White Paper

Markets Served
Data centers

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Power infrastructure modularity.

Building a data center to meet the needs of an uncertain future is an expensive and wasteful exercise in over-engineering. New designs need to be modular, with built-in expansion capabilities. In the data center, power infrastructure and modularity can mean the following:

- **UPSs that scale for added capacity or redundancy**
- **Extended battery modules to customize backup runtime**
- **Plug-and-play power distribution components that break down room-level wiring into row- or rack-level modules**

This paper looks at the concepts and benefits of modularity in all these elements of the power system.

Modularity in power infrastructure

Oversized data centers are a thing of the past. But, there is still a fear of running out of capacity, so what do you do to avoid paying for excess but simultaneously avoid being caught short? Tailoring power infrastructure for scalability can be easily achieved with today's readily available modular components.

Modularity used to mean adopting more components and therefore more risk. Modularity today means building blocks to enable users to add, remove or redeploy those building blocks to create variations of the original function or process. This can be done in incremental build outs in the form of pods, universal racks, virtualization, stackable storage arrays and so on.

Modularity enables you to:

- Pay only for the functionality you need in the short term
- Expand at your own pace without starting over with a new platform each time
- Components are smaller and easier to install
- Small zones can be isolated for service, without having to shut down the whole data center
- Reduce footprint with rack mountable options or end of row designs

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Distributed UPS architectures

Historically, many data centers chose a centralized power protection strategy, where a large, standalone UPS powered the entire data center. This approach works when growth can be accurately forecasted, which is a challenge as data centers continue to change and evolve.

In recent years, many data centers have adopted a zoned strategy, where the data center is divided into zones each powered by its own UPS. This approach is not only more scalable than a centralized UPS strategy, but a UPS maintenance event or failure only affects a single zone rather than the whole data center. The zone concept has advanced further with distributed architectures, where each rack or set of racks has its own UPS—and the UPS itself is modular to expand as needed. This approach has a strong appeal for colocation and hosting providers where they can segment customers and scale out only when there is demand.

Redundancy can be established through paralleling, to establish Tier II and higher reliability. In paralleling, two or more UPSs are electrically and mechanically connected to form a unified system with a single output—either for extra capacity or redundancy. In an N+1 redundant configuration, you would have at least one more UPS module than needed to support the load. As a conjoined system, each UPS stands ready to take over the load from another UPS whenever necessary, without disrupting protected loads. Paralleling provides an excellent solution for matching growth while extending the value of existing UPSs.

UPSs (8-60 kW)

Today there are power quality solutions that are compact, rackmount and expandable from 8 to 60 kW in a single 19-inch rack while reducing energy and cooling costs. These units reduce complication with deployment and can be installed without an electrician.

Each UPS can have the same paralleling technology as larger systems and each module contains its own internal battery trays, built-in static switch, maintenance bypass capability and hot swappable components for ease of replacement or upgrade. The intrinsic reliability of the multi-megawatt parallel systems is preserved in smaller capacity systems.

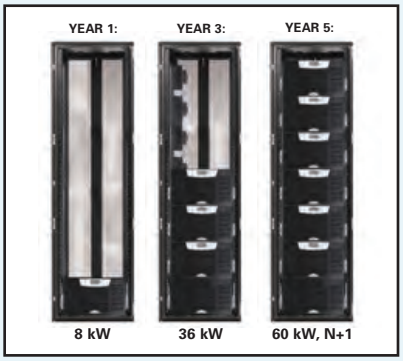

Figure 1. A modular UPS expanding in building-block increments. You can start with one 8 kW module and expand to 60 kW with an extra module for redundancy as you add IT equipment.

UPSs (20-400 kW)

Traditionally, large UPSs are remote from the critical loads and located in the grey space. This works well for systems that are fully loaded soon after commissioning or have consistent loads levels or closely managed load variations, but that is rarely the case. You can now get UPSs with higher power ratings in a compact design with internal redundancy and embrace the scalable configuration at the 20-400 kW level.

A new trend to distribute critical power at the end of each row reduces upfront capital expenditure (CAPEX), and allows for unforeseen future growth with vertical scalability at the row level.

End of row designs reduce single points of failure by placing the critical power next to the critical loads. When it's time to add more capacity or even replace components, the smaller units allow for quicker deployment, lower incremental costs, and improved availability.

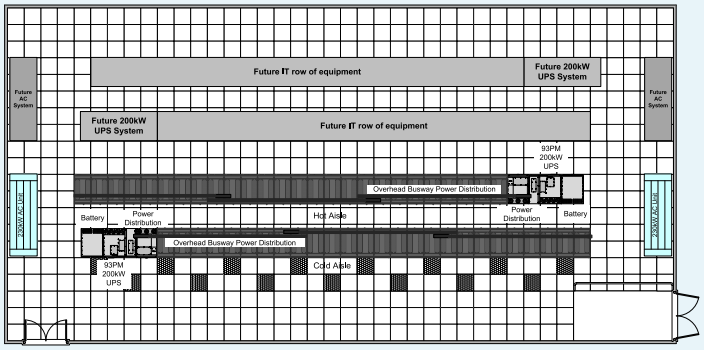

Figure 2. An example of distributing critical power at the end of each row. Data center is able to scale from 50 kW to 800 kW of future capacity.

A common concern to putting a UPS of this size in the white space is with airflow management and lack of floor placement options, but UPSs of this size should provide maximum deployment flexibility by providing innovative thermal management options, flexible configurability and full service access from the front.

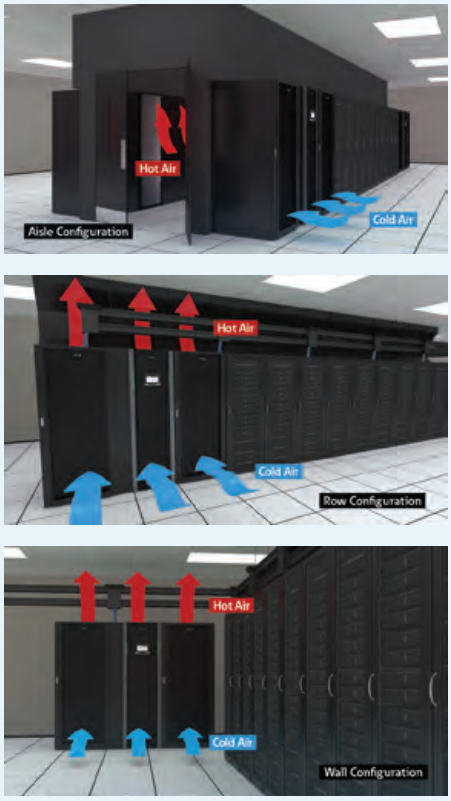

Figure 3. The UPS supports ventilation ideal for against the wall configurations, in-row configurations that support slim chimneys, and hot/cold aisle configuration.

What to look for in a modular, distributed UPS

The traditional thinking was that when you adopt modular components, you increase component count, and your risk of failure. Modularizing a system—using a bank of 12 kW UPS modules or 50 kW UPS modules instead of a larger, stand-alone UPS improves availability and serviceability while also dealing favorably with typical budget constraints, constant changes and the need for the lowest total cost of ownership.

Hybrid configurations are an option for data centers that want to mix distributed power protection with an existing centralized systems to support customers requiring 2N and/or higher level of availability and serviceability at a lower cost than upgrading the entire data center.

Make certain you look for a UPS with the following criteria:

- Small footprint, high power density per rack
- Ease of expansion, and speed of deployment
- Ability to install the UPS in your existing racks, if desired (8-60 kW)
- Ability to simplify installation by fitting in line or alongside any standard-depth rack (20-400 kW)
- Ability to share space with IT and power distribution equipment
- End-of-row mid-size UPS, with thermal management for hot/cold aisle applications (20-400 kW)
- Internal redundancy for improved serviceability
- Swappable components for ease of replacement and upgrade
- Ready for plug-and-play power distribution
- Paralleling for synchronous function as a single unit
- Provisions to ensure reliability of parallel operations
- Option to expand battery runtime as needed
- Capable of monitoring and management via software and LCD display

Battery

Historically, many data centers chose a centralized power. A typical data center might only resort to battery power for a few minutes a year, or perhaps a few minutes over the entire lifetime of a UPS. It's just long enough to gracefully shut down systems or start up a generator, which is why battery backup is still a lifeline for business continuity and demand for battery time continues to escalate. That means the batteries must be as modular as the UPSs they support.

Large centralized "monolithic" UPS may need multiple dedicated battery cabinets to achieve even a minimum acceptable runtime. In a modular UPS, internal batteries can provide sufficient system runtime without adding any additional footprint or complexity. However, if you need more runtime than that, look for a UPS that also supports external battery modules (EBMs) as well.

For example, for UPSs in the 8 kW to 60 kW range, you can add a 3U battery EBM, with higher amperage discharge than the internal batteries. These battery modules can be in the same rack as the UPS or a different rack, and plug into the back of a UPS module. Up to four of these EBMs can be connected to a single unit, increasing runtime from just under 5 minutes to 34 minutes per module at full load, up to an hour or more for lighter loads.

Figure 4. For true modularity and flexibility, look for EBMs that can be placed in the same rack with the UPS, in adjacent racks, daisy chained, and can share space with existing IT equipment.

Power distribution

With data center devices smaller than ever—often served by dual or triple power supplies—a single rack of equipment might produce 40 or more power cords to manage. Power consumption per rack is higher than ever, and continuous uptime is essential. What's the best way to distribute power to racks in the era of modularity?

The conventional approach has been to bring power in from the centralized power system (UPS) to a PDU transformer that "steps down" power to the desired voltage. Power then goes through the main breaker to an intermal panel board, or a remote panel (RPP), then to power strips in racks. While this approach is widely accepted, the complexity of this arrangement – particularly multiple connections from panelboard to power strips – makes it expensive, time consuming to install, and not particularly amenable to change.

One alternative is to use busway positioned over the rack rows, with user replaceable "drop boxes" with the appropriate circuit breakers, monitoring and receptacles or cables to serve one or more IT cabinets. These boxes can be placed at intervals along the bus, and do not require an electrician to install or maintain.

Another alternative is to use a rack power module to provide plug-and-play distribution from a UPS or panelboard to a rack-based power distribution unit (PDU) or directly to IT equipment. Select a rack power module that can deliver power in an organized manner to loads of various voltages, input power cord types and output receptacles—supporting a broad range of applications.

The modular approach has fewer cables to manage and greater flexibility, both for changing the IT equipment and the distribution system that powers it. Traditional wall-mounted panel boxes yield a tangle of cables and an inflexible infrastructure—undesirable attributes in the era of modularity.

Rack PDUs distribute power from a UPS, panelboard, subfeed or branch circuit breaker to IT equipment. Modern rack PDUs can be installed in many locations and can be removed and redeployed as needed, making it easy to support moves, adds and changes in IT systems. Rack power modules can serve dual roles—either sending power directly to IT equipment or to additional PDUs to provide more outlets, redundancy and flexibility.

Monitoring capabilities at all levels of the modular power infrastructure ensure that moves, adds and changes will not bring unwelcome surprises in terms of overload conditions or tripped circuits. With the latest PDUs and software, you can monitor and manage network-connected power distribution components at the rack level via one Web-based user interface and one IP address. Straightforward and budget-friendly software is available to aggregate power data from a virtually unlimited number of rack PDUs and UPSs on an IP network into a cohesive, enterprise-wide view. Going modular doesn't have to compromise visibility; in fact, it extends visibility further to the edge of the distribution system.

What to look for in rack PDU:

- IEC outlet grip, color-coded outlet sections, low-profile form factor and a high operating temperature for best-in-class power management
- Light weight and available in horizontal and vertical solutions for a wide range of key applications
- User-replaceable displays which do not require removal of the rack PDU.
- Ranges from 15A to 60A up to 400V to offer a variety of plug and outlet configurations
- Ability to easily move, redeploy and swap out rack PDUs without tools or an electrician
- Ease of use through front-access only design, top and bottom cable access, and spacious wire-ways
- Ability to monitor over the network through IP communication and have remote control or receptacle-level metering

Conclusion

Modular components are smaller and easier to install—a real plus since power distribution equipment may be reinstalled several times over its service life to keep pace with moves, adds and changes.

A modular power infrastructure make it easier to support scalability in IT equipment. Just make certain you plan ahead. When evaluating components for the data center power infrastructure, look for the ability to support modular expansion and redeployment later.

Today the ROI can be captured in integrated software that offers easy visibility of the entire solution through a single pane. In other words, all UPSs and rack PDUs in the virtual network can be viewed and managed from the same virtualization dashboard, together with network, servers and storage devices. This eliminates the need for IT managers to run separate software to manage all their power devices seamlessly, saving time and reducing workload.

There are more options than ever to capitalize on modular architectures to tailor the power system for your unique data center requirements and the velocity of change. As you plan to upgrade power systems or build a new facility, seek to create a power infrastructure that is as adaptable as the IT infrastructure must be.

About Eaton

Eaton is a power management company with 2014 sales of $22.6 billion. Eaton provides energy-efficient solutions that help our customers effectively manage electrical, hydraulic and mechanical power more efficiently, safely and sustainably. Eaton has approximately 102,000 employees and sells products to customers in more than 175 countries.

Eaton's service offerings are used every day by Fortune 500 organizations. Over the course of 35 years, Eaton has remotely monitored thousands of UPS devices.

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