White Paper

Markets Served
Multi-tenant data centers

By Ed Spears
Product Manager, Eaton Power Quality Solutions Operation, Eaton
and
Benny Ng
Director of Infrastructure, Hurricane Electric Internet Service

Energy-efficiency in Multi-tenant data centers

Strategies for reducing power-related costs without compromising reliability or agility

Executive summary

Cloud computing vendors, hosting companies and other IT service providers are opening multi-tenant data centers (MTDCs) at a rapid pace. Thanks largely to the intense competitive pressures they face, such facilities must maintain exceptionally high levels of energy-efficiency.

This white paper explains why a variety of challenges can make meeting that goal difficult, and then describes how the latest uninterruptible power systems (UPSs), air containment solutions and economizers can help MTDC owners significantly lower power-related operating expenses without weakening reliability or agility. It also uses the experiences of Hurricane Electric Internet Services, a leading retail colocation provider, as real-world evidence of the benefits MTDC operators can realize by embracing energy-efficiency best practices.

Powering Business Worldwide

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Key MTDC requirements

Fueled in part by the rise of cloud computing, MTDCs are quickly growing in size, number and popularity. Indeed, analyst firm 451 Research expects North American MTDC revenues to climb at a CAGR of 15.42 percent through 2015.

To succeed in an increasingly crowded market, MTDC providers must focus relentlessly on a demanding set of requirements, including these:

- **Affordability:** Though price isn't the only variable businesses consider when evaluating third-party data centers, it's one of the most important, so MTDC operators must always offer competitive rates.
- **Efficiency:** MTDC vendors that wish to earn decent margins despite those low rates must capitalize on every opportunity to conserve energy and floor space.
- **Sustainability:** Profitability isn't the only reason energy-efficiency must be a top priority at MTDCs. Some 50 percent of Global 500 companies currently have written sustainability plans that require them to procure goods and services from environmentally-responsible suppliers, and that figure continues to climb.
- **Reliability:** To meet the terms of their stringent Service Level Agreements (SLAs), MTDCs must deliver near-continuous uptime.
- **Agility:** Fast-growing businesses prefer MTDCs with the flexibility to rapidly deploy, modify and scale applications.

Common MTDC efficiency challenges

To satisfy such steep requirements, MTDCs operate in ways that can create severe energy-efficiency challenges, including the following:

Low UPS loading. To preserve reliability, many MTDCs utilize redundant UPS and/or 2N architectures in which multiple units operate at partial loads, so if one device fails or requires maintenance, the others can quickly compensate. While such deployment schemes guard against downtime, they also lower energy-efficiency, because lightly loaded UPSs waste more power and produce proportionally more heat than those that are fully loaded.

Extreme operating temperatures. The clients most MTDC vendors support make extensive use of virtualization and blade servers. Though both technologies radically increase a data center's compute density, they also generate enormous amounts of heat in smaller spaces. Dispersing that heat can be a difficult and expensive task.

Transient spikes. Damage may be caused to the input side of the UPS (filter/rectifier) when a transient spike occurs. During a preventive maintenance call, these parts are checked for any impairment.

Figure 1. Virtualization radically improves compute density but can also raise data hall operating temperatures.

Inefficient cooling. MTDCs housed in older buildings often rely on so-called "chaos" air distribution methodologies to keep temperatures within acceptable limits. In such cooling schemes, computer room air conditioning (CRAC) units around the perimeter of the server room pump out massive volumes of chilled air that both cool IT equipment and help push hot server exhaust air toward the facility's return air ducts. However, by allowing hot and cool air to mix and re-circulate, chaos air distribution strategies decrease cooling efficiency and drive up electrical bills.

In more effective versions of chaos air distribution, data centers position server racks such that only hot air exhausts or cool air intakes face each other in a given row. Such "hot aisle/cold aisle" arrangements allow convection currents to produce a continuous airflow that improves data hall efficiencies but still leaves data center operators with significant cooling burdens to offset.

Best practices for maximizing MTDC energy-efficiency

MTDC operators have a variety of options for coping with those and other efficiency challenges. Among the most effective are these:

Use energy-efficient UPSs

A new generation of sophisticated UPSs can help MTDCs increase efficiency without compromising reliability. Such devices come in two basic types:

Variable, modular UPSs: Many double-conversion UPSs now contain multiple power modules. The most advanced such devices also allow data centers to load those modules variably. Therefore, rather than distribute loads evenly across all modules at low levels, companies can load one or more modules fully and leave the other, unneeded ones on standby. Should a hardware failure or other issue cause load requirements to jump suddenly, the UPS can automatically and immediately activate the standby modules. The end results are greater efficiency under normal conditions and continuous uptime when problems occur.

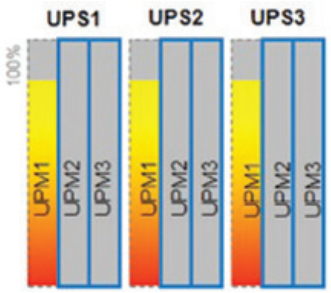

Figure 2. Variable, modular UPSs allow data center operators to load one module heavily rather than several ones lightly in normal operation, for maximum energy-efficiency.

Multi-mode UPSs: Variable, modular UPSs function exclusively in double-conversion mode, while multi-mode UPSs support two operating modes. In normal operation, the UPS runs in a highly efficient energy-saver mode, but if power conditions fall outside pre-determined tolerances, the device automatically and immediately switches to double-conversion mode. When power quality returns to acceptable levels, the UPS automatically transitions back into energy-saver mode.

Though the newest double-conversion UPSs are often over 90 percent efficient, multi-mode UPSs are up to 99 percent efficient when running in energy-saver. As a result, they offer MTDC vendors the ultimate combination of low operating costs and high reliability.

Some multi-mode UPSs also come with built-in harmonic reduction functionality. Harmonics are distortions in a data center's voltage or current waveform typically produced by non-linear loads, such as servers, variable frequency drives and fluorescent lights. If left unaddressed, harmonics can reduce energy-efficiency and reliability while shortening the lifespan of expensive electrical equipment.

In the past, data center operators concerned about harmonics had to devote precious floor space to specialized mitigation technologies. Today, they have the option of using multi-mode UPSs equipped with harmonic reduction technology instead. Older devices with this capability decrease harmonics only while in double-conversion mode, but newer, state-of-the-art models can mitigate harmonics, perform power factor correction and balance loads while in energy-saver mode too.

Implement an air containment solution

Cooling is a major driver of data center energy costs, especially at facilities like MTDCs that are filled with dense, hot server racks. By deploying an air containment solution, MTDC operators can lower their cooling costs by some 30 percent or more.

Containment solutions enclose server racks in sealed structures that capture hot exhaust air, vent it to a CRAC or other cooling system, and deliver chilled air directly to the server equipment's air intakes.

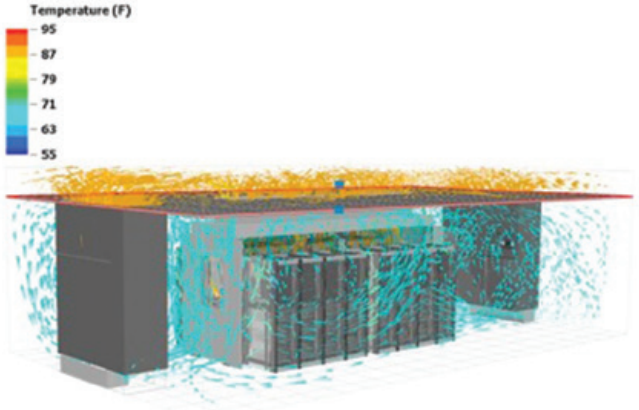

Figure 3. Containment-based cooling strategies improve efficiency by completely isolating the supply and return air streams.

Organizing and controlling air streams in this manner dramatically increases cooling efficiency. For example, to compensate for the effects of re-circulated exhaust air, hot aisle/cold aisle cooling schemes must often chill return air to 55°F/12.78°C. Containment-based cooling systems, however, completely isolate return air, so they can safely deliver supply air at a much warmer 65°F/18.34°C, measurably reducing cooling-related energy expenses.

As an added benefit, air containment solutions improve reliability by protecting servers from thermal shutdown caused by hot exhaust air. They also enhance flexibility by giving facility operators greater freedom to position server racks in whatever way best suits their needs, rather than in the rigidly aligned, uniformly arranged rows required by hot aisle/cold aisle arrangements.

Utilize economizers

Though most data centers continue to rely on them, CRACs take up valuable floor space, are costly to maintain and are a significant source of energy waste. As a result, MTDC owners are increasingly deploying smaller CRACs, eliminating them altogether or using them only as backups for more energy-efficient cooling technologies such as economizers.

There are two basic kinds of economizer:

- Water-side economizers take advantage of frigid outdoor temperatures to chill the fluid in a liquid cooling system's closed cooling loop.
- Air-side economizers pump hot server exhaust air out of the data center and pump in naturally cool air from outdoors. Though they tend to be most effective when used in cold, northern latitudes, air-side economizers are a practical option for at least part of the day even in mild or warm climates, according to numerous expert studies.

Which kind of economizer an MTDC uses must be based on variables like where it's located and whether or not it uses liquid cooling, but almost every MTDC will benefit from the "free cooling" that economizers provide.

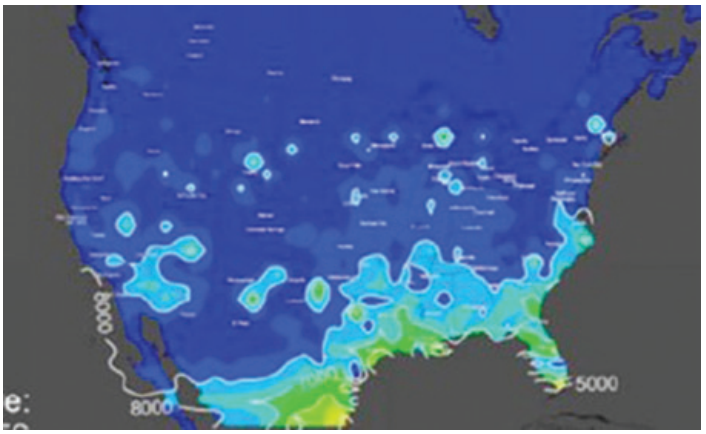

Figure 4. Studies show that air-side economizers are a practical option for at least part of the day even in mild or warm climates.

Case study: Hurricane Electric Internet Services

Headquartered in Fremont, Calif., Hurricane Electric Internet Services is a retail colocation provider with three MTDCs in the San Francisco Bay Area. It operates the world's largest IPv6 backbone, as measured by number of networks connected, as well as one of the world's top 10 IPv4 backbones. Hurricane Electric's experiences with the energy-efficiency strategies described above reveal just how much impact those practices can have on an MTDC vendor's profitability, reliability and agility.

Situation

Unlike many other MTDC owners, Hurricane Electric is an entirely self-funded enterprise that doesn't draw on third-party venture capital. Consequently, it has an even greater need than its competitors to operate as efficiently as possible. In addition, as a retail provider, the company deals with clients ranging from small startups to established cloud-computing giants, and those companies have equally varied capacity requirements. Consequently, Hurricane Electric must keep efficiency high across light loads, heavy ones and everything in between. Like all MTDCs, moreover, it must do so while maintaining nonstop availability.

Results

Installing multi-mode UPSs has empowered Hurricane Electric to raise UPS loading to 60 percent and UPS energy-efficiency to more than 99 percent in normal operation. Partially as a result of those improvements, the company's cooling requirements have dropped significantly, too, allowing it to run its new cooling system in economizer mode more often.

Furthermore, since Hurricane Electric chose a modular multi-mode UPS, it can perform maintenance procedures without taking downstream devices offline. The ultimate upshot of all those gains has been lower mean time between failures (MTBF), quantifiable savings and a stronger bottom line.

Conclusion

Competing and winning in the market for MTDC services isn't easy, but MTDC operators that make energy-efficiency a constant priority can earn solid, consistent profits just the same. As illustrated in particular by the experiences of Hurricane Electric Internet Services, utilizing new, more efficient UPSs; air containment solutions; and economizers can help MTDC owners reduce wasted power and ease cooling loads while actually enhancing reliability and agility. Therefore, MTDC vendors that wish to position themselves for long-term success should work with their power system and cooling providers to investigate the suitability of the efficiency best practices described in this paper for their environment.

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About the authors

Ed Spears is a product manager in Eaton's Power Quality Solutions organization in Raleigh, NC. A 30-year veteran in the power systems industry, he has experience in UPS systems testing, sales, applications engineering and training, as well as working in power quality engineering and marketing for telecommunications, data centers, cable television and broadband public networks. You can reach him at EdSpears@Eaton.com.

Benny Ng is director of infrastructure at Hurricane Electric Internet Services. Based in Fremont, Calif., Hurricane Electric operates its own global IPv4 and IPv6 network and is considered the largest IPv6 backbone in the world as measured by number of networks connected. Ng, who is a Certified Sustainable Building Advisor with Level I and Level II Building Operator Certifications, oversaw construction of both of the company's Fremont data centers. He has been with Hurricane Electric for more than 16 years.

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Eaton
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Cleveland, OH 44122
United States
Eaton.com

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