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Power Distribution at the Cabinet Level
Improving Energy Efficiency

WHITE PAPER STI-100-010 November 2013

Executive Summary
This paper helps companies deploying IT cabinets in a data center to determine what type of power distribution gear to install at the cabinet level by providing a series of questions to be answered.

Overview
In order to provide a full energy efficient solution with regards to data center cabinet-level power distribution, monitoring and management, it is important to ask the right questions and get the information you need to define the intended goals you may have for your facility. During the planning phase of your data center build out, there are many critical decisions to be made regarding data center efficiency and power. The purpose of this paper is to highlight and define the possible goals you may have, determine how to get the power information you need, and understand what to do with the information to meet your goals.

What type of power should you bring to the cabinet?
This question is best answered with more questions.

1) What type of equipment will you be using in the cabinet?
2) Who will be utilizing the equipment?
3) What are the uptime statements?
4) What is the cost of downtime?
5) If something were to fail, what damage would it cause?

Years ago it was commonplace to bring in one power feed per cabinet but the power draw and needs within the server cabinet have evolved. The need for a second or more power feeds brought to the cabinet is not only necessary for increased density but also for redundancy.

Power lines to the cabinet, either under the floor or overhead, have their limitations due to space and various specifications/regulations. Some considerations that you need to know for power lines to a cabinet are:

1) How many power lines?
2) What voltage?
3) What load capacity?
4) Is the power coming from a single or multiple sources?
5) How does the density affect the capacity to cool?

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The question of what power to bring to a cabinet is a tricky one as there are many issues to consider, such as:

- load necessary for existing operations
- load needed for future growth
- redundancy for failover

It is up to the Facilities group to provide the power and other services to the raised floor or server cabinet.

What data points are important to Facilities to assist them in their day to day operations?

Total amount of power needed to keep the servers running is important but only part of big picture. Fluctuations within the data center are constant and are not just limited to power. Current load, voltage and environmental information are vital as well as historical trends and the capability to see peaks and flows in consumption to determine data center efficiency.

All of the requirements that were just illustrated need to be analyzed from several different levels. The first way to look at this information is from the aggregate, holistic view. What is the power consumption as a whole for a room or building? For power related information this is a good starting point but not for environmental readings; that topic will be covered later. The other required bits of information as similar to the aggregate information, what changes is the vantage point. The reason being is that with aggregate or even branch circuit level monitoring, small/localized fluctuations may not easily be seen. For example, when a server first turns on, it utilizes a lot of power in a short amount of time before becoming more stable. Power in-rush is not just limited to a single server or device initially turning on, it is an issue to be considered for all devices that are running normally, being rebooted or recovering from a planned or unplanned outage. Other factors to consider—when a server or IT device performs its normal job, does it rely on other devices to provide a service or application? Simply put, does an IT device have to reach out to a SAN to get information? The answer is probably yes. The point that I am trying to make is that it's important to realize that while our initial goal is to provide power to a device, there are many other issues to consider that have a direct correlation to that simple goal.

Power monitoring

Data center power monitoring is a hot topic. Power Monitoring and Environmental Monitoring should be performed simultaneously and as often as possible. Whether it's for billing reports, usage monitoring, capacity planning or monitoring, the need to understand how much power is being used is very important. Understanding that power usage fluctuates is very important--how much does it change, when does it change? What is the delta between the changes? All of this information needs to be gathered over a period of time, analyzed and compared.

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The comparison of actual usage and theoretical capacity can shed a lot of light on some very common issues within the Data Center. For example, there are some data centers which are running out of power. Continual power monitoring with a data center monitoring solution can confirm or deny that statement.

The term or idea of power monitoring is ambiguous, what facets of power should be monitored?

- **Load** – The amount of amps being used by your devices. Amperes or Amps are a standard measurement of electrical current for how much electricity is moving through a wire at a set time. The amp draw is calculated by the electrical requirements of the devices plugged in, and is regulated by a circuit breaker or fuse.
- **Power** - Time rate of doing work, usually expressed in horsepower or watts
- **Voltage** - A fixed value for a circuit that is a measurement of electrical potential
- **Apparent Power** - Apparent Power is the product of root-mean-square (rms) voltage multiplied by rms current and the measurement by which power companies bill.
- **Active Power** - The "real" power (Watts) associated with an AC load, which is the product of the voltage, current and cos of the phase angle.
- **Power Factor** - Power Factor is the ratio of Real Power to Apparent Power. A Power Factor of 100% indicates perfect power, while lower values indicate that the circuit is wasting energy.
- **Crest Factor** - Crest factor is the ratio between the instantaneous peak current required by the load and the RMS current. High crest factor can lead to overheating of power supply components

Environmental

Temperature and humidity can have long term effects on IT equipment. High temperature, low temperature, temperature fluctuations, high humidity, low humidity and humidity fluctuations continually happen within a data center. Just like power, you can't touch or see temperature and humidity. The importance of that obvious statement is that it is important to measure temperature and humidity in as many positions within a data center as possible. There are many sensors available on the market today which can measure ambient readings. What they lack is the sensitivity to recognize or report on hot spots. Ambient readings combined with local readings are vitally important to data center and facilities managers because it takes away guess work or assumptions.

The newer ASHRAE standards call for temperature readings within three different points within the server cabinet. A Master PDU combined with an EMCU can offer four EMTH sensors, capable of reading both temperature and humidity. The sensors' capabilities combined with the ability to uniquely name the sensors ensures that the readings are meaningful.

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Redundancy

This is more of a theoretical versus practical discussion. The following bullets are important topics related to redundancy:

- **Multiple power paths**
- **Multiple UPS**
- **Multiple PDUs**
- **Multiple generators**
- **IT devices with more than one power supply**
- **Capacity planning**
- **Capacity monitoring**
- **Enforcement of capacity planning**
- **Automatic transfer switch (ATS) or Fail-Safe Transfer Switch (FSTS)**
- **Ability or plan to test power paths**
- **An understanding of how to react to a power problem**

Power problems happen and we have to be able to understand and accept that. That is the reason why uptime numbers are not 100%. Acceptable downtime is dependent on many factors but a data center with a good service record and high levels of redundancy can still be highly regarded with a small amount of downtime hours per year.

Downtime, although not great to have, is ok as long as the reaction plan is solid. If a hard drive on a computer fails it is likely that the system administrator will have a service contract with the manufacturer and a way to quickly receive a replacement and get the device up and running again. Upstream from that we must consider a power path issue, whether it be local to a PDU or a long a circuit. If an Over Current Protection Device (OCPD) were to fail we need to understand what it will affect. What servers will fail; which ones will remain running? If a power feed into a single cabinet were to fail or become unavailable, would a second power feed be available and/or capable of supporting the lost load? With your normal studies or known specifications of your devices, would you be able to prepare for that worst case scenario?

If a branch of a PDU were to fail or a OCPD trip, what would that affect? How would you be notified? This leads to two other scenarios: selective coordination and firmware/network interfaces. Should an OCPD trip, would you be able to find out what caused it, find out when it tripped and be able to understand what other devices could be affected by that type of issue?

It's important to think about selective coordination and understand the trip curves of the various levels of protection within your power infrastructure. Starting from the bottom up, there is value in being able to set high

and low thresholds at the outlet and branch levels of a PDU. To properly set these values we need to consider several topics already covered in this paper: power, voltage and load. A branch or bank of outlets on a Server Technology PDU typically contains 8 outlets and conforms to the specifications of UL 60950-1, branch circuit protection. Branch Circuit protection can aid in redundancy from a planning and implementation point of view.

The good thing about the redundancy discussion is that it has direct ties to efficiency, from the point of energy saving and also time saving after the result of a failure. For example a properly loaded PDU, meaning a full understanding of the minimum, maximum and median power consumption plus the implementation of a plan on proper plug placement and distribution will lead to a more efficient, redundant data center infrastructure.

Capacity Planning / Management

As with the prior points on what to measure, where to measure, reports and reaction plans, there is a recurring theme within this paper and a well-run data center. An ounce of planning & prevention goes a long way. We need to understand what is in the data center, we need to understand the theoretical and actual limits of the infrastructure and we must plan for smooth operations as well as disasters. All of the pre-planning and benchmarking will create and enforce capacity management.

Conclusions

Deciding on what solution is the right cabinet-level power distribution solution can be complicated, and it's important to understand and define the goals early in your planning process to ensure you achieve success. Once you come to a better understanding of what your goals are, the available solution will be apparent. Working with your local Server Technology power expert, you can start planning a smarter solution today f or tomorrow.

About Server Technology®

Server Technology, a brand of Legrand, is leading the engineering and manufacturing of customer-driven, innovative and exceptionally reliable power, access and control solutions for monitoring and managing critical IT assets for continual availability.

Server Technology's power strategy experts are trusted to provide Rack PDU solutions for data centers worldwide ranging from small technology startups to Fortune 100 powerhouses. Because power is all we do, Server Technology can be found in the best cloud and colocation providers, forward thinking labs, and telecommunications operations.

Server Technology customers consistently rank us as providing the highest quality PDUs, the best customer support, and most valuable innovation. We have over 12,000 PDU configurations to fit every data center need and most of our PDUs are shipped within 10 days.

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