

Advances in Wire-Free Power and Environmental Monitoring in the Data Center

Open Architecture API Integration capabilities offer the ultimate flexibility when using intelligent cabinet PDU Technology/ Sentry Power Manager Software and RF Code's Wire-Free Solutions

Includes customer case study

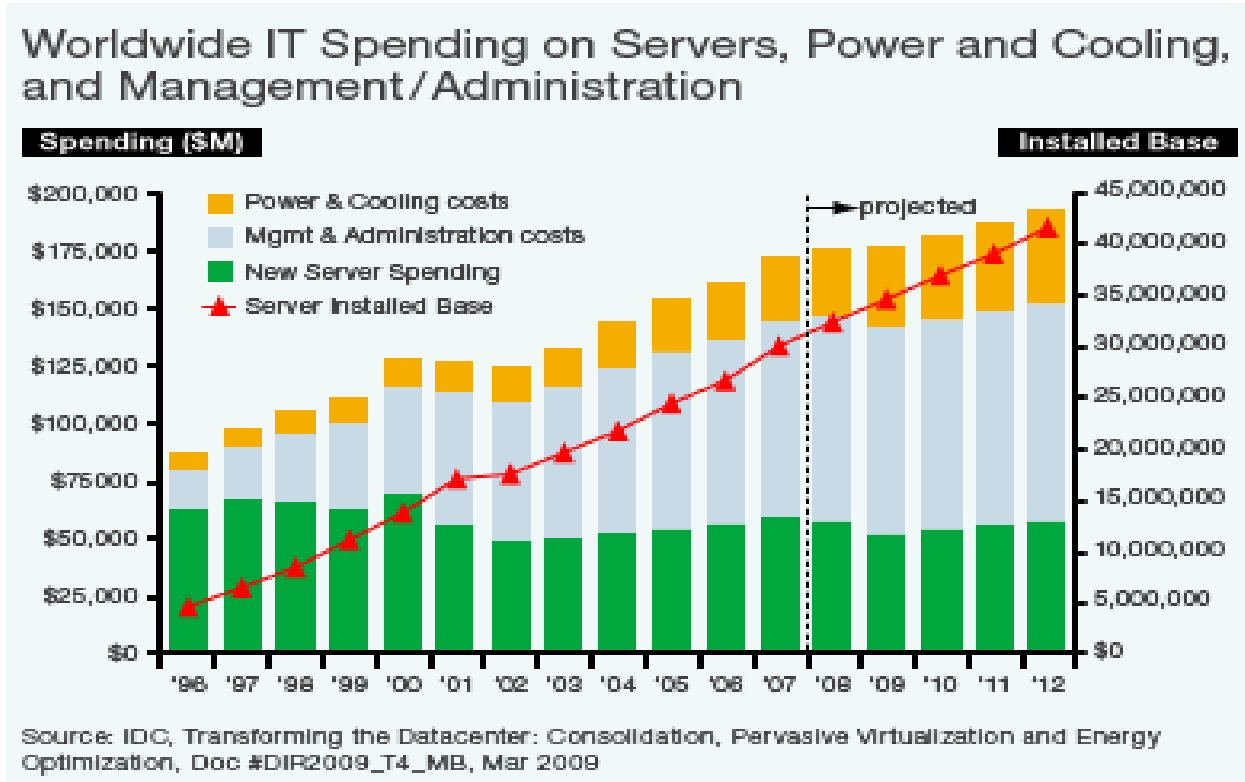
February 28, 2013



Introduction

Increasing powering and cooling demands within the data center have been the topics of choice for Data Center (DC) and Facility Managers for several years now. Increased power demands are a result of the need for more compute power and higher density devices have resulted. These high density installations include stacks and stacks of servers and the trend of implementing blade servers within these server “farms.” Cooling problems are a direct result of the increased power demands based on the simple fact that more power increases the demand for cooling.

Energy costs have escalated enough that annual power costs are expected to exceed server acquisition costs this year according to recent estimates.



(Figure 1)

To make better decisions, reduce power consumption and maximize each cabinet installation, more information is needed -- per device, per application, per cabinet, per groups of cabinets and per facility. The ability to monitor the current draw or power of an individual outlet (device) within a Cabinet Power Distribution Unit (PDU) as well as the voltage infeed, opens the door for significant opportunities to monitor and maximize efficiency, plan for future installations and determine the best location to allocate additional cooling resources. Monitoring power at the PDU inlet or device level provides considerably more detailed information not obtained if the user were to monitor at the UPS, the floor PDU supplying power to the racks or at the breaker panel/remote power panel.

The need for both power and environmental monitoring is driving new and unique solutions within the data center space. Two organizations at the forefront of these innovations partnered, integrated and released their unique solution in January of 2011. Continued innovation, customer installations and advancement of these solutions has prompted the creation of this white paper to ensure that recent updates and applications of this technology are documented and understood.

Server Technology Overview

Server Technology's experts produce the highest quality rackmount power distribution and monitoring solutions that help manage power capacity, reduce downtime and improve energy efficiency. Our extensive selection of Sentry CDUs are engineered and manufactured to meet the highest quality standards and are 100% performance tested for reliability and accuracy. Server Technology eliminates single points of failure, reducing downtime and costs. Our PDUs are designed to be adaptable and enable quick delivery of solutions that meet customer-specific requirements. Server Technology gives IT and infrastructure professionals the control to make accurate capacity planning decisions, reduce risks and meet energy efficiency goals.

Server Technology PDUs offer features such as;

- environmental monitoring (up to 6 temperature and 6 humidity measurements)
- water sensor
- dry contact closure
- remote reboot of unresponsive devices
- SNMP traps and email alerts
- Linking to manage two PDUs (A and B power infeed from a single IP address)
- Input load monitoring w/local LED display (no circuit over load & three phase load balancing)
- Web interface, SSL, SSH, Telnet, RS-232 access, TACACS+, LDAP/LDAPS, Radius, DHCP and Syslog support
- Inlet power monitoring (PIPS)
- Outlet/Device level power monitoring (POPS™)
- Capacity planning and threshold alerts

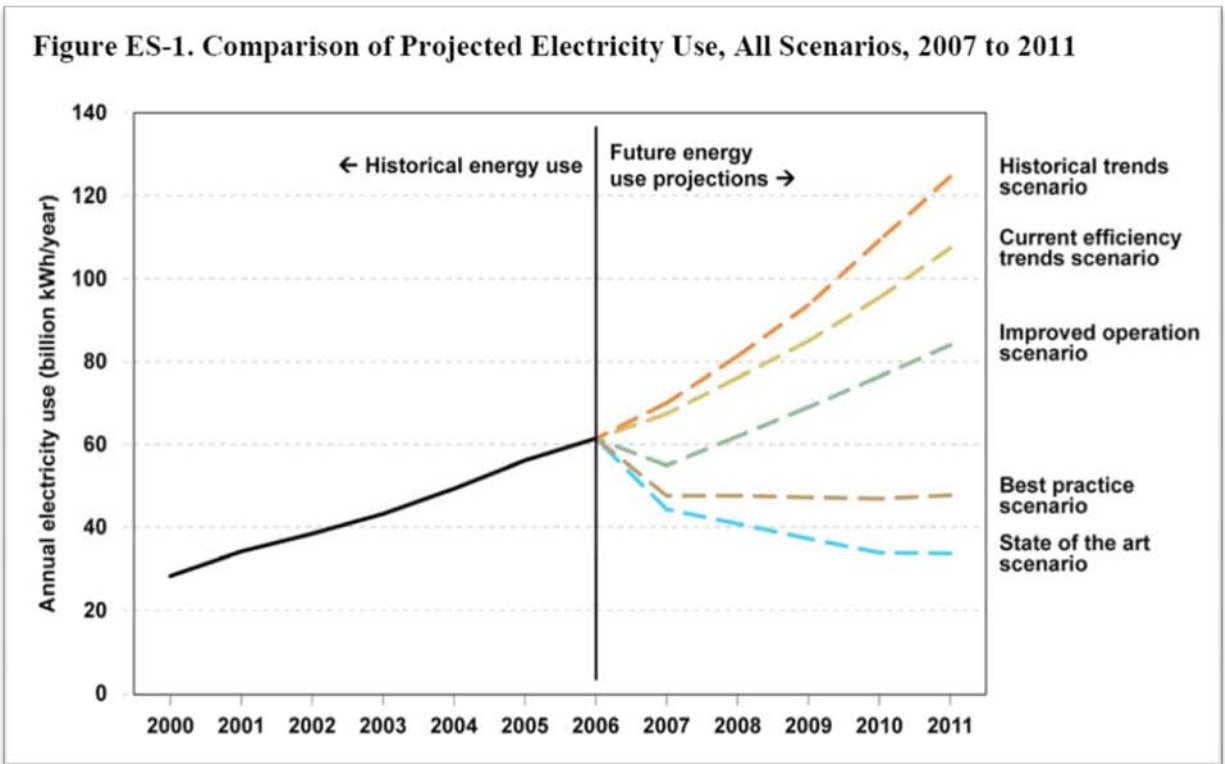


Figure 2

Increased power costs and demand (see Figure 2) combined with decreased power availability are driving power monitoring and management within today’s data centers. These demands have led to new power monitoring capabilities within the PDU to replace power monitors within the RPP (remote power panel) and the ability to measure at the device level. Innovative PDU features including PIPS™ (per inlet power sensing) and POPS™ (per outlet power sensing) provide the ability for the IT or facilities manager to understand the power usage at each specific cabinet, device or application. PIPS and POPS PDU technologies provide for:

- Capacity Planning
- Identifying stranded capacity
- Identifying locations where new devices can be installed
- Locating “zombie” servers
- Internal bill back for power usage within the organization
- Power monitoring within the PDU instead of the RPP
- Load balancing of three phase circuits
- Identification of hot spots within the data center
- IT power information for PUE calculations

PIPS™

PIPS (Per Inlet Power Sensing):

Server Tech PIPS PDUs (Figure 3) combine all of the features and function of Server Tech’s Smart and Switched PDUs with the ability to provide power monitoring at the inlet to the CDU.

Power Measurement Parameters Include:

- Current (Amps)
- Voltage (Volts)
- Power (Watts)
- Apparent Power (VA)
- Power Factor
- Accumulated Energy (Whr)

This information is available per phase for three phase products or per inlet for both three phase and single phase products. Additionally, neutral current information is available for three phase Wye products.

PIPS measurements replace existing branch circuit monitoring systems by providing higher accuracy and lower cost measurements of each branch circuit attached to the PDU.

POPS™:

POPS (Per Outlet Power Sensing):

Server Technology’s POPS product (Figure 3) with measurement accuracy levels currently not available anywhere else in the market today, provides per outlet power sensing for each individual outlet for:

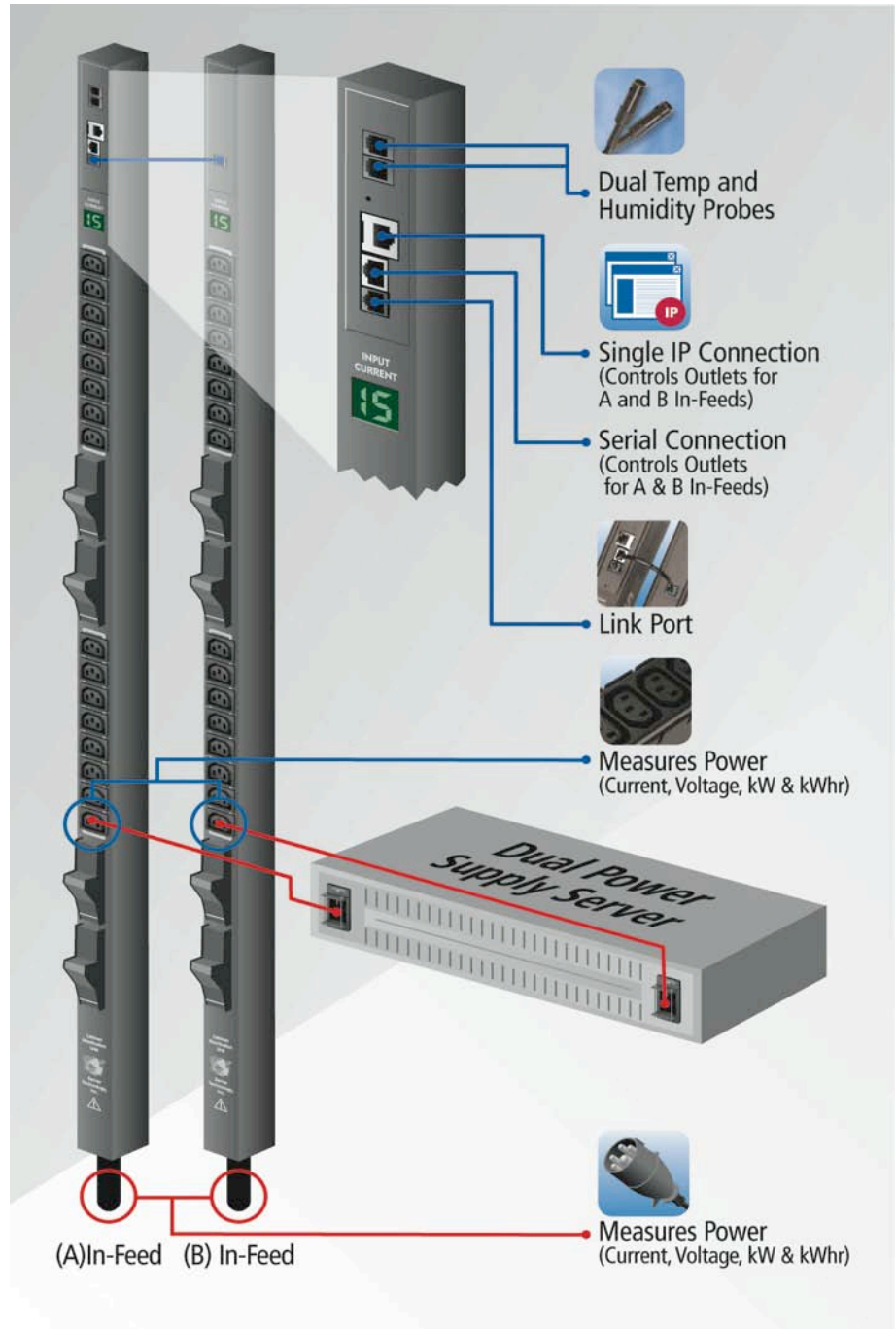


Figure 3

- Load (amps)
- Voltage (V)
- Active power (watts)
- Apparent power (VA)
- Crest Factor
- Power Factor

Though individual outlet information is interesting, it is the application of the POPS technology that provides the real value within the data center. By grouping outlet power information, device level measurements can be made. This information is directly aligned with The Green Grid's recommendations of continuous power measurement at the device level.

This information can be used for:

- Calculating the PUE metrics from The Green Grid
- Confirming that a particular device is indeed turned off by looking at the current draw of a particular outlet
- Sending out an SNMP trap or email alert if the current draw on a particular outlet drops above or below a specified threshold and alerting the user that the devices power supply is damaged or that the device is idle and therefore a candidate to be turned off or virtualized
- Outlet grouping to calculate the amount of power a particular device, multiple devices or a specific application is using

RF Code Overview

RF Code provides an enterprise class, wire-free sensor solution that is ideal for monitoring in real time the environmental conditions in IT dense areas such as data centers and IT closets. RF Code's completely wire-free approach to environmental monitoring is an affordable, flexible alternative to traditional wired environmental monitoring solutions.

The solution components consist of:

- R120 Rack Door Tags-monitor and report on the open and closed status of doors, enabling you to track enclosure access attempts.
- R130 Dry Contact Tags-connect to dry contact devices and continuously monitor and report on the open or closed state of the devices.
- R135 Fluid Sensor Tags-flexible thin-film fluid detection sensors

- R150 Temperature Tags- monitor temperature-sensitive assets in IT racks
- R151 Tethered Temperature Tags-monitor temperature in hard to access places such as the supply and return of CRACs.
- The R155 Humidity-Temperature Tags monitor the relative humidity (RH) and ambient temperature surrounding sensitive assets in IT racks
- R160 Differential Air Pressure Sensor monitors air pressure readings in raised floor environments.
- The M250 Wired Reader interprets and reports the radio frequency messages emitted by RF Code tags and is connected to the Ethernet network
- Sensor Manager is RF Code’s monitoring software application that collects all of the sensor location and sensor data from the M250 Readers. Sensor Manager presents and manages the wire-free sensor information in a variety of different ways such as live table views, map views, reporting and graphing as well as comprehensive thresholding and alerting. Sensor Manager also provides management of the RF Code tag and reader infrastructure

RF Code Solution Components

Asset Manager & Sensor Manager Software <ul style="list-style-type: none"> • Full database • Local or remote • Tag to asset association • Customizable schema • Different user levels • Alerting engine 	Open API
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Zone Manager Software <ul style="list-style-type: none"> • Location engine (middleware) • Reader management • Configurable rules • Data Reduction • Change Value Reporting • Subscription Interface 	Open API
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Active RFID Readers <ul style="list-style-type: none"> • Highest density • Rules engine • Fixed & mobile versions • POE option • Wireless option 	Open API
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Active RFID Tags <ul style="list-style-type: none"> • 5 year life • Small size • Low Price • Multiple form factors • Asset Tracking Tags • Sensor Tags

RF Code Wire-Free Sensor Tags

All of the RF Code sensor tags have the following features and characteristics:

- Multiple sensor updates per minute via the RF Code radio frequency network ensure that all environmental conditions are monitored closely
- Small form factor size (2.22 in. X 1.74 in. X 0.35 in. | width X depth X height)
- Multiple mounting options such as adhesive, zip tie lanyard and screw attach plate
- 5 year battery life (depending upon the sensor type) with field replaceable batteries
- Low cost with tag list prices ranging from \$24.95 to \$99.95 depending up on the tag sensor type

- Exceptional RF range



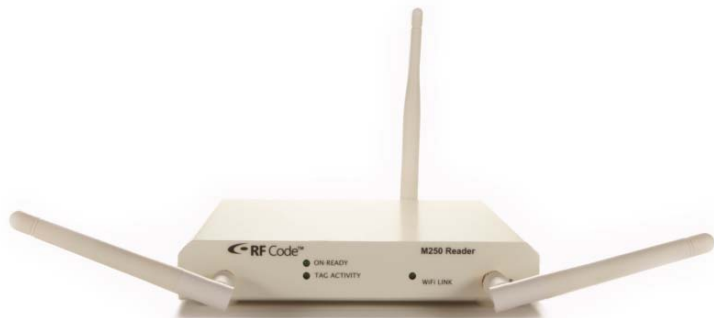
All of the RF Code sensor tags transmit their data using a patented communications protocol at 433.92 MHz. RF Code sensor tags are not WiFi or Zigbee based, making them smaller in size, easier to deploy and much lower in price than most other wireless sensor solutions. RF Code also has a significant advantage in radio frequency performance. By using the 433.92MHz frequency, the RF Code data transmissions have much better performance around dense metal environments such as racks and servers in a data center. Unlike almost all other wireless sensor solutions, RF Code sensor tags can be placed inside IT racks that are fully enclosed with no need for wires or cables to get the radio transmission electronics outside of the rack. Finally, RF Code’s sensor tag architecture is designed for massive scalability allowing for thousands of sensors in relatively close proximity.

RF Code M250 Reader

The RF Code M250 Reader is connected to the Ethernet network and collects all of the radio frequency data transmission from the RF Code sensor tags. A single M250 reader can easily handle 1,400 sensor tags. The M250 reader can be powered via standard 110/220 power, 12-24 volt DC, or via Power-Over-Ethernet (POE). In an environment where RF Code sensor tags are placed inside fully enclosed IT racks (sides and doors), a single M250 Reader can typically cover 2,000 square feet in a data center environment.

The M250 Reader includes a rules engine that enables it to perform data reduction so it doesn’t have to constantly send the same information repeatedly over the Ethernet network. Only changes to tag sensor states and tag sensor data are communicated via the Ethernet network.

The M250 Reader supports flexible network connectivity. It supports encrypted links, multiple simultaneous connections, as well as UpConnect capabilities where the M250 can initial the network connection.



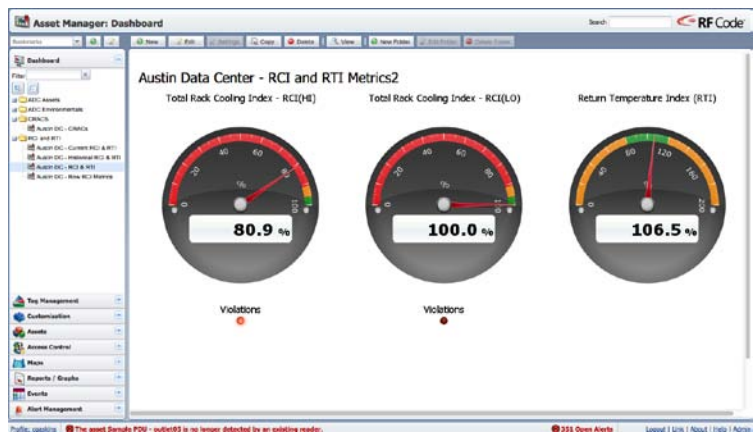
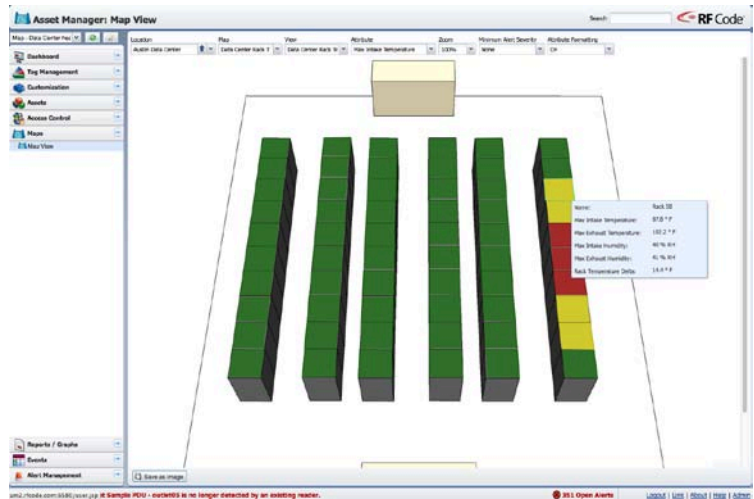
RF Code Sensor Manager

RF Code's enterprise-class monitoring application, Sensor Manager, collects all of the sensor data from all M250 Readers in a data center. The Sensor Manager software manages all of the TCP/IP connections to the M250 readers, as well as the types of tags that will be observed. Sensor Manager stores all of the sensor data into an SQL database enabling users to quickly access current environmental information as well as historical environmental information via an extremely fast and flexible Web 2.0 user interface.

Sensor Manager provides users with the ability to view information in a variety of ways including tables, reports and graphs. Sensor Manager also provides a very robust policy-based alerting engine that enables users to set complex thresholds and direct alert notification to multiple destinations.

Sensor Manager also includes the power Rack Cooling Index (RCI[®]) and Return Temperature Index (RTI[™]) metrics. RCI is a best practice performance metric for quantifying the conformance with thermal data center guidelines and standards such as ASHRAE and NEBS. RTI quantifies the energy performance of the air-management system. It is a measure of net by-pass air or net recirculation air in the data center.

Finally Sensor Manager also functions as an integration point allowing BACNet and Modbus building management applications to collect vital environmental information.



Original Joint Solution Overview

As power and cooling costs are expected to continue to increase, the possibility of increased regulations, customers requiring companies to act responsibly towards the environment and new tools and technology for determining efficiency are all driving power monitoring solutions. The unique integration between Server Technology's PDUs and RF Code's Wire-Free technology provides a cost effective power monitoring solution. Figure 3 below illustrates the integrated solution at the cabinet level.

RF Code's R170 PDU Tag for Server Technology simply plugs into the serial port of the Server Technology PDU. The R170 sensor tag then collects and transmits power monitoring information from the PDU while eliminating the wired connections to each PDU as well as the IP address overhead for each PDU. All of this is offered in a simple "plug & play" installation that enables the powerful power metrics collected by the Server Technology PDU to be transmitted over the RF Code Wire-Free infrastructure. The power information available via the joint solution includes:

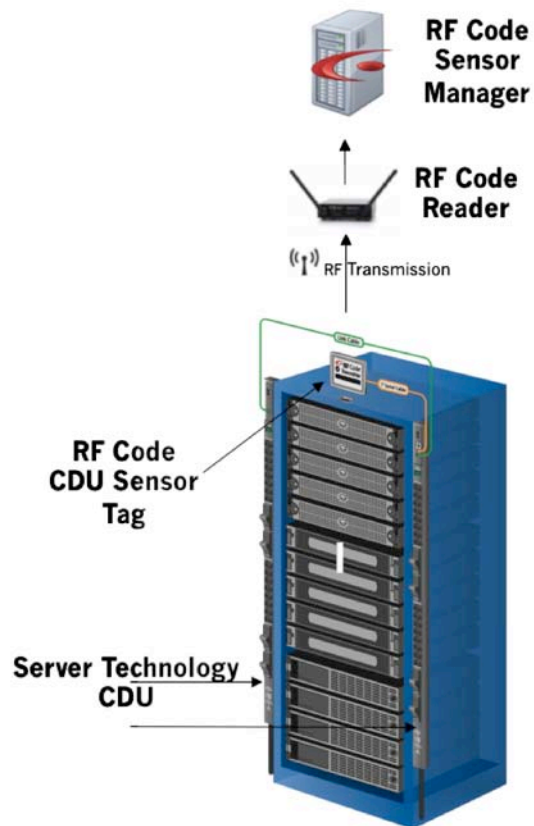
- PDU data
- Phase data
- Outlet data
- Breaker data
- Feed Line data

The data collection and reporting cycle involves two levels of timeliness--every 10 minutes and every hour--with 10-minute interval data taking priority over hourly interval data. The 10-minute interval data consists of:

- Per-Phase Voltage/Power Use

The hourly interval data consists of:

- Per-breaker amperage transmitted every hour
- Per-socket watt-hours and configuration transmitted every hour
- Per-socket power-factor transmitted every hour
- Feed Line ID, amperage and overload status every hour



- CDU model and CDU serial number packets transmitted at least once per hour
- Per -breaker tripped status is sent in real-time upon a state change
- Individual outlet state change (on/off) is sent in real-time for switched CDU's

Critical alert information such as the tripping of a breaker or the disconnection of the tag from the PDU is transmitted immediately as the highest priority.

The RF Code R170 sensor tags work with the following Server Technology Inc. products:

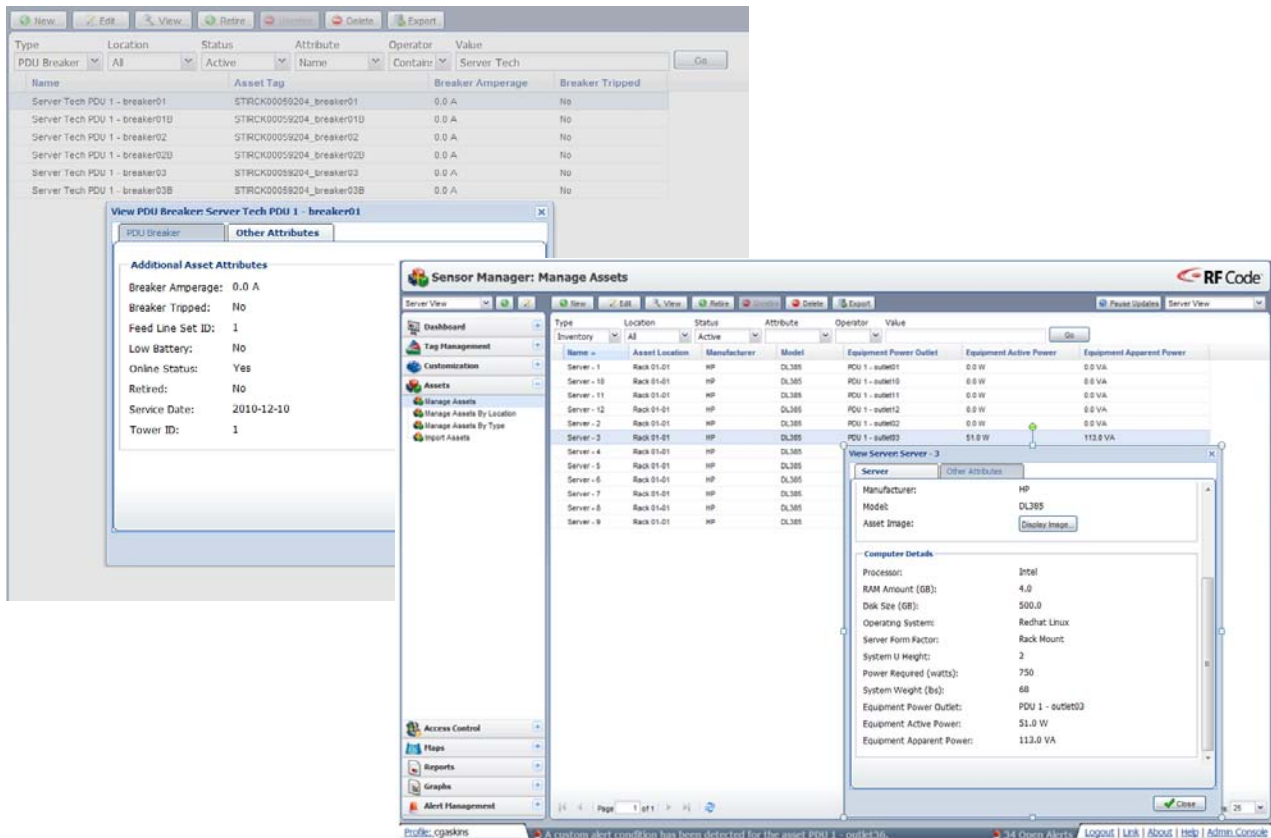
- Smart PIPS CDU's with or without POPS
- Switched PIPS CDU's with or without POPS
- Supports Master only or Master/Link CDU Configurations

It is important to note that no outlet control via wire-free solution when using switched units as the RF Code wire-free infrastructure is unidirectional protocol.

Once the power information has been transmitted by the sensor tags and received by the readers, it is available in the RF Code Sensor Manager application and can be utilized in a variety of ways such as:

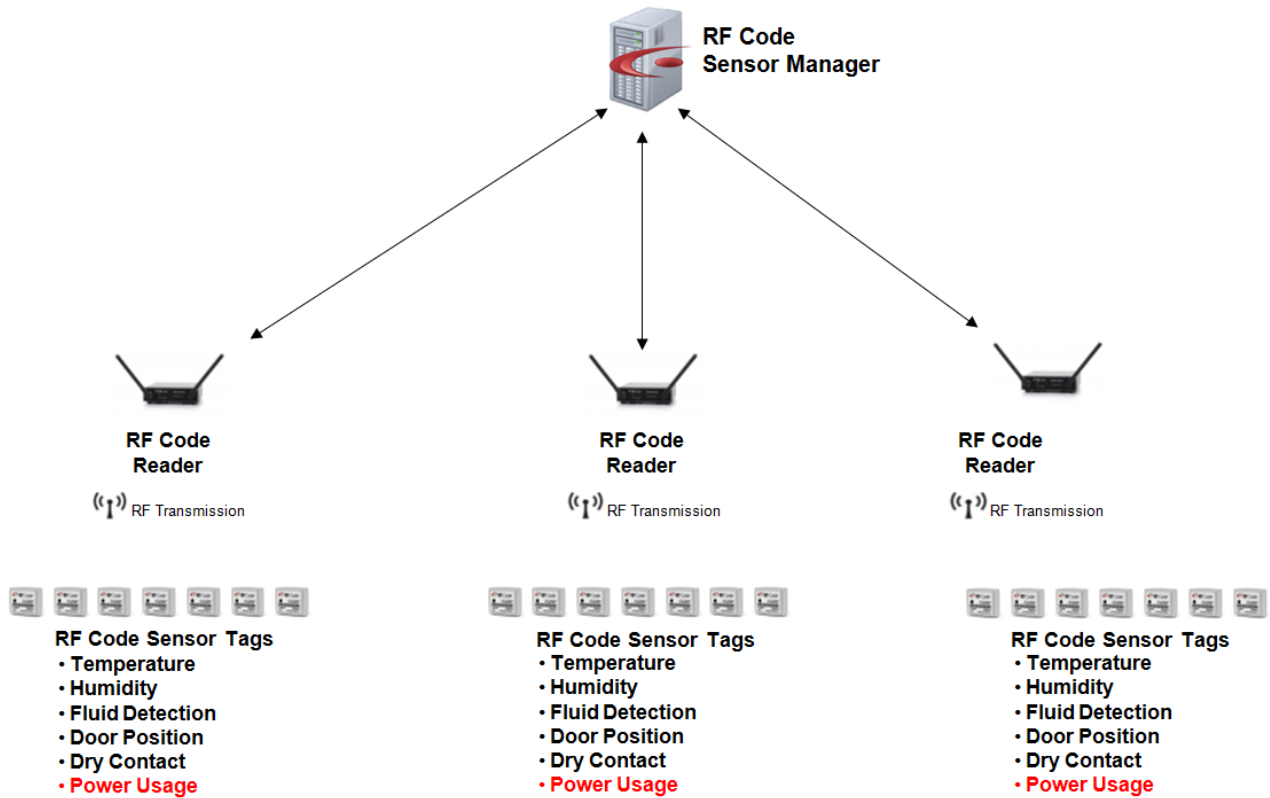
- Real-time & map views
- Reporting & graphing
- Alerting & thresholding





Integrating Server Technology’s power monitoring products with the wire-free monitoring provided by RF Code provides the following solutions:

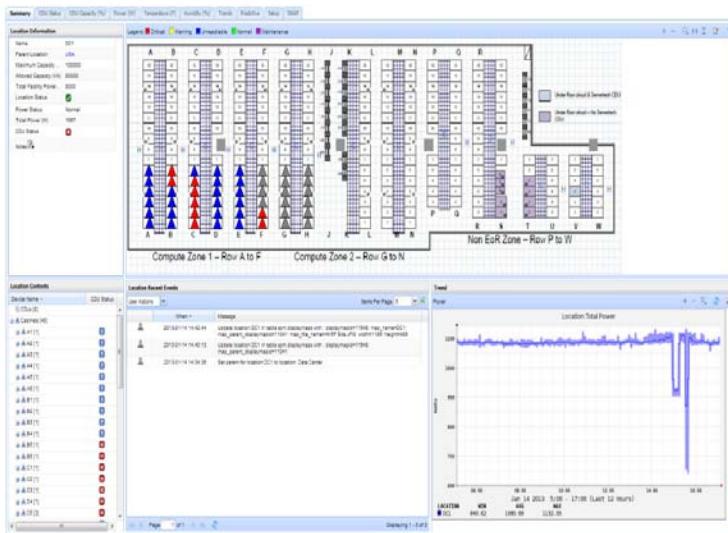
- Cost effective monitoring solution avoiding the high costs of wired IP addresses and support
- A homogenous view of the data center’s power and environmental information can be easily accomplished with RF Code’s Sensor Manager Software.
- Simple Plug and Play Installation
- Eliminates all IP address configuration and maintenance for the CDUs.



New Solution integration utilizing Sentry Power Manager (SPM) Software – Overview:

For existing SPM / PDU applications that either have or are considering Wire-Free environmental monitoring from RF Code

Server Technology has an extensive installed base of existing networked Smart and Switched PDUs with and without PIPS and POPS. These installations often include the Sentry Power Manager software application for PDU monitoring, management and control of these devices.

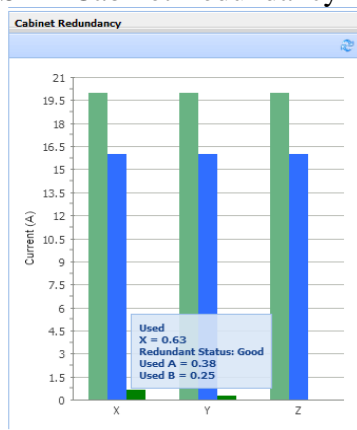


SPM Cabinet Status View

Cabinet List												
Name	Total Power (W)	Parent	Area (ft^2)	Height (U)	Space Available (U)	Notes	Clear All					
Items Per Page 20												
Name	Power Status	Total Power (W)	Redun... Status	Parent	Area (ft^2)	Height (U)	Space Available (U)	Power Density (W/R^2)	Capacity Used (%)	Notes		
H6	Normal	0	Empty	DC1	0	42	42	0	0			
H5	Normal	0	Empty	DC1	0	42	42	0	0			
H4	Normal	0	Empty	DC1	0	42	42	0	0			
H3	Normal	0	Empty	DC1	0	42	42	0	0			
H2	Normal	0	Empty	DC1	0	42	42	0	0			
H1	Normal	0	Empty	DC1	0	42	42	0	0			
G8	Normal	0	Empty	DC1	0	42	42	0	0			

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SPM Cabinet Redundancy Report



Sentry Power Manager provides:

- Capacity Planning
- Power Usage/power management

- Proactive vs. reactive energy management
- One central location for data center power management
- Open API integrates easily with existing BMS and DCIM solutions
- Automates PDU upgrades and configurations

A new API integration between RF Code's Zone Manager and Server Technology's SPM application allow these installations to quickly and easily add or integrate the RF Code wire-free infrastructure to monitor a number of different parameters all visible within the existing SPM system.

These parameters include:

- Temperature
- Humidity
- Pressure
- Fluid Detection
- Door position
- Dry Contact
- Dew Point

Sentry Power Manager also monitors (where applicable):

- Tamper for sensors
- Motion for sensors
- Low Battery for sensors
- Panic for sensors
- Reader status
- Zone Manager status (reachable or not)

Trends:

- Temperature
- Humidity
- Pressure
- Dew Point

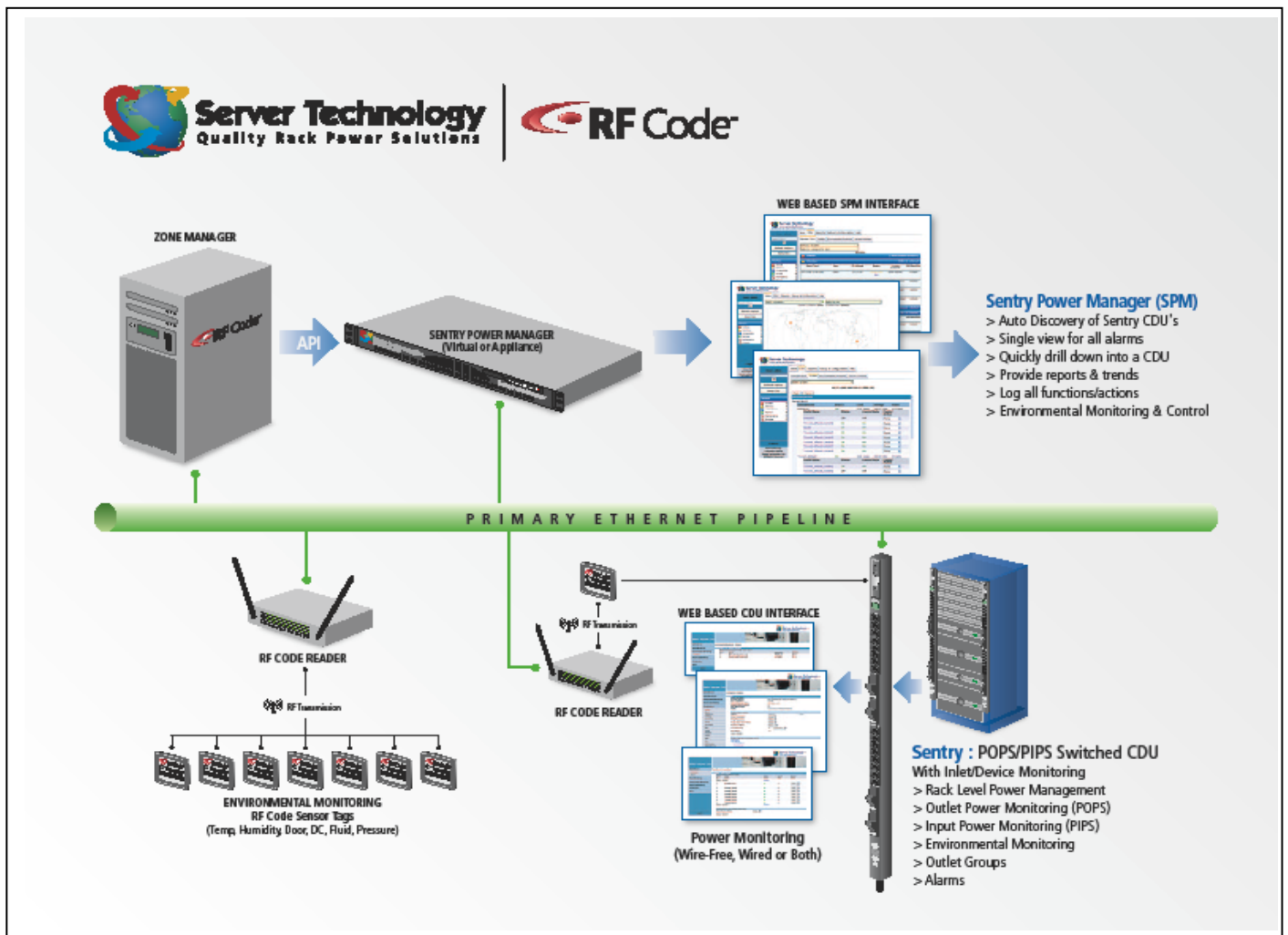
Reports:

- Sensor Report

Thresholds (for email alerts):

- Parameters- Temperature, Humidity, Pressure and Dew Point
- Low critical, low warning, high critical, high warning

There are a number of ways that this joint solution can be implemented within your data center. The drawing below shows implementation possibilities of these two unique technologies.



Summary:

This combined SPM / RF Code wire free solution is activated by a software license key from Server Technology for SPM activation. In this overview both RF Code wirefree devices and SPM, with connected PDUs are deployed throughout the data center. Through RF Codes open API SPM connects to the RF Code Zone Manager to track sensor data collected from the deployed sensor tags and transmitted by the readers, making all power and environmental data available through the SPM systems user interface.

Customer Case Study: Installation Example - Customer Implementation of the joint RF Code and Server Technology Integrated Solution

For applications that require secure independent monitoring - multiple user access within a single cabinet or location

Mission-critical power distribution and environmental monitoring within multiple custom installations, across more than a thousand racks of IT equipment, requires out of the box thinking and a unique design solution. Especially when one of the key requirements is to provide highly secure independent monitoring by both the local business management team, as well as complete monitoring and control by each of their remote customers' outside operations teams. A creative solution was needed as security dictated that these access points were not mixed due to each group being from different organizations and the high security nature of the application.

To meet these requirements, Server Technology developed a hardware platform that met the stringent power requirements, and then partnered with wireless industry leader RF Code in Austin, Texas to meet the additional secured environmental and power monitoring needs. By integrating a PDU with both wired and wireless networking paths (at the same time), Server Technology and RF Code were able to leverage each other's core strengths to provide a solution that provided mission-critical highly intelligent smart power at the PDU/device level, with the unprecedented capability of dual-organization monitoring and control access. The dual access enables the customer and their co-location customers to independently monitor power and environmental data unaware of the others presence.

This implementation allowed the co-location customer complete access to the PDUs ability to monitor, manage and control both power and temperature and humidity within the equipment cabinet rack. This is done through the secure network access of the PDU. This installation also allows the co-location facility to monitor both power information and environmental information including user alarms, alerts and some user actions through RF Code's Wire Free technology and their Sensor Manager software solution. This access is separate from the PDU access allowing two secure points of entry within the system.

Benefits include;

- PIPS and/or POPS power monitoring via the CDU
- Temperature and Humidity Monitoring via the CDU
- Outlet Control On/Off/Reboot via the CDU
- PIPS and/or POPS power information via Sensor Manager
- Outlet state status via Sensor Manager
- Power ID tag battery and status information via Sensor Manager
- Temperature, Humidity, Pressure, Fluid Detection, Dew Point, Door detection and Dry contact detection via Sensor Manager

Conclusion

More and more companies are looking for ways to act responsibly towards the environment and for new tools and technology for determining efficiency. They're exploring ways of making their data centers more environmentally friendly, "green" and more efficient all with the end goal of reducing costs.

These organizations are looking for “best of breed” solutions with open architecture designs that allow information to be shared via well documented and organized APIs. These open APIs allow for power and environmental information to be shared which ultimately results in increased efficiency and overall maximization of ROI.

Devices like POPS and PIPS CDU’s capable of making a variety of power measurements at the outlet in inlet level within a Data Center provide a significant advancement in the DC Manager’s ability to determine the DC’s efficiency. The wire free solution combines the benefits of these CDUs with the simplicity and monitoring capabilities of RF Code’s sensor tags provides a complete solution. Calculating PUE and other metrics are the first step to understanding power consumption and looking for ways to improve data center efficiency. Remember: **“You cannot improve something that you are not measuring.”**

About the Authors

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Calvin Nicholson is Server Technology's Senior Director of Software and Strategic Alliances. Server Technology Inc., designs and manufacturer's intelligent power distribution products for enterprise data centers. Previously the Director of Product Marketing with GameTech International creating strategies and specifications for new product development of Gaming Management systems, games and portable card minding devices. Calvin also held various positions in the Process Control Instrumentation field, including Sales Engineer, Product Manager, Account Manager and Marketing Manager for ABB with both domestic and international responsibility.

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Chris Gaskins is RF Code's Vice President of Product Development. He is responsible for all product development and product management activities at RF Code. Chris joined RF Code from American Power Conversion where he was responsible for the Security and Environmental Product Line which included product management, product marketing, and engineering. Chris also has held various positions at in the product engineering and development organizations of NetBotz, AppGate, Tivoli Systems, and IBM.

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