WHAT A HIGH-DENSITY DATA CENTER MEANS TODAY

And how you can prepare for its evolution

VANTAGE
DATA CENTERS

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HIGH DENSITY

has been a hotly contested subject in the world of data centers for years. But with global data consumption in the zettabytes—and the subsequent demand on IT resources—it may finally be time to start building up, not out.

In this ebook, we will explore the evolution of high-density computing and high-density data centers, highlight current market trends, and discuss key considerations in moving to a high-density environment.

DEFINING HIGH-DENSITY COMPUTING AND THE HIGH-DENSITY DATA CENTER

The data center is all about power and cooling, and high density is how you maximize the usage of those two things.

HD POWER

High density in the data center is attained by increasing your power draw (computing power) per square foot or rack.

In a recent *Data Center Journal* article, Jeff Clark writes, "What's considered high density today is closer to 10-12kW per rack compared with 2-4kW per rack less than a decade ago."[1]
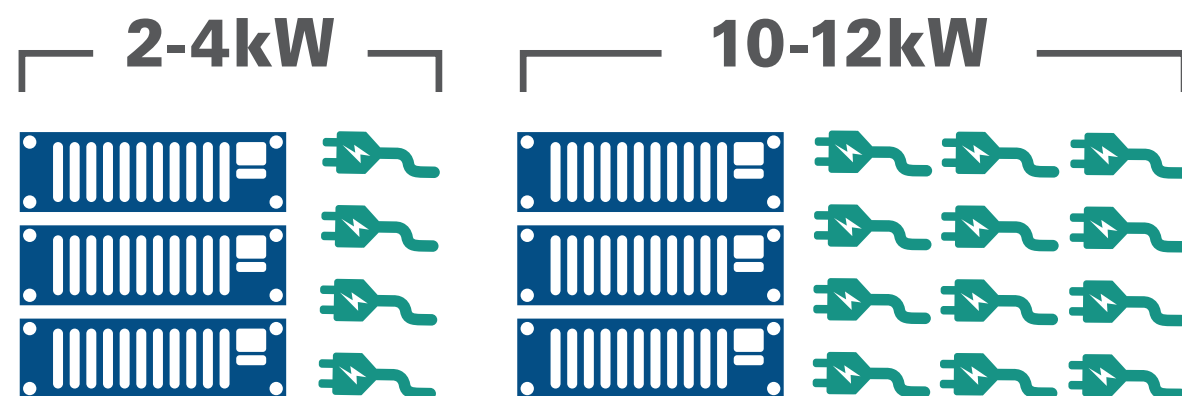
Pulling all that extra power, the high-density environment will differ from a traditional one in everything from computing components (what you put in your rack) to the way it's managed and controlled (cooling, namely).

Components you can expect to find include:

Blade Servers

By packing a number of server cards (aka blades) into a single chassis, blade servers allow more processing power in less rack space, which simplifies cabling and reduces power consumption.[1]

Microservers

These small, low-power, one-processer servers can be packed more densely than rack or blade servers. And because they typically share power and cooling, they can increase power efficiency while also increasing energy efficiency.[1]

Virtualization

This software-enabled solution spreads IT processes across multiple servers and reduces idle time on every machine, thereby increasing utilization and efficiency.[1]

HD COOLING AND CONTAINMENT

Also important to high-density computing is the computer room air handler (CRAH). It uses fans, cooling coils, and a water chiller system to remove heat and hot-aisle containment.

The CRAH works by cooling the exhaust from your equipment and sending that cooled air through the servers in a continuous cycle (for more on the role of the CRAH in efficiency,).

AT A GLANCE:
VIRTUALIZATION

Use fewer machines and run the ones you have at a higher utilization. Such is the theory behind virtualization. By placing multiple virtual machines with separate workloads on the same physical server, virtualization doesn't just remove excess hardware (consolidation)—which cuts cooling and power costs—it gets more work done in less space, while accounting for failover.

" Utilization of your machines changes constantly, and virtualization uses this to its advantage. Even if one physical server goes down, your application should be written so that the remaining servers can pick up the slack. By doing this, you can run the data center even hotter, use less energy to cool the air, and save even more money because when a physical server goes down, no productivity is lost."

Chris Yetman, COO
Vantage Data Centers

Learn more about Chris' industry experience >

THE EVOLUTION OF THE DATA CENTER

Over the past decade, data centers have made huge advancements to be able to support the high-density computing of today. Traditionally, data centers used multiple racks of low-power systems that weren't capable of getting work done efficiently.

Not being privy to the benefits of containment, these legacy data centers suffered gross inefficiencies by overcooling their rooms. And since they were working with sensitive machines that could run only one application, they wasted energy trying to create the perfect environment to cater to their equipment.

As hardware, computers, and programming finally hit their technological stride, data centers started harnessing that intelligence to make their buildings run smarter. Major advancements were made, paving the way for the rest of the industry (see Figure 2).

Today, some data centers have densities of 400 watts per sq. ft., or even more. The amount of work getting done in the same amount of space can be 4 to 5 times that of a legacy data center.
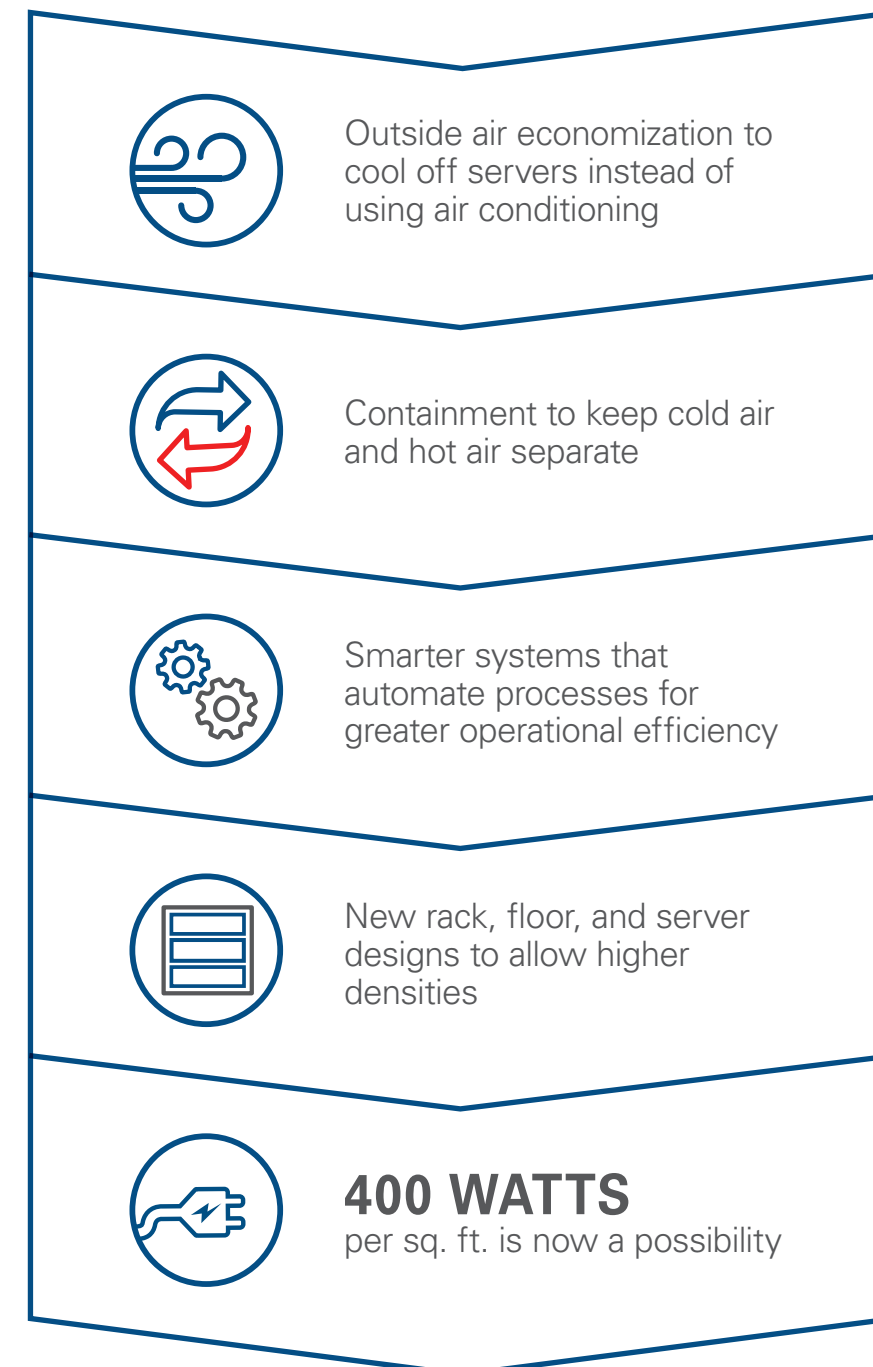
Outside air economization to cool off servers instead of using air conditioning

Containment to keep cold air and hot air separate

Smarter systems that automate processes for greater operational efficiency

New rack, floor, and server designs to allow higher densities

400 WATTS per sq. ft. is now a possibility

Figure 2

AT A GLANCE:
OCP AND HIGH DENSITY

Where innovation and bleeding-edge systems are concerned, you can't talk about high-density computing without at least touching on the Open Compute Project.

OCP is an initiative started by Facebook that designs and deploys open-source data center hardware focused on flexibility and efficiency. The community-minded group openly exchanges ideas, specs, and intellectual property to create simple and inexpensive solutions for scalable computing.

Just like high density, OCP products are designed to build intelligence into what you already have rather than buying extra hardware—doing more with less. You can snap components in and out of your existing equipment with ease, and if/when a component breaks, it's easy to fix. You'll spend less on energy, less on real estate, and less on systems when leveraging open-compute gear and high density.

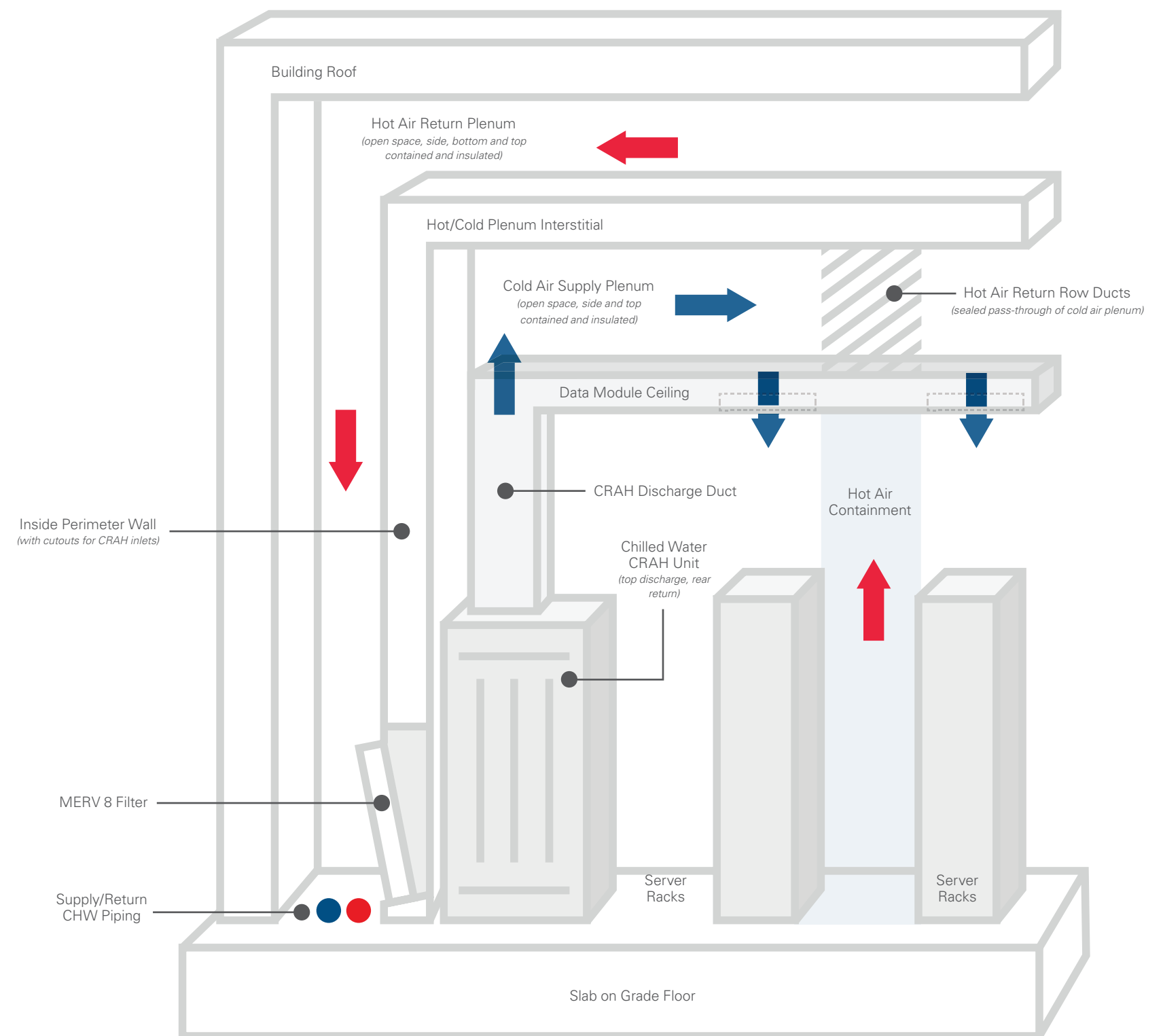Want to learn more? Read the OCP Report >

DESIGNING FOR HIGH DENSITY

Gartner explains that some of the main factors in designing for a high-density zone include planning for innovzations in IT hardware, managing space, and managing cooling.

Because traditional forced-air cooling methods are less effective delivering uniform cooling at densities above 15kW per rack, a high-density zone will typically require supplemental cooling, such as in-row or in-rack cooling. This is a less-than-ideal design as it takes up rack space and can drive up costs.

Alternatively, if designs are purposeful, air can be effectively delivered via built-up systems with slab-on-grade. This means including containment throughout the data center, leveraging highly efficient direct-drive fans and CRAH units, and using outside-air economization whenever possible.

The diagram to the right highlights a standard design of how airflow is efficiently contained and managed to provide the maximum amount of cooling as your denser racks are producing greater heat.

Building Roof

Hot Air Return Plenum
(open space, side, bottom and top contained and insulated)

Hot/Cold Plenum Interstitial

Cold Air Supply Plenum
(open space, side and top contained and insulated)

Hot Air Return Row Ducts
(sealed pass-through of cold air plenum)

Data Module Ceiling

CRAH Discharge Duct

Hot Air Containment

Inside Perimeter Wall
(with cutouts for CRAH inlets)

Chilled Water CRAH Unit
(top discharge, rear return)

MERV 8 Filter

Server Racks

Server Racks

Supply/Return CHW Piping

Slab on Grade Floor

THE CRAH, ΔT, AND EFFICIENCY

One of the measures of an efficient data center design is the management of the CRAH and its ΔT—the difference in temperature between the intake of the CRAH and the exhaust of the CRAH. Though it may seem counterintuitive, the hotter temperatures created in a high-density environment can actually be beneficial for airflow management.

"The hotter the air coming in, the more efficient the air handler becomes. The cooler the air coming in, the more inefficient it becomes," explains Vantage COO Chris Yetman in an interview about the future of high-density data centers. "This is why containment matters quite a bit— as well as being able to densify so you can take advantage of a nice high ΔT."

By comparison, a low-density environment, which may leave half of the rack open to allow for future growth, can cause air contamination and inefficiency. Even if the spare rack space is closed off with a curtain, some cool air will leak through and cool the warm air in the hot aisle. This contamination will throw off the ΔT, requiring more energy and more money to cool the air.

> **!**
>
> Discussing the specifics around high-density design with your data center provider—from rack weight to containment to the latest and greatest software/hardware advancements—will enable you to better future-proof your investment.

SUPPORTING HEAVIER RACKS

Higher densities naturally mean heavier cabinets. And since demand for density and storage are on the rise, the once unheard-of 2,000-lb. cabinet is now more like 3,000-3,500 lbs. Both slab and raised-floor designs can accommodate these heavier weights, but there are pros and cons to each. Raised floors are highly flexible, allowing you to hide wires and move tiles around to direct airflow. On the flip side, slab floors move your cabling overhead for easier access, while delivering better weight-bearing thresholds than raised floor. Slab also allows you to mount and anchor your racks more easily (a perk for earthquake territory).

AT A GLANCE:
THE DATA CENTER DISRUPTOR
VAPOR IO

Poised to change the design of the high-density data center, Vapor IO is a company creating innovative equipment never before seen in the industry. Vapor's CEO and Founder Cole Crawford spoke with us about the company's flagship product, the Vapor Chamber, which is born from the need to make temperature and airflow management at the data center easier.

Where most cages are filled with rows of racks, the chamber reconfigures these racks in a ring, so the heat output is automatically contained in a vertical column. With one fan at the bottom, you can control the rate at which the air is drawn through the system.

Since Crawford was the founding executive director of the Open Compute Project, he brings an open-source perspective to everything he does at Vapor. The company's data center runtime environment (DCRE), for example, uses a software/hardware combo, including bus bars and connector designs, to manage the physical infrastructure. The free-to-use open-source version is called OpenDCRE.

"
We've created what we believe is the world's first and most open out-of-band management framework."

Cole Crawford, CEO & Founder
Vapor IO

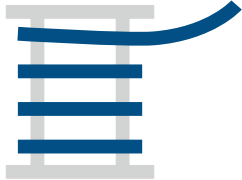**Find out more about Cole Crawford >**

WHY HIGH DENSITY AND WHY NOW?

While achieving high density might seem like a big challenge, there are reasons more data centers are building out high-density zones.
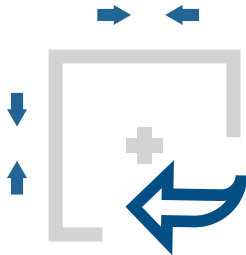
Trends driving the increase in density include:

80%

Power and cooling allocations account for 80% of OpEx

Reduced distance in cable runs and networks

Reduced cooling and space footprint

Power and cooling availability and efficiency

Virtualization and cloud-dense workloads

x2

Moore's Law – The number of transistors in a dense integrated circuit doubles approximately every two years[4]

> " We're trying to maximize the dollar value of [every] rack— trying to go as dense as possible to ensure that we're maximizing the space within the rack and that we're maximizing the power that's supplied to the rack as well."

Harmail Chatha, Director of Global Data Center Operations
Groupon

Find out more about Harmail Chatha >

And the benefits add up, too. Industry experts embedded in high-growth projects like Groupon's Director of Global Data Center Operations Harmail Chatha agree that the systems surrounding high density are actually more efficient. By growing vertically, you're maximizing your dollars spent. Smart operators, he says, are starting to understand that they can have a mixture of compute within a single rack and get maximum ROI out of their investments.

How you cool the data center also plays a part in efficiency. Containment alone, cites a *Data Center Knowledge* article, can bring the power consumption-to-cooling ratio down to a nearly 1 to 1 match in kW consumed, saving the data center approximately 30 percent of its annual utility bill without additional CapEx.[5]

To put it simply, any data center purpose-built for high density will be able to support the next-gen IT infrastructure for High Performance Computing, thereby optimizing the data center footprint and overall associated costs.[6]

> "
> Data center users pay a premium for real estate, so why wouldn't you want to do more work in less space? It's going to be smarter for how you cool it."
>
> **Chris Yetman, COO**
> *Vantage Data Centers*

AT A GLANCE:

IS YOUR DATA CENTER DENSITY-READY?

If you're considering a move to high density, here's where to start:

1. What is your current density?

2. Is there adequate power in your current space to increase load?

3. Can you run higher voltages out to the data center floor?

4. Does your current cooling have capacity to handle load?

5. Does your data center use containment?

6. Does it use economization?

7. What are the weight limitations of your floor load?

8. Can your environment handle heavier-weight racks?

IS HIGH DENSITY HERE TO STAY?

"

It's going to take additional industry maturation for the world to accept that it's okay and possible for you to run a multi-architecture, multi-vendor, multi-density solution. But the technology and the desire from the industry is certainly there."

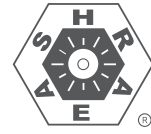**Cole Crawford, CEO & Founder**
Vapor IO

Whether due to retrofitting costs, lack of resources, reliance on legacy systems—or any number of factors—data centers have been slow to fully embrace high density. Even data center colocation could have played a role in suppressing high-density adoption because of their reliance on open-cage environments. The lack of containment means customers running greater densities (creating greater heat) can affect the performance of the customers around them.

But despite the slow start, Gartner reports, "The fastest-growing segment of the server market is the high-density blade sector, meaning that high-density zones will need to be incorporated into most data centers during the next five years."[2]
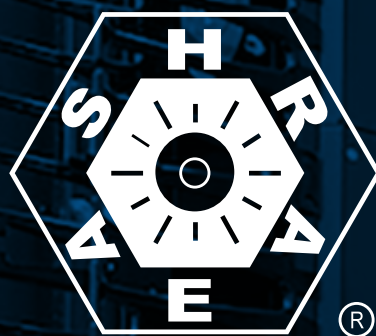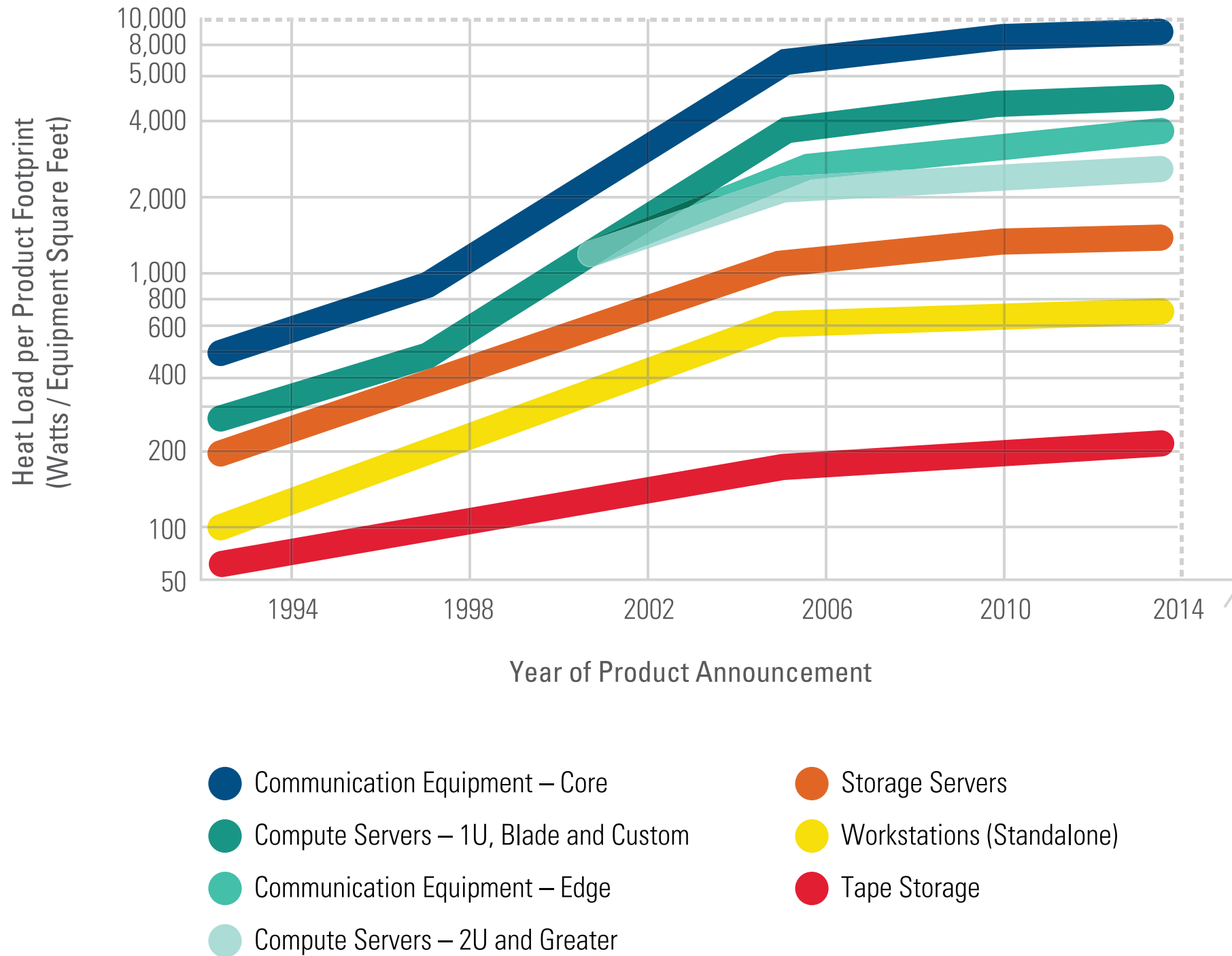
THE SIGNIFICANCE OF ASHRAE

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) is an organization devoted to the advancement of indoor-environment-control technology in the HVAC industry. In 2014, ASHRAE's 9.9 committee announced that data centers are tolerant to a wide range of temperatures and humidity— temperatures from 59°F to 89.6°F and relative humidity from 20% to 80%.[7] This news enabled data centers to immediately increase their energy efficiencies over ASHRAE's past specifications.

ASHRAE Datacom Trend Chart Showing Increasing Density Over Time

Heat Load per Product Footprint (Watts / Equipment Square Feet) vs **Year of Product Announcement**

Legend:
- Communication Equipment – Core
- Compute Servers – 1U, Blade and Custom
- Communication Equipment – Edge
- Compute Servers – 2U and Greater
- Storage Servers
- Workstations (Standalone)
- Tape Storage

This chart from the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) shows the rate at which data center density has been increasing over time, measured by watts per equipment per square feet.

Global behemoths like Facebook, Google, Microsoft, and Amazon were early adopters of high density—and for good reason. Due to their rapid growth, the benefits of a denser environment became glaringly obvious and too compelling to ignore. But as data and technology continue to proliferate (and the cost of physical space increases), companies of all sizes can gain efficiencies by leveraging the high-density learnings and strategies of these technological predecessors.

HOW VANTAGE CAN HELP YOU BUILD UP

NOT YOUR LEGACY DATA CENTER

Vantage built its 400-watts-per-sq.-ft. V2 facility five years ago, carving out its high-density expertise with a handful of visionary clients. Where traditional and wholesale data centers can host about 150 watts per sq. ft., V2 is designed to run 10-12kW racks continuously. And now, its two new facilities will accommodate 200-watt and 300-watt deployments, comfortably—while tapping into innovative cooling techniques like outside air economization.

NOT IN THE BUSINESS OF REAL ESTATE

Industry-leading PUEs are only the start. Because Vantage is more concerned about your TCO than selling real estate, they consistently deliver the most cost-effective solutions, so you can get more work for your wattage.

"

I believe Vantage is one of the pioneers of the industry. They sit down with their customers and say, 'We don't just sell you a cost per square foot. We don't just sell you a cost per kilowatt. Let's solve a business problem together.'"

Cole Crawford, CEO & Founder
Vapor IO

WHEREVER YOU ARE IN YOUR HIGH-DENSITY JOURNEY, VANTAGE CAN ACCOMMODATE AND DESIGN FOR YOUR NEEDS.

Let's get the conversation going.
Email us at info@vantagedatacenters.com.

VANTAGE
DATA CENTERS

[1] Clark, Jeff. Data Center Journal. "What Does High Density Mean Today?" November 2011. [2] Gartner. "Gartner Says More Than 50 Percent of Data Centers to Incorporate High-Density Zones by Year-End 2015" March 2011. [3] Judge, Peter. Data Center Dynamics, "Vapor IO Announces 'Hyper-Collapsed' Data Centers" March 2015. [4] Harrison, Luke. Interconnections – The Equinix Blog. "High-Density Data Centers: Driving Efficiency and Lowering Costs". [5] Normadeau, Kevin. Data Center Knowledge. "Benefits of Data Center Containment" November 2012. [6] Larbey, Matthew. Data Center Dynamics. "Why High Density Computing is Crucial for Business Success" May 2015. [7] Energy 350. "ASHRAE Releases New Data Center Standards" November 2014.