Data Center Optimization: A Guide to Creating Better Efficiency and Improving Rack Heat Density in Air Cooled Facilities

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Summary

The modern data center has changed. There are new demands around cloud computing, big data and infrastructure efficiency. This change is being driven by more users, more data and a lot more reliance on the infrastructure that make up the data center. With private cloud technologies and the rapid growth in data leading the way within many technological categories (the Internet of Things), working with the right data center optimization technologies has never been more important.

IT administrators must understand how to control their resources, align with the business and create greater levels of efficiency. Most of all, there are emerging challenges around the workload. With all of this in mind, how do you create efficiency levels that keep up with modern business demands? Do you know where data center demands have changed? What if your organization has compliance-bound workloads? How do you build business and end-user confidence with solid management best practices?

In this white paper, we explore new concepts around emerging data center demand, where energy efficiency and cooling optimization fit in and modern best practices around your data center.

Introduction

There is a revolution happening in the data center environment. Administrators are being tasked with delivering much more, while still retaining optimal efficiency levels. Let us consider an example—globally, data center power consumption has been growing. In fact, a 2015 NRDC[1] report indicates that data center electricity consumption is projected to increase to roughly 140 billion kilowatt-hours annually by 2020. This is the equivalent annual output of 50 power plants, costing U.S. businesses $13 billion annually in electricity bills. As more organizations place their assets into the data enter, good data center management becomes extremely important for multiple reasons we will describe in more detail in this paper.

Not only are data center administrators working hard to cut costs, they are also working hard to minimize management overhead and improve infrastructure agility.

By using intelligent and scalable platforms, your organization can reduce resource allocation, improve cloud utilization and more. Solid data center platforms empower your data center to consume less energy and trim infrastructure costs. It is more money to your business in return.

In this white paper, we will discuss the following key topics so that your data center operate more efficiently and cost-effectively:

- Growing energy utilization
- Creating cooling efficiencies
- Enabling efficiency best practices

Furthermore, we will look at great ways to overcome cooling, energy and even design challenges.

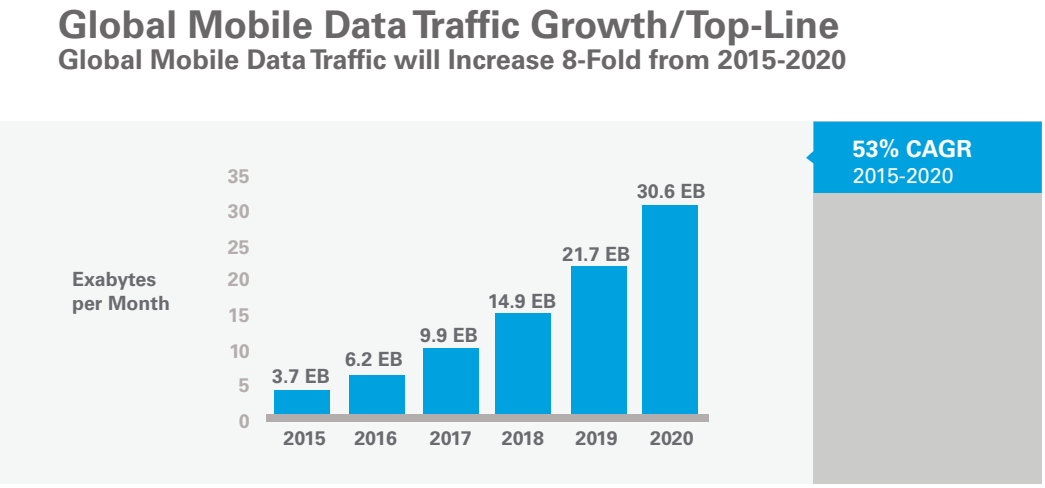
Growing Data Center Needs and Managing Efficiency

As technologies surrounding cloud computing and convergence continue to push forward, the data center environment will be required to support these platforms. Data center resource utilization will be directly impacted as a result. IT administrators must work to identify where their resources are currently allocated and how they can be optimized. Most of all, they must be aware of new technologies that may directly affect overall data center optimization.

Growing Data Center Utilization, Increasing Rack Densities and the Internet of Things (IoT)

As businesses focus on getting products out to the market faster, increasing efficiency and innovation, and as the global population becomes highly connected to mobile devices, the IoT is expected to grow exponentially.

Cisco estimates the IoT will consist of 50 billion objects connected to the Internet by 2020, and that there will be 4.1 billion Internet users, up from 3 billion users in 2015. Additionally, by 2020, there will be 26.3 billion networked devices and connections globally, up from 16.3 billion in 2015.



Source: Cisco VNI Global Mobile Data Traffic Forecast, 2015-2020[2]

Simply put, there will be no industry that will not be affected by this digitalization transformation. In this scenario, the data center has become a very relevant part of any industry or market.

In parallel to the growing need for compute power and rack densities in data centers, there are energy efficiency targets that must be met to address current environmental laws. Items that would have an impact on energy efficiency in data centers include server hardware design (producing less heat), more intelligent power management products, improved environmental cooling control tools, data center monitoring tools and more.

Additionally, data center administrators still have to face other concerns such as operating and upgrading costs. In a recent Green Grid research into European data center usage, energy efficiency and operating costs are the most common areas of the data center reported as requiring improvement. Furthermore, the difficulty in predicting future cost (43 percent) and the cost of refreshing hardware (37 percent) are cited as top challenges of developing resource efficient data centers, along with a difficulty of meeting environmental targets (33 percent).

The future requires intelligent products

As indicated above, rack power densities and energy efficiency are going to be top concerns in the near future.

To overcome these challenges and be prepared for the future, data center administrators must deploy intelligent technologies.

Power and Energy Considerations

The latest AFCOM State of the Data Center[3] report showed that 70 percent of respondents indicated that power density (per rack) has increased over the past 3 years, and 26 percent indicated that this increase was significant. Because of the big dependency around data center services, redundancy and uptime are big concerns. There are fairly steady trends around redundant power levels spanning today and the next three years. For example, the report shows that at least 55 percent already have, and will continue to have, N+1 redundancy levels. Similarly, no more than 5 percent of respondents either currently have, or will have, 2(N+1) redundant power systems. For the most part, data center managers are using at least one level of redundancy for power.

To successfully sustain higher power densities, it is important to define the power requirements and monitor the power use in the data center. Resource needs will fluctuate with the evolution of the business and technological advancements, so do not limit yourself with architecture that specifies limited power capabilities. When it comes to power and energy, consider the following:

- Power monitoring and utility grid diversification
- Cooling integration
- Systems that support N+1 or higher power redundancy
- Technologies that enable an energy-efficient facility

On that note, given the current focus on the environmental effects of data centers in today's "green" culture, many data center technologies are taking a closer look at ways to improve their cooling and power efficiency. Data centers are replacing constant speed pumps and fans in their cooling plants with variable frequency motors, which can match cooling demand to supply more accurately. They're also investing in smart, automated ways to configure and operate their cooling, including power plants in response to data floor and outside temperatures and humidity.

Remember, it's not just about infrastructure efficiency, an entire building can also be certified as an environmentally friendly facility, including the data center space. New kinds of cooling and energy efficiency technologies can help organizations achieve the very coveted LEED certification/BREEAM Certification, which is one the highest efficiency marks a facility can obtain today. These efficiency systems can contribute to achieving 12-20 credits in the areas of advanced energy metering, low-emitting materials, interior lighting and optimized energy performance.

Cooling Considerations

Like power, cooling must be a big consideration in the new data center age. Data centers are increasing density, and cooling is critical to keep operations running efficiently. As the AFCOM State of the Data Center report indicates, 58 percent of the respondents currently run and will continue to run at least N+1 redundant cooling systems, with 18 percent operating an N+2 cooling redundancy architecture. This means you should look for technologies that allow for Tier IV operation, as they present no potential points of failure around redundant systems.

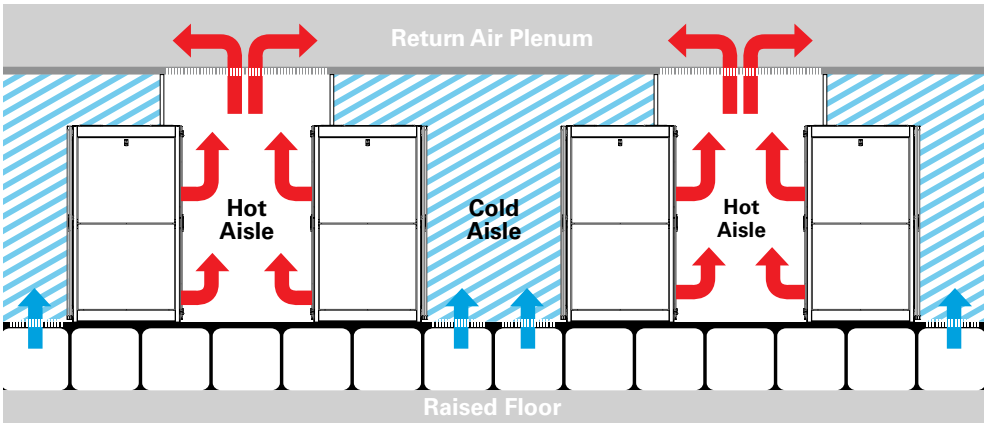
The idea is simple: "Measure, improve, maintain and evolve." This means using continuously proactive tools that maintain clear visibility into data center efficiency. Data center efficiency scales far beyond power alone.

As rack heat densities approach and increase above 5kW, holistic cooling optimization technologies are able to offer approaches such as containment systems, cabinets with enhanced sealing features and energy-efficient computer room layouts. Remember, cooling energy inefficiencies expose the data center to:

(A) Poor separation of hot and cold air, causing loss of cooling effectiveness
(B) Air leaking through cabinets, allowing hot air circulation back into equipment inlets instead of flowing into the CRAC units
(C) Airflow obstructions that constrict cooling airflow

To address these challenges, new types of aisle containment systems address thermal management, improving data center operational efficiency and reclaiming lost power. It's critical to ensure that airflow is well controlled and that hot/cold aisle containment is in place. Efficient aisle control, as well as good environmental management, can really help a data center remain environmentally conscious. Furthermore, aisle containment can improve airflow and cooling efficiency by as much as 10 percent, according to Gartner Analyst, Dave Cappuccio.

Aisle containment provides physical separation of cold and hot exhaust air by enclosing the hot or cold aisle or ducting hot air away from cabinets with "chimneys" that facilitate a cool air supply to equipment air intakes at the desired, uniform temperature. Hot aisle containment or ducted cabinets provide similar results. In airflow management, the separation of hot and cold air within the server room is the first critical step to maximizing cooling system efficiency. Once airflows are separated, there is a wide range of adjustments to cooling systems that reduce operating cost and increase efficiencies. A successful airflow management also increases "free cooling" hours.



Have you looked at "free cooling?" Did you know that free cooling is recommended in ANSI/ASHRAE/IES Standard 90.1-2013[4], "Energy Standard for Buildings Except Low-Rise Residential Buildings?" Did you also know that free cooling helps save energy and will likely become a standard element within all data center environments?

Gartner goes on to define free cooling[5] as any technique used to reduce the energy consumed by cooling systems or the time that the cooling units run by using the outside temperature of air or water to cool the data center or other facilities. Generally, it comes from the use of air-side and water-side economizers. From there, air-side economizers work in two ways. Mainly, economizers use direct fresh-air cooling by filtering (and possibly adjusting the humidity of) outside air, which is piped in to cool the data center. In cold climates, it may even be warmed by the hot air being expelled, so as not to be too cold. Air-side economizers can also work without bringing direct air into the data center, but by heat transference from warmer inside air to cooler outside air.

Remember, there are big pluses to deploying an efficiency cooling system. A 2010 study shows how the advantages[6] of a 100-percent free cooled data center include the savings in air-conditioning equipment and monthly electrical bills for operating air-conditioners. Also, you're allowing your gear and infrastructure to operate more efficiently.

Optimizing the data center not only helps your organization regain control over valuable resources—it helps your administrators plan for the future.

Final Thoughts and Best Practices

The data center will always continue to evolve and expand. New technologies will continuously affect how you deploy resources, optimize workloads and even integrate cloud computing.

Consider this—The Green Grid hosted the first in a series of virtual roundtables to discuss its latest research in Europe into key trends impacting data center energy efficiency, monitoring tools and the pressures placed upon IT leaders to increase energy efficiency. What did trends show? There is still a lot of efficiency to be captured—and a lot of willingness to make the data center a lot more optimized. Their researched showed that:

- 88 percent stated that data centers are an important part of their Corporate Social Responsibility (CSR) strategy.
- However, nearly half (43 percent) have no energy efficiency objectives in place for the design and operation of their data centers.
- In addition, only 29 percent of organizations are able to entirely quantify the environmental impact of their data centers. (This is despite increasing pressure from both national and EU policy makers to improve environmental sustainability.)

Here's the big takeaway from the roundtables: 97 percent saw areas in which their data center monitoring, including energy efficiency, could be improved.

With all of this in mind, let's take a quick look at some best practices that will help your data center run much more efficiently now and into the future.

Address Airflow Management

Separate hot and cold air within your equipment rooms to boost cold air running through equipment. Specify cabinets that can provide a complete front/rear seal around equipment to maximize airflow through equipment. This typically requires an extra set of baffles for use within the cabinet, blanking panels for open rack spaces and a barrier at the base of the cabinet. Specify a method of hot/cold air separation within the room. There are three basic solutions: a "chimney" at the top of the cabinet to remove hot exhaust air from the cabinet, a hot aisle containment solution that is an enclosure built around the hot aisle, or a cold aisle containment solution, which is an enclosure built around the cold aisle.

Remove Barriers to Higher Power/Heat Densities

Removing constraints around critical airflow design opens the door to higher power and heat densities. High-density data centers feature robust airflow management design and practices where the cabinets function as a complete isolation barrier between supply and return air. This isolation is accomplished by a combination of accessories such as blanking filler panels, equipment mounting area perimeter sealing air dams and floor-tile cut-out brush seal grommets, along with a system to remove the return air from the room into a suspended ceiling return air space. Such a system would include a solid rear cabinet door with gasket seal and a vertical exhaust duct running between the cabinet and suspended ceiling. In this construction, there is no longer any dependency on how much air can be pushed through a single perforated floor tile, and there is no heated air anywhere in the room to prevent the use of cold air delivered anywhere into that room. As heat densities

increase beyond the level that could practically be achieved by under-floor air delivery without creating extra-wide cold aisles, the access floor can be eliminated altogether, and the room can be flooded with high volumes of cold air through wall grates or from overhead.

Track Rack Conditions and Environmental Variables

Keeping track of environment variables will help create a more efficient rack design. Some servers generate more heat, while others may need more power. By seeing what system is taking up which resources, administrators can better position their environment for optimal use. Work with solutions that can give you the ability to look into the thermal and environmental performance of your infrastructure. Using these tools, an organization can make better decisions on how to build their rack infrastructure. Furthermore, work with technologies that give you options around environmental enclosures, efficient network and server cabinets, and even designs supporting seismic protection. All of this improves data center efficiency, resiliency and redundancy.

Power Monitoring

Always monitor the power consumption rates of your environment. The idea here is not only to know how much power is being used, but to make the environment more efficient. Look for ways to save on power based on requirements. For example, certain power-heavy racks may need to be distributed more efficiently, thus saving on power consumption and costs. Also, as space becomes a concern, look for systems that can support space-conscious upgrade cycles. Look for equipment capable of higher heat/power densities, while still using the same space.

Cooling Monitoring

Much like power, keeping an eye on cooling is important as well. This can be outlined as part of Service Level Agreement (SLA), or an organization can manually monitor cooling as well. Tracking inlet temperatures against ASHRAE guidelines and evolving equipment specifications is key. Ensuring that IT systems are running optimally will revolve around how well the environmental variables are controlled. Furthermore, always explore new kinds of cooling systems, which help support cloud systems, new levels of convergence and a quickly evolving business model.

Monitor Uptime and Status Reports

Regularly check individual system uptime reports and keep an eye on the status of various systems. Having an aggregate report will help administrators better understand how their environment is performing. Furthermore, managers can make efficiency modifications based on the status reports provided by a data center's reporting system.

Budget for New Airflow and HVAC Optimization Systems

For example, with the ducted exhaust system, every bit of cold air produced by the HVAC system has to go through a server.

- The only path between supply air and return air is one of heat transfer through a server, so there is no waste.
- There is no bypass or need for the overprovisioning that is required in standard hot aisle/cold aisle data centers.

The efficiency claims of close-coupled and liquid-cooled solutions are based on comparisons to inherently inefficient data centers with a high amount of bypass air, and overprovisioning of cooling necessitated by the extreme variations in pressure and airflow throughout a room. Because of the traditional dependencies on air delivered through proximate perforated access floor tiles, cooling capacity provisioning formulas have had to plan for providing adequate air to the lowest airflow spot in a room, resulting in typically 200 – 300 percent overprovisioning, resulting in huge amounts of wasted bypass air. When it no longer matters where the cold air is delivered and when 100 percent of it must travel through a server, there is no longer a need for that overprovisioning and therefore, there is no more waste.

> **"Take data center infrastructure to a new level."**

To have an optimally running data center that can support technologies such as convergence and cloud computing, your organization will have to take data center infrastructure to a new level. New kinds of cooling technologies and power systems aim to create an even healthier data center ecosystem capable of evolving with new trends. Here's the good news: more technologies are being implemented into the data center that allow for a much more flexible rack and floor architecture. It's becoming easier to segment racks, divert power/cooling via automation and enable even better mechanics around environmental control. When deploying these technologies, look for manufacturers that have all of the following traits:

- Data center design and solution expertise that address the future of technologies
- Customization capabilities to address your unique facility requirements
- Global manufacturing, availability and support so that you can count on them wherever your data center may be

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Bill is an enthusiastic technologist with experience in data center design, management, and deployment. His architecture work includes large virtualization and cloud deployments as well as business network design and implementation. Bill enjoys writing, blogging, and educating colleagues around everything that is technology. During the day, Bill is the Vice President of Strategy and Innovation at MTM Technologies, where he interacts with enterprise organizations and helps align IT strategies with direct business goals. Bill's whitepapers, articles, video blogs and podcasts have been published and referenced on InformationWeek, NetworkComputing, TechTarget, DarkReading, Data Center Knowledge, CBS Interactive, Slashdot, and many others. Most recently, Bill was ranked #16 in the Onalytica study which reviewed the top 100 most influential individuals in the cloud landscape, globally.

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