

Modernizing Vintage Data Centers

Improving the reliability, efficiency and effectiveness of older computing facilities by upgrading their power and cooling systems

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Executive summary

Most companies hope to get as much as 20 years of dependable service from their data centers. Unfortunately, there are many obstacles to achieving that length of service. In particular, some of the key mechanical, electrical and plumbing (MEP) components that data centers rely on are not designed to last that long. In addition, rapidly changing data processing requirements demand that data centers remain flexible and support greater rack densities.

Organizations with a data center 10 years of age or older have several options, including building a new data center, putting applications in the public cloud, leasing space in a colocation facility or modernizing the existing data center. Many companies looking to make the most of previous investments choose to modernize their existing facilities, as it can often be done more cost effectively than the other options and usually yields significant improvements in reliability, efficiency and operational effectiveness.

This white paper discusses how aging MEP infrastructure components can affect older data centers; suggests a series of beneficial upgrades; and outlines best practices for successfully planning, implementing and testing those renovations.

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Relevant data center trends

IT has changed in ways few data center designers could have anticipated a decade or more ago. Among the most important recent technologies and priorities are these:

Virtualization: Seeking to lower capital and operational expenses by consolidating underutilized hardware, businesses today are making widespread use of server virtualization, which enables a single physical server, also called a host, to support multiple virtual machines, each with its own operating system and applications.

Cloud computing: Companies looking to lower overhead and improve efficiency are rapidly adopting cloud computing. Indeed, analyst firm IDC expects global spending on public cloud solutions, which deliver applications and infrastructure resources via the Internet, to reach \$72.9 billion in 2015. Private cloud infrastructures, which employ the same basic technologies as public clouds but reside behind an individual organization's firewall, are swiftly gaining traction in corporate data centers as well.

Rising power densities: Virtualization, blade servers and cloud computing all pack greater numbers of hotter, more heavily utilized devices into smaller areas. As a result, all three technologies are radically increasing power densities in today's server racks. In fact, while a typical rack of conventional servers might draw 4 to 6 kW of power, a typical rack full of blade chassis can draw as much as 30 kW.

Power Density Level	Equipment Protected	Power in the Rack
Standard density	5 to 15 1U servers	2 to 4 kW
Medium density	15 to 30 1U servers	4 to 8 kW
High density	42 - 1U, or 2-3 blades	8 to 15 kW
Ultra High density	4 to 6 blade servers	15 to 30 kW

Figure 1: Virtualization, blade servers and cloud computing have combined to increase data center power densities dramatically.

Stronger focus on energy efficiency and sustainability: Climbing energy prices, increasingly strict government environmental regulations and growing concern over issues such as global warming and pollution have turned efficiency and sustainability into major priorities for businesses of every description. For help in measuring a data center's power efficiency and setting realistic efficiency improvement targets, most data center operators rely on a metric called Power Usage Effectiveness (PUE). Developed by The Green Grid, a technology industry non-profit consortium dedicated to raising data center efficiency, PUE divides the total power entering an IT facility by the total power used by IT equipment in that facility. The closer the resulting figure is to 1.0, the more efficient the data center is.

Issues faced by vintage data centers

Older data centers are usually ill equipped to handle trends like those just discussed, for the following reasons:

- **Aging equipment:** In a vintage data center, core mechanical and electrical components such as uninterruptible power systems (UPSs), static transfer switches (STSs) and power distribution units (PDUs) are often nearing the end of their recommended service life. Over time, such systems inevitably become less reliable and more expensive to maintain.
- **Low efficiency power and cooling equipment:** Older mechanical and electrical systems also tend to deliver lower energy efficiency than newer, more modern products, further increasing operating costs.
- **Regulatory compliance issues:** Weak power and cooling efficiency can make complying with environmental regulations exceedingly difficult, if not impossible.
- **Insufficient cooling capacity or ineffective cooling:** The cooling systems used in most vintage data centers date back to an era of significantly lower power densities. As a result, they often struggle to cope with the intense heat generated by today's dense, power-hungry IT equipment.
- **Complex cabling:** Many older data centers feature intricate subfloor cabling schemes that impede airflows and complicate management.
- **Lack of flexibility and scalability:** Integration of newer IT technologies requires the MEP infrastructure to adapt to future changes and load demands to meet future business drivers while minimizing future capital expenditures. Virtualization and cloud environments can cause roaming hot spots in the data center due to dynamic shifting of workloads.

Recommended MEP infrastructure backbone upgrades

For many companies, updating an older data center is significantly less costly than constructing an entirely new facility. Here are some of the most cost-effective and practical steps organizations can take to increase the reliability, efficiency and capacity of a vintage computing facility:

Replace UPS hardware

Replacing older UPSs with newer models is a low-risk, relatively low-cost way to boost reliability. Furthermore, it can slash energy waste too. While late-model UPSs are often as little as 80 to 82 percent efficient under standard loading conditions, newer models routinely achieve 92 to 95 percent efficiency. The latest, most advanced UPSs, meanwhile, deliver 99 percent efficiency even at light loads.

Update power distribution systems

Installing modern rack PDUs equips older data centers to reliably and efficiently support higher power densities. In particular, 30-amp three-phase PDUs generally supply more than enough power for high-density racks without producing excessive amounts of heat. When larger, 50-amp rack PDUs are used, the high power density of the IT equipment inside often raises rack operating temperatures above the capacity of conventional cooling systems, forcing companies to invest in expensive liquid-based cooling solutions.

Updating an older data center's power distribution scheme from the PDU to the rack also provides an excellent opportunity to reposition subfloor cable runs above the server racks, where they're easier to access and less likely to weaken cooling efficiency.

Implement rack or aisle containment systems

Many vintage data centers employ cooling schemes based on so-called “chaos” air distribution methodologies, in which computer room air conditioning (CRAC) units around the perimeter of the white space pump out chilled air that both cools IT equipment and pushes hot server exhaust air towards the facility’s return air ducts. By allowing air to move freely throughout the data center, however, such techniques permit exhaust air to find its way back into server air intakes and cool supply air to join the return air stream, lowering cooling efficiency.

Employing a hot aisle/cold aisle rack orientation configuration, in which only hot air exhausts or cool air intakes face each other in a given row of server racks, marginally improves efficiency by generating convection currents that produce a cooling, continuous air flow. The most effective cooling schemes, however, utilize server rack containment technologies. Designed to organize and control air streams, containment solutions enclose server racks in sealed structures that capture hot exhaust air, vent it to the CRAC units and then deliver chilled air directly to the server equipment’s air intakes. The end results include enhanced efficiency, better reliability and lower energy bills.

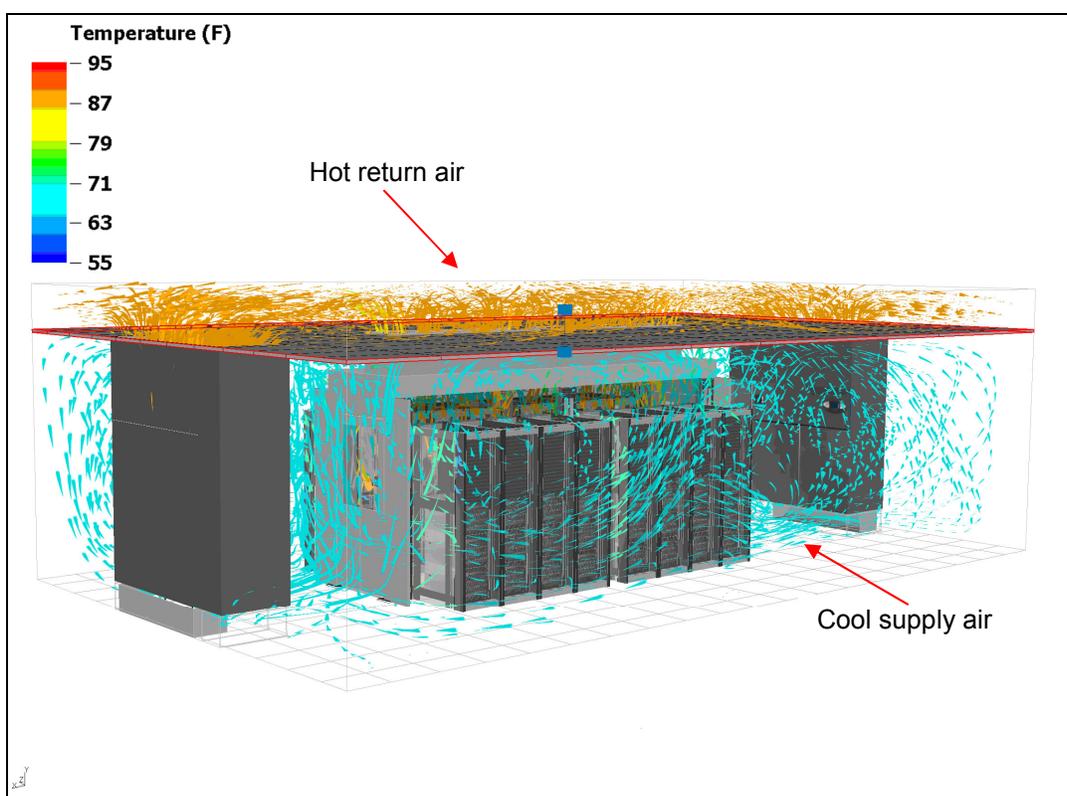


Figure 2. Containment-based cooling strategies improve efficiency by completely isolating the supply and return air streams.

Update components in electrical switching or distribution systems

The switching equipment used in many vintage data centers is designed to provide up to 20 years of service. However, organizations can improve the performance, safety and efficiency of their switches by servicing them regularly and updating circuit breakers and relay schemes after 10 to 12 years.

Install or upgrade monitoring and management systems

Many older data centers do not properly monitor resource usage, and those that do often use outdated monitoring and management hardware and software platforms. Installing or upgrading power and energy metering devices and reporting software allows data center managers to collect and archive enterprise-wide

power usage data that can be used to fine-tune energy management practices, calculate PUE ratios and perform forensic analysis of system failures and maintenance issues throughout the power chain.

Many newer monitoring systems can assist with operational tasks such as moves, adds and changes (MAC) and capacity planning.

Deploy a redundant electrical architecture

Data centers with a dual bus architecture contain two UPSs (or sets of UPSs), each with its own power path to the server racks. This approach allows critical workloads to remain operational even if one UPS fails or requires maintenance. While adding dual buses dramatically improves redundancy and availability, it also drives up capital and operational spending, making it an advisable option only for facilities that place an especially high premium on maintaining uptime.

Implement higher AC voltages to the rack

Higher AC voltages to the rack can increase efficiency in multiple ways. Delivering 400V or 480V in place of 208V enables data center managers to decrease losses in distribution cabling and remove transformers from the PDUs. This can deliver efficiency improvements between one and three percent in most data center configurations. It also, however, introduces heightened arc flash risks. For more information, see the [Eaton white paper on arc flash safety in 400V data centers](#).

Benefits of upgrading a vintage data center's MEP infrastructure

As the recommendations above make clear, modernizing a vintage data center's mechanical and electrical infrastructure can enhance availability, raise power and cooling capacity, lower operational expenses and reduce greenhouse gas emissions. It can also, however, yield these additional and perhaps less obvious advantages:

- **Improved safety levels:** Implementing upgrades to power distribution equipment yields improved arc safety and ease of maintenance, as well as opportunities to take advantage of remote operating equipment. Upgrading fire detection and suppression systems can remove water from the data center and replace it with alternate technologies.
- **Enhanced flexibility and functionality:** A modernized data center is better equipped to accommodate a wider range of recent technologies, such as cloud computing. It's also more capable of supporting even newer innovations in the future.
- **Improved serviceability:** Retrofitting a vintage data center's MEP systems usually improves their redundancy, making it easier for administrators to repair power equipment or perform necessary maintenance tasks without lowering availability.
- **Greater scalability:** Increasing a vintage data center's power and cooling capacity enables companies to maximize their use of virtualization and blade servers, technologies that increase scalability by freeing up floor space for future expansion.
- **Enhanced customer perception:** Multi-tenant data centers such as colocation or managed hosting sites often use their facilities as a marketing tool to prospective customers. Presenting a modern state-of-the-art appearance in areas such as system design and aesthetics can help organizations differentiate their data center or validate the price of their services

Challenges of upgrading vintage data center infrastructure

Despite their many benefits, data center upgrades also pose a variety of significant planning and operational challenges, including these:

- **Funding the project:** Before data center managers can update a vintage computing facility, they must first persuade senior executives to fund and authorize such a project. That means building a detailed and persuasive business model complete with concrete ROI calculations. Without prior experience, however, assembling such facts and figures can be difficult.
- **Out-of-date documentation:** Retrofitting an older data center's electrical systems haphazardly can result in overloads and other dangerous conditions. To prevent such problems from occurring, facilities managers need access to complete and accurate blueprints of the data center's existing electrical infrastructure. Unfortunately, however, many companies neglect to keep those documents up to date.
- **Risk of downtime during construction:** Few companies can afford to take a vintage data center offline for months at a time during upgrades. Yet replacing electrical and mechanical systems in a live, production environment without affecting availability can be a demanding task and requires careful planning
- **Code compliance:** Data center operators must verify that any changes they make to a vintage facility's electrical systems comply with current arc flash safety requirements. Conducting thorough arc flash studies without jeopardizing critical workloads, however, takes specific engineering knowledge and skills.

Key steps in an optimal vintage data center upgrade

Renovating a vintage data center's MEP infrastructure is a complex undertaking that defies easy summarization. Here, however, is an introductory overview of the most critical stages in that process:

Assembling the right project team

The project team for a data center upgrade should include all relevant stakeholders from within the organization as well as a complete set of appropriate vendor partners. Internal stakeholders should be in agreement with respect to goals and objectives for the project, and there should be no organizational silos between the IT and facilities departments. Make sure that vendor partners under consideration have documented proof of having successfully completed similar projects under similar circumstances in the past.

Assessment and planning

Before commencing a data center upgrade, organizations should create a complete list of their facility's limitations and identify multiple options for overcoming them. There are numerous possible solutions to any given data center problem, and evaluating all of them is the best way to ensure that you select the best approach available for your specific needs. A vendor with expertise in data center modernization can help identify appropriate options to study.

Establishing the business case

Once they've identified potential options, businesses must weigh their costs and benefits and then decide which ones make the most sense to pursue. Based on that analysis, managers can then prepare a business case for securing adequate funding.

Note that while cost saving and return on investment are likely to figure prominently in the business case for a data center modernization project, non-fiscal considerations are often important as well. For example,

sometimes the strongest justification for a data center upgrade is that accomplishing your organization's long-term strategic goals will be impossible without it.

Note also that many utilities, governments and regulatory bodies offer financial incentives to data centers that significantly improve their energy efficiency. Though no comprehensive catalog of such programs exists at present, an experienced vendor can help businesses determine which offers are applicable to their initiative. Be advised that many rebate programs require organizations to apply for and receive the rebate before *any* construction work commences.

Setting project objectives

After receiving funding approval, data center managers should create a list of goals and success criteria for their upgrade effort that clearly specifies not only which infrastructure changes are within the project's scope but which are not as well.

Creating a project plan

The next step is preparing a thorough plan of action, including a realistic schedule. In addition, a well-written project plan should:

- Indicate precise steps for minimizing disruption to production workloads during upgrades, assuming the data center must remain operational throughout that process.
- List potential issues that could arise while work is underway and define contingency measures for addressing them. What will you do if an electrician accidentally severs the building's main circuit, for example, or your entire facility temporarily loses Internet connectivity? Finding solutions to such problems before they arise can save precious time later.

Executing the plan

To ensure quality results, businesses should work only with contractors that have exceptional project management abilities and a demonstrated history of completing similarly ambitious efforts on time and under budget. It is also important to make certain that the project manager holds meetings at frequent and regular intervals to ensure that the project is following the agreed upon schedule and that any issues are addressed promptly

Updating blueprints

Though a largely administrative step in the retrofit process, updating the data center's blueprints is an important best practice that will make life significantly easier for future IT and facilities managers. To ensure that revised drawings are as accurate as possible, organizations should hire an engineer or draftsman to assist them.

Conducting tests

The commissioning process for an upgraded data center should include careful testing of any system that has been changed, added or replaced. Such tests should assess modified components both individually and collectively. For example, if an organization updated its UPS hardware, deployed new PDUs and installed aisle or rack containment cooling, it should confirm that each of those systems functions properly on its own and then verify that they also work correctly together by subjecting them to various simulated workloads.

Validating results

Before putting their upgraded data center into production, companies should return to the goals and objectives they defined earlier and validate that they've achieved all of them. This should be a rigorous and objective evaluation of the modernized facility's real-world performance and capabilities, executed with the assistance of a knowledgeable vendor consultant.

Performing an arc flash hazard analysis

If a data center retrofit included electrical changes, checking the revised infrastructure for compliance with current arc flash safety codes is critical. An arc flash hazard analysis can help businesses spot arc flash risks and identify appropriate mitigation strategies. Data centers should always conduct hazard studies in partnership with a qualified power systems engineer.

Conclusion

The world of technology has seen plenty of change in recent years. To keep up with it, organizations with data centers that are 10 years of age or older should seriously consider modernizing those facilities. Upgrading a vintage data center's mechanical and electrical infrastructure can boost reliability, efficiency, flexibility and scalability, while simultaneously reducing operational spending. It can also save companies the considerable expense of building entirely new facilities.

Though upgrading a vintage data center isn't simple, careful planning and skilled execution can dramatically streamline the process and strengthen return on investment. Above all, organizations contemplating a retrofit of an older data center's MEP infrastructure should seek assistance from a skilled vendor with deep and relevant experience.

About Eaton

Eaton Corporation is a diversified power management company with more than 100 years of experience providing energy-efficient solutions that help our customers effectively manage electrical, hydraulic and mechanical power. With 2011 sales of \$16.0 billion, Eaton is a global technology leader in electrical components, systems and services for power quality, distribution and control; hydraulics components, systems and services for industrial and mobile equipment; aerospace fuel, hydraulic and pneumatic systems for commercial and military use; and truck and automotive drivetrain and powertrain systems for performance, fuel economy and safety. Eaton has approximately 73,000 employees and sells products to customers in more than 150 countries. For more information, visit www.eaton.com.

About the author

John Collins has more than 18 years of experience in the data center industry. He joined Eaton in January 2011 and is solely focused on ensuring the company's data center products and solution offerings evolve with the market. John previously held various roles in sales, sales management, and product management, where he was responsible for various global product offerings relating to power generation, power quality, and power distribution. He's currently involved in many industry groups, including The Green Grid, 7x24 Exchange and AFCOM. John received his bachelor of science in electrical engineering from the University of Rhode Island and served for 10 years in the U.S. Marine Corps.

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