduit's global manufacturing, logistics, and e-commerce capabilities along with a global network of distribution partners help customers reduce supply chain risk. Strong technology relationships with industry leading systems vendors and an engaged partner ecosystem of consultants, integrators and contractors together with its global staff and unmatched service and support make Panduit a valuable and trusted partner.

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