

# Integrating People, Process and Technology to Transform Data Center Operations and Performance

*A White Paper on Data Center Efficiency*

## Executive Summary

Data centers must become more efficient, reliable and agile to support future business growth. Yet the problems of the past—low utilization, lack of visibility and inefficient equipment and processes—are holding many organizations back from achieving the required transformation.

The solution requires tighter integration between the three core elements of the data center: people, process and technology. People are ultimately accountable for data center performance and preparing for the future, requiring data center management to rise above a narrow focus on system-level performance to consider how data center systems work together to support performance objectives. This can only be achieved when the right technology is in place. First, it requires a robust and adaptive infrastructure that can minimize ongoing operating problems and enable—rather than restrict—change. Equally important is technology that delivers real-time visibility into how changes in demand and operating conditions in one system impact related systems. Armed with these technologies, data center management can implement the equipment and process changes needed to resolve the problems of the past and allow them to achieve the efficiency, availability and agility their organizations will increasingly demand of them.

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## Introduction

The data center is at a critical stage in its evolution. During the high-growth years of 2003-2008, many organizations scrambled to keep up with capacity demands, often compromising long-term planning and efficiency for speed of deployment. When the 2008 global economic crisis hit and capacity demands eased, those organizations found themselves with a mix of dated infrastructure technologies, inefficient change management processes and an incomplete picture of what they had and how it was being used. Unfortunately, they also found themselves without the resources to address these fundamental problems.

Now, as budgets return to “normal” levels and the world becomes more social, mobile and cloud-based, businesses looking to use technology to support and spur growth face a dual challenge: fixing the problems of the past while simultaneously preparing for the future.

Those problems haunt data center managers in at least four ways:

### 1. Operational inefficiency

Few issues have gotten as much press in the data center industry as energy efficiency. Yet inefficiency is still the norm. McKinsey and Company, on behalf of the *New York Times*, analyzed energy use by data centers in 2012 and found that “on average, they were using only six percent to 12 percent of the electricity powering their servers to perform computations. The rest was essentially used to keep servers idling.”

Two things became clear. First, improving data center efficiency was not as easy as some made it out to be. Second, focusing too narrowly on energy consumption addresses only one aspect of the challenge. The energy savings realized through improved efficiency, while often significant, can easily be dwarfed by the savings in capital and human resources realized through true operational efficiency.

### 2. Insufficient asset visibility

How can an organization improve utilization without knowing what resources exist and how they are used? Many organizations have consistently added new servers without decommissioning older servers, creating sprawl and stranded capacity. Once this problem is established, it requires an investment of time and resources—as well as process changes—to develop and maintain an accurate map of data center assets. This lack of visibility also extends to costs. Most organizations do not have visibility into asset operating costs, and therefore can’t quantify how much could be saved if asset utilization was increased.

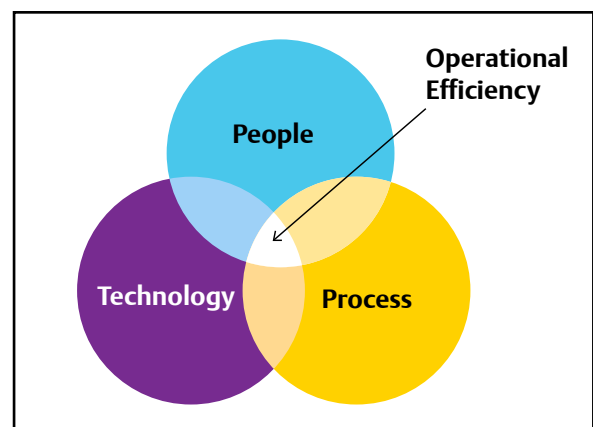
### 3. Low resource utilization

Return on capital is an increasingly important measure of IT effectiveness. For existing facilities, increasing the return on capital means getting utilization rates up from the dismal levels McKinsey found in their study and extending equipment life. This also drives up operational efficiency as energy is not wasted on idle servers, and service and support resources can be focused on productive assets. For new data centers, it means achieving higher levels of operational efficiency at startup without sacrificing future flexibility.

### 4. Inefficient change management

Poor change management processes have created many of the problems that exist today. Too often, the people responsible for deploying new equipment don’t have visibility into all of the systems impacted by the change. One may have a view of available rack space but not power and cooling capacity, while another has visibility into the virtual layer but not the physical. The result is that change processes take too long, make inefficient use of human resources and can introduce vulnerabilities.

These factors all contribute to an IT infrastructure that is inefficient—in terms of energy, human resources and capital—cannot respond quickly to change and is vulnerable to downtime. Those consequences are becoming increasingly intolerable to organizations looking to use information technology to support data-driven decision making, spur innovation and attract and serve customers. Solving them requires the move toward a holistic approach to data center management that rises above organizational, system-level silos while optimizing the interaction of people, process and technology to achieve true operational efficiency.



**Figure 1. Operational efficiency requires an approach that optimizes the relationships between people, process and technology.**

## People: Managing the Present with an Eye on the Future

What if you were offered a job as the manager of a factory that supplied all the food for your town? The town has no way to preserve food, so the factory produces meals just in time to be consumed. If the factory goes down, people go hungry; if it stays down for too long, their survival is jeopardized. The factory is filled with equipment that is running non-stop, but only 10 percent of the equipment is actually producing food at any given time. Unproductive equipment consumes a big part of your operating budget but it can't be shut down because no one is sure which equipment is productive and which isn't. You know you will need to spend all of your time preventing 99 percent of the things that could go wrong with the factory's fragile and complicated systems from actually going wrong, which no one will appreciate. Instead, they will blame you for every problem. Plus, you suspect the population of the town is growing; it won't be long before the town's hunger exceeds your ability to produce food. The owner of the business doesn't understand why it costs so much to produce the town's food, while the townspeople are always complaining that you don't cater to every craving.

Would you take the job? If you manage a data center, you already have. And, you probably don't regret it, because, while the job is incredibly difficult and sometimes thankless, it is now at the center of the IT universe and has never been more important to business success.

However, you do face the same challenge as the manager of that hypothetical food factory: finding the time and resources to address the causes of the inefficiencies and vulnerabilities that threaten operations today and limit your ability to prepare for the future.

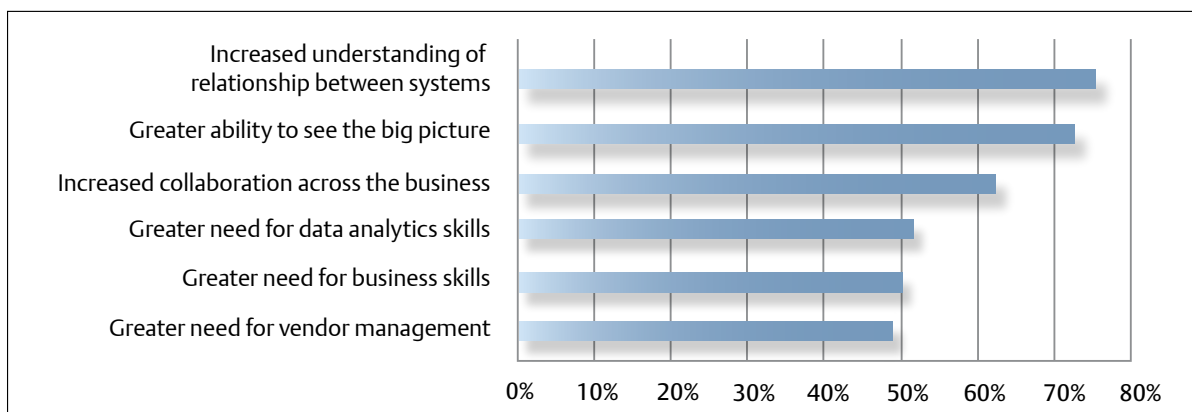
## The Evolving Data Center Management Skill Set

When participants in the spring 2013 Data Center Users' Group (DCUG) survey, sponsored by Emerson Network Power, were asked how they expected the skill set of data center managers to change in the next five years, exactly zero percent said there would be no change. The majority saw multiple changes on the horizon (Figure 2).

The two changes identified most frequently by respondents fall under the category of managing more holistically. Seventy-five percent believed they will need an increased understanding of the relationship between various systems, while 73 percent identified the need for a greater ability to see the big picture.

The fact that data center managers don't have these capabilities today speaks to the complexity of the current environment and the lack of management tools that can provide the required visibility and control. Acquiring these new "skills" or capabilities is essential to addressing the challenges identified earlier in this paper. Rather than attempting to optimize individual systems for efficiency and availability, the data center of the future will need to be managed as an ecosystem in which all of the components are related to and, to varying degrees, dependent on other components.

The next two new skill sets identified by the DCUG survey—increased collaboration (64 percent) and increased data analysis (52 percent)—are related to the Big Data trend.



**Figure 2. Changes to the data center skill set required in the next five years, as identified by DCUG members.**

In November, 2012, the *Harvard Business Review* wrote that data-driven decision making “has the potential to revolutionize management.” That could put IT squarely in the center of a management revolution. Supporting that revolution within the business requires that data center managers be able to consolidate and mine the unprecedented volume of data created by social media, ecommerce and other digital transactions while also becoming a resource for executives across the business seeking to use that data. That means collaborating with marketing, product development, human resources and other departments to develop, execute and support Big Data strategies.

Organizations that successfully address this challenge will experience significant benefits. Through research supporting its Big Data feature, the *Harvard Business Review* found that “companies in the top third of their industry in the use of data-driven decision making were five percent more productive and six percent more profitable than competitors.” When IT contributes to improvements of that nature and magnitude, it becomes a strategic asset to the business.

Closer to home, the data center management team will be expected to participate in this revolution by aggregating and analyzing IT data across the enterprise to identify vulnerabilities and make more informed decisions on IT spend and resource allocation. Management systems capable of transforming the stream of real-time operating data into meaningful information will finally allow management to see the relationships between systems and manage them holistically.

The final two changes in the data center skill set identified by the DCUG survey reveal the need for greater business and vendor management skills. The first may be partly driven by the growing number of data centers that are directly connected to revenue generation and therefore are more integral to business operations. Executives responsible for those facilities need to stay current on technology while also understanding—and anticipating—business demands and objectives.

*The data center management team will be expected to participate in the Big Data revolution by aggregating and analyzing IT data across the enterprise to identify vulnerabilities and make more informed decisions on IT spend and resource allocation*

Business skills will also grow in importance for those in organizations that deploy internal clouds and charge back IT services, effectively transforming Information Technology from a service that supports the business to a business that delivers services.

Vendor and partner management skills are expected to grow in importance as organizations rely more on cloud services. Instead of just providing the technology systems on which the business depends, vendors will increasingly be hosting the applications and storing data critical to day-to-day business operations. Problems resulting from poor vendor selection and management will have a more immediate and direct impact on business operations.

## Strategies for Adapting

In light of the current operational issues many organizations face and the pressing need to evolve toward more holistic management, the challenge for data center managers seems daunting. But there are strategies for finding a better balance between the demands of today and the needs of the future:

### 1. Explore the potential of new data center infrastructure management (DCIM) platforms

As the data center became more complex, the need to consolidate and analyze data across systems increased; however, that same complexity made it harder to achieve real-time visibility across systems. Previous-generation management systems simply didn't have the scale or sophistication to bring together the necessary data and convert it into a meaningful view of real-time operations.

Current-generation systems have overcome this challenge through the use of dedicated appliances capable of consolidating data from across systems and the environment to provide a meaningful view of real-time operations. This development essentially breaks through the current system-level management ceiling that has prevented data center managers from seeing the big picture.

### 2. Break down organizational silos

With a holistic, real-time view of data center operations, it becomes easier to break down organizational silos based on data center systems. System-level expertise will remain critical to successful data center operations but it is most valuable when system-level experts share the same view of operations and work together. Geographic silos can also impede optimization. More organizations are seeking global service partners than can deliver consistent support and services anywhere in the world.

### 3. Supplement internal skills as necessary

Based on the changes to the data center skill set identified by the DCUG, the data center manager of the future will be expected to operate more like a "general contractor," managing to the big picture, collaborating across the business and actively managing a network of partners that deliver specific skills and capabilities.

*System-level expertise will remain critical to successful data center operations but it is most valuable when system-level experts share the same view of operations and work together.*

## Process: Enhancing Operational Efficiency

Process inefficiencies, often overlooked in the race to deploy new technology, can rob an IT organization of its agility, divert human resources from strategic pursuits and introduce vulnerabilities that lead to downtime. Typically, these inefficiencies can be traced to one of four causes:

### 1. Overdependence on manual processes

With the monitoring technologies available today, it no longer makes sense to have data center personnel walking the floor to monitor equipment status or take inventory. Data center management teams have to shed the "cobbler's children" mentality in which they are so occupied supporting service delivery that they lag the rest of the business in adopting technology to automate processes.

### 2. Information silos

When operating data is fragmented across the organization, personnel have to either chase down information from multiple sources or make decisions without a full understanding of the impact on interdependent systems, potentially creating new problems to be addressed.

### 3. Insufficient information

Worse than having to chase data is not having any way to acquire it. This forces decision-making based on instinct rather than data.

### 4. Poorly defined processes

In some cases adequate, processes have not been defined or documented. This is particularly true for tasks that occur less frequently, such as commissioning or service.

These process inefficiencies manifest themselves in every phase of the data center lifecycle, from planning and commissioning to ongoing management.

## Planning and Commissioning

Nearly 70 percent of early equipment failures can be traced to design, installation or startup deficiencies. Inefficiencies in the planning phase of a new facility or build-out not only increase the risk of failure but also create future problems when additional capacity is required. These can result from insufficient information regarding the needs of the business and best practices and technologies available to meet those needs. One example is planning data center space before design criteria have been finalized. A proper understanding of data center infrastructure technologies and the densities that can safely be achieved can have a significant impact on data center costs and growth plans. Best practice infrastructure designs that can be tailored to business requirements, along with use of standardized technologies, mitigate many of the risks associated with planning data center infrastructure.

Commissioning can also introduce problems. Improper coordination and calibration of protective devices, wiring errors, design errors and other issues can all affect equipment performance. These can generally be avoided through a thorough and systematic commissioning process. This is a time when a professional service organization with the ability to test system components together prior to installation and conduct on-site inspection and testing prior to startup can deliver significant value. Commissioning and startup testing also provides baseline information that can be used to evaluate future maintenance decisions.

## Management and Optimization

Lack of visibility into assets is a recurring theme when discussing the causes of operational inefficiency. This can be corrected by creating and maintaining a visual model of the data center environment that includes equipment location and specifications. This model often replaces multiple spreadsheets, consolidates information from various sources to streamline processes and enables data center management to perform what-if scenarios to determine the impact of changes before they are made.

Once established, it becomes a foundational management tool that drives greater efficiency, agility and availability.

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Equipment monitoring enables some manual processes to be eliminated and is essential to achieving higher availability levels. The ability to receive immediate notification of a failure—or an event that could ultimately lead to a failure—through a centralized system allows for a faster, more effective response to system problems. Equally important, a centralized alarm management system provides a single window into data center operations that prioritizes alarms by criticality, ensuring the most serious incidents receive priority attention. Taken a step further, data from the monitoring system can be used to analyze equipment operating trends and develop more effective preventive maintenance programs.

Preventive maintenance is another area where poorly defined or executed processes can have disastrous consequences. Emerson Network Power analyzed data collected by its service organization, which maintains the most extensive database of service-related events for large UPS systems in the industry, and developed a mathematical model that projects the impact of preventive maintenance on UPS reliability. These calculations indicate that the UPS Mean Time Between Failures (MTBF) for units that received two preventive service events a year is 23 times higher than a machine with no preventive maintenance service events per year.

Monitoring and preventive maintenance can help eliminate some of the issues that prevent organizations from addressing the causes of inefficiencies. Once these preventive measures are in place, the management team can begin to shift the focus from short-term issue resolution to longer-term optimization.

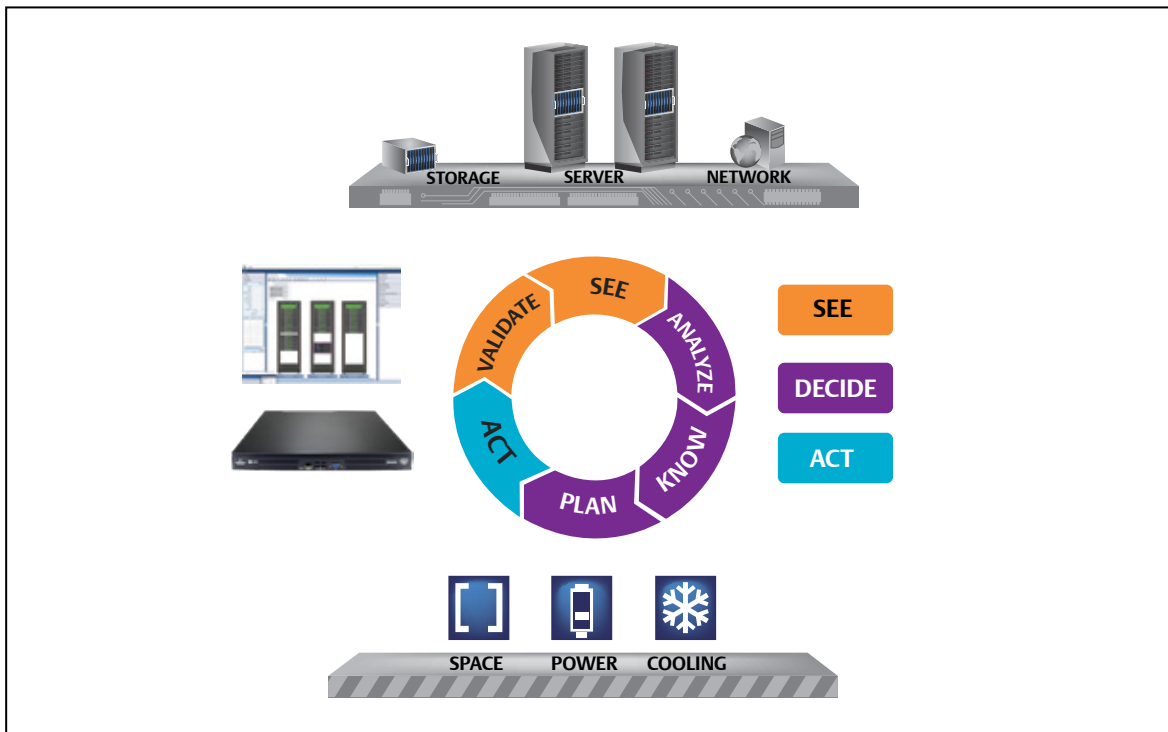
For example, the best view of IT power consumption comes from the power distribution units inside racks. They can provide receptacle-level visibility into volts, kilowatts (kW), amps and kW per hour, providing a detailed view of data center energy consumption. When this data is consolidated with data from service-level processors within the IT equipment, it allows unproductive servers to be identified and decommissioned while supporting more dynamic capacity management. Problems like resource utilization can begin to be addressed.

DCIM platforms support this type of active optimization by delivering a more holistic view of operations. The challenge is implementing a system that can handle the huge amounts of data generated by data center systems. The data center appliance mentioned previously is designed specifically to collect data from a variety of devices that share these critical characteristics:

- **Real-time:** Historical data may come too late to be useful or may not accurately reflect current conditions. An effective DCIM system uses real-time performance data so that management can know exactly what is happening at any given time and can model the impact of planned change to understand the consequences immediately.
- **Contextual:** It's no use collecting data across different types of devices if that data can't be translated and put into context that allows performance across systems to be understood.
- **Prioritized:** The problem data center managers face isn't too little information. It is too much. Data used by the management system must be prioritized to ensure that critical operating data is not overwhelmed by less important information.

By bringing together real-time information from across the data center, putting it into context and presenting in ways that support effective decision making, DCIM frees data center managers from managing blind and gives them the ability to unify IT and facilities data to achieve:

- **Higher availability** by recognizing dependencies and understand performance in real time, predict the impact of change and automate complex event management and alarm notifications.
- **Better efficiency** through a comprehensive inventory of every asset's floor or rack position, role-based user interfaces that simplify the use of detailed data and a unified view of the data center that facilitates collaborative planning.
- **Increased utilization** through accurate insight into current usage, real-time, trend and historical change tracking and the ability to preview the impact of change before it is made.



**Figure 3. DCIM platforms provide data center managers with real-time, contextual, prioritized information that bridges the physical and IT layers of the data center infrastructure. This data helps them to 1) see the current state of their facilities, 2) make data-driven decisions for how to operate and optimize their infrastructures and 3) take action and measure the effectiveness of those actions.**

## Technology: Infrastructure that Creates the Foundation for Growth and Agility

The data center infrastructure—power and cooling systems that ensure safe and continuous operation—often represents the least agile and scalable component of the data center. If improperly designed and maintained, it can constrain growth and contribute to downtime. Conversely, the right infrastructure creates a foundation for continuous availability, increased return on capital and cost-effective growth.

### Strategies for Scalability

Heat density has been one of the top three concerns identified by the DCUG in eight of the last nine years. Yet, according to DCUG survey data, average rack power density in the data center was about the same in 2013 as in 2006, when the survey was initiated. This is likely the result of the influx of more efficient servers and greater virtualization and indicates there is an opportunity to add capacity by increasing rack density.

When rack densities rose to 6 kW in 2006, it created problems for many facilities that were still relying on a cooling infrastructure that was installed 10 or 15 years earlier and designed to handle densities of 1 to 3 kW per rack. Cooling technologies have evolved considerably since then.

Perimeter cooling systems now operate at much higher levels of efficiency and have built-in intelligence that allows them to communicate and collaborate. In addition, cooling has steadily migrated closer to the source of heat, increasing efficiency and the ability to cool higher density racks. Aisle- and rack-based systems can safely support 20 or 30 kW racks. With the proper power and cooling infrastructure in place, most data centers can double or triple their existing capacity without increasing data center space. This can also enhance data center efficiency, as denser data center environments are inherently more efficient than environments that spread out the load.

If additional capacity is required, an aisle-based or container-based expansion strategy can be employed in which initial capacity is met by the required number of aisles or containers but space and power capacity are reserved for the addition of future “modules.” When capacity is needed, additional aisles or containers—with integrated cooling, monitoring and power protection and distribution—can be added, enabling an easy-to-implement modular growth strategy.

This approach has been especially popular with organizations that need to expand quickly to react to market demands or opportunity, such as colocation providers, or those delivering cloud services. With proper planning, significant blocks of new capacity can be added in a fraction of the time it would take to conduct a traditional build-out or build a new data center. Because they have the ability to respond quickly, these organizations can reduce their upfront capital costs and increase operating efficiency by using a higher percentage of their operating capacity at startup.

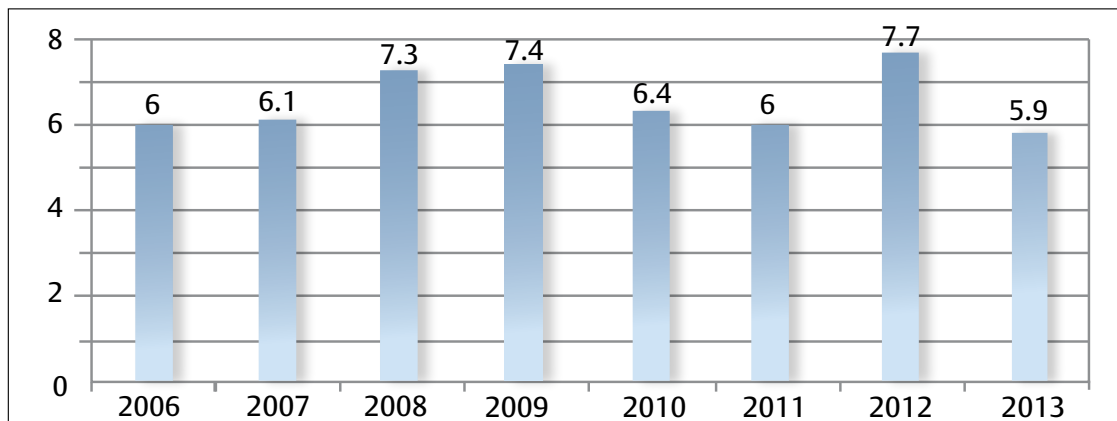


Figure 4. Changes to the average power density (in kW) per rack in the data center, as identified by DCUG members.



Alternately, capacity can be added through cloud or colocation providers, but even in this case, infrastructure remains an important consideration. First, the in-house data center infrastructure should be able to adapt to varying loads without compromising efficiency. Perhaps more importantly, the infrastructure of the cloud or colocation provider should be evaluated to ensure it uses technologies and configurations proven to support high availability.

### Protecting Availability

While it is difficult to predict exactly what will be expected from the data center of the future, it is hard to imagine a scenario in which downtime isn't a serious issue. Data centers attempting to completely eliminate power-related downtime generally use a dual-bus architecture to eliminate single points of failure across the entire power distribution system. This approach includes two or more independent UPS systems each capable of carrying the entire load with N capacity after any single failure within the electrical infrastructure. This is a proven approach for delivering Tier IV availability, but does require custom switchgear and limits power equipment utilization to 50 percent, impacting initial costs and operating costs.

Alternate configurations have emerged in recent years to support high availability while increasing power equipment utilization, including distributed reserve dual-bus architecture. Static transfer switches (STS) are used to provide redundancy across multiple UPS systems as well as the transfer switch itself (Figure 6).

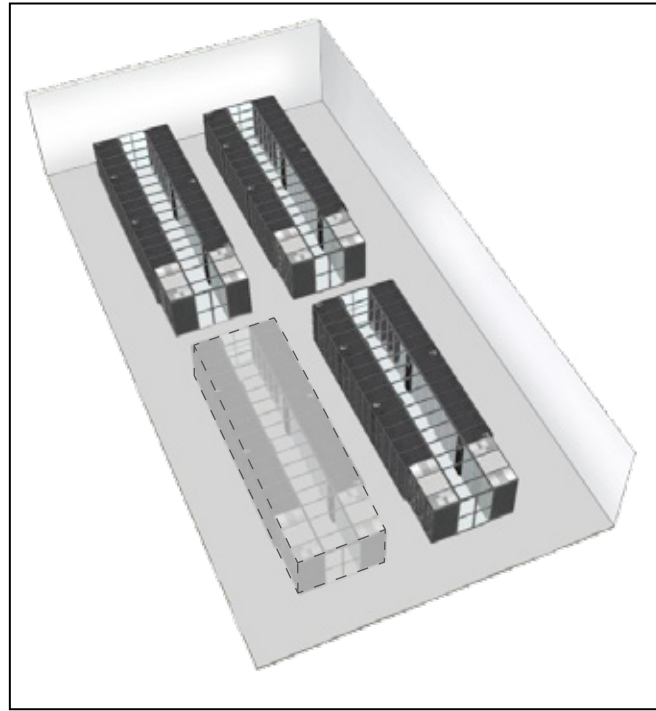


Figure 5. Aisle-based expansion module

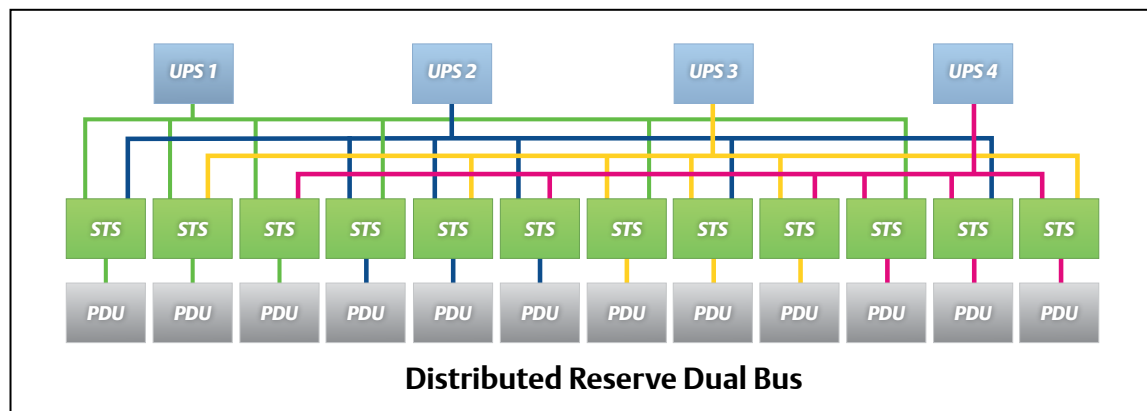
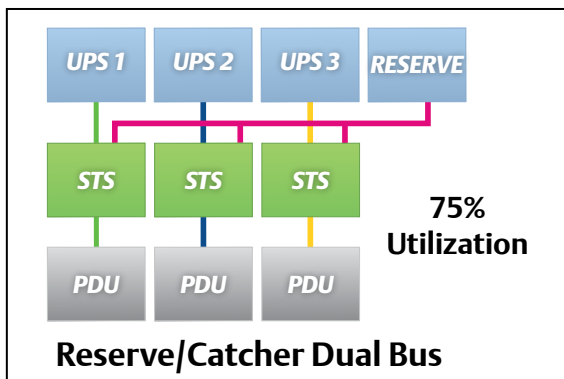


Figure 6. The distributed reserve dual-bus architecture uses multiple primary UPS systems, connected through standard static transfer switches, to increase power equipment utilization while delivering dual-bus protection.

A simpler version of this architecture is represented by the reserve-catcher dual bus. This approach is extremely attractive to organizations seeking dual-bus availability with lower initial costs and greater efficiency. Like the distributed-reverse dual bus, it uses static transfer switches as the power tie; however, instead of creating redundancy through distributed primary UPS systems, it uses a secondary or reserve system to provide dual-bus protection across multiple primary UPS systems. The result is lower initial costs than other dual bus approaches with increased power equipment utilization.



**Figure 7. The reserve-catcher dual bus represents an economical approach to dual bus protection, reducing initial costs and supporting higher utilization rates.**

Other less critical facilities may consider a parallel redundant configuration, such as the N + 1 architecture—in which “N” is the number of UPS units required to support the load and “+1” is an additional unit for redundancy. This architecture provides cost-effective scalability.

### Advancing Efficiency

For organizations seeking to optimize data center efficiency, Emerson’s Energy Logic provides a comprehensive, vendor-neutral approach to achieving meaningful reductions in data center energy costs. It maximizes ROI through the “cascade effect” in which efficiency improvements at the IT component level cascade out to reduce the demand on power and cooling, magnifying savings.

Power and cooling systems can be configured to increase efficiency, either within the framework of Energy Logic or independently. Double conversion UPS topologies deliver better protection than other types of UPS because they completely isolate sensitive electronics from the incoming power source, remove a wider range of disturbances and provide a seamless transition to backup power sources. With the combination of improved operating efficiencies and the use of Active Eco-Mode™, these robust power systems can achieve efficiencies of 98 percent. In addition, intelligent paralleling can improve the efficiency of redundant UPS systems in a parallel configuration by deactivating UPS modules that are not required to support the load and taking advantage of the inherent efficiency improvement available at higher loads. Additional efficiencies can also be achieved in the distribution system by bringing higher voltage power closer to the point of use, minimizing stepdown losses.

Cooling was once incorrectly identified as the chief villain in the data center energy crisis, but today’s technologies deliver outstanding efficiency by leveraging four trends.

#### 1. Cooling closer to the source of heat

A high-density cooling infrastructure that enables rack-centric cooling modules to be plugged in as needed brings unparalleled scalability and efficiency to data center thermal management. The next step in this migration is integrating the data center cooling system with the server, allowing heat to be removed before it leaves the rack and eliminating the need for server fans.

#### 2. Higher-efficiency, more responsive components and systems

Newer room cooling units using digital compressors have the ability to adapt their capacity to changing room conditions, eliminating the on-and-off cycling of previous generation systems that wasted energy and increased component wear. Electrically commutated (EC) fans in these units have also been proven to reduce fan power consumption by 18 percent to 30 percent compared to variable drive fans.

### 3. Increased use of outside air

Using outside air to provide “free-cooling” cycles reduces or eliminates chiller operation or compressor operation in precision cooling units, enabling economizer systems to generate cooling unit energy savings of 30 to 50 percent, depending on the average temperature and humidity conditions of the site. While often considered primarily a cold weather solution, economizers can provide benefits in more temperate climates as well. For example, in Atlanta, a data center with a leaving water temperature of 55° F will be able to use full economization about one-quarter of the time and partial economization an additional quarter of the time. This can create cooling energy savings of 43 percent.

### 4. Intelligent controls

Intelligent controls have enabled a shift from cooling control based on return air temperature to control based on conditions at the servers. This can allow temperatures in the cold aisle to be raised closer to the safe operating threshold now recommended by ASHRAE (max 80.5° F). Smarter controls also allow multiple cooling units to work together, shifting workloads to units operating at peak efficiency and preventing units in different locations from working at cross purposes.

## Conclusion: Bringing it Together to Optimize Performance

Just about every data center today faces a problem of “not enough.” Not enough power and cooling capacity, not enough space, not enough capital, not enough visibility into operations, not enough expertise or not enough time for planning. In some cases, not enough of all of the above.

No single technology or skill set or process change can remove all of the constraints that prevent organizations from optimizing data center performance and efficiency. But when people, process and technology are addressed through a systematic review and evolution of data center management skills, processes and technologies each of those constraints can be effectively overcome.

Here is how to get started:

- **Review existing data center processes**, including planning, commissioning, deployment and service to identify opportunities for automation and areas where necessary data or skills are creating inefficiencies in light of new technologies now available. If Microsoft Excel spreadsheets are critical to management, it is likely data is fragmented and personnel lack the visibility they need to manage change.
- **Analyze the skill set of the data center management team** in light of future requirements to identify opportunities for collaboration and areas where internal skills need to be supplemented with new hires or outside resources. In many cases, internal resources are willing and able to support emerging requirements but are so consumed reacting to unexpected events they don't have the time to be proactive. Eliminating process inefficiencies and infrastructure vulnerabilities can free up time for them to shift their focus from putting out fires to planning for the future.
- **Review current infrastructure technologies and configurations** for their ability to meet efficiency, availability and scalability goals. While many organizations may believe the only way to achieve those goals is with a new data center, significant improvements in all three areas can often be achieved through equipment upgrades. Consult with your infrastructure vendor to compare the return on investment of an infrastructure upgrade with that of a new data center.
- **Ensure the foundation for effective management is in place** in the form of an up-to-date visual model of the data center and centralized monitoring of infrastructure systems. This will likely include the deployment of a DCIM platform capable of providing a holistic view of data center operations based on real-time data that spans facilities and IT systems.

**Emerson Network Power-  
Global Headquarters**

1050 Dearborn Drive  
P.O. Box 29186  
Columbus, Ohio 43229  
United States Of America  
800 877 9222 Phone (U.S. & Canada Only)  
614 888 0246 Phone (Outside U.S.)  
614 841 6022 FAX  
Contact@EmersonNetworkPower.com

**liebert.com**

**Emerson Network Power**

**EmersonNetworkPower.com**

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