



# Data Center 2025:

*Exploring the Possibilities*



**EMERSON**<sup>TM</sup>  
Network Power

# Welcome to Data Center 2025

An industry-wide initiative, spearheaded by Emerson Network Power, to create a vision—or multiple visions—of the future of the data center. As part of Data Center 2025, Emerson has conducted interviews with key industry influencers, solicited feedback from the industry at the Data Center 2025 online portal: [EmersonNetworkPower.com/DataCenter2025](https://EmersonNetworkPower.com/DataCenter2025), and conducted an online survey that generated more than 800 responses.

The year 2025, eleven years from the writing of this report, represents a horizon that is close enough to project how current trends could play out—the data centers being commissioned today will be at the halfway point in their projected lifecycle in 2025—and yet far enough away that there is still opportunity to shape what that future will look like.

As you review the Data Center 2025 findings, you may be struck by the optimism of the participants in some areas. From use of renewable energy to power density to sophisticated management tools, participants set a high bar for the future. In some cases their projections are so optimistic they seem almost impossible when compared to the current state.

But those projections begin to make sense when you consider that innovation has always been the engine that drives IT. It is impossible to predict exactly what those innovations might look like, what disruptive technologies might emerge in the next ten plus years, but for the most part participants in the study have faith that they are coming.

And that bodes well for the future of our industry.

# Looking Back to Look Ahead

The year 2025 is 11 years from the release of this study. If we look back 11 years to 2003, the data center industry was just starting to emerge from the dot-com bust. There was a surplus of data center capacity, rack densities were in the 250 W to 1.5 kW range, and the broadband and social media revolutions hadn't yet made their presence felt.

A lot has changed since then.

The years 2003 to 2008 would be marked by steady growth in the demand for computing and storage as virtually every industry became more digitally dependent. This created a massive ramp-up in data center capacity. New servers were added weekly in some facilities, and each generation of servers eclipsed the previous in power density. More and more computing was consolidated

in the data center, and data centers themselves were being consolidated to simplify management and reduce costs. Organizations scrambled to keep up with capacity demands and data centers became increasingly heterogeneous and complex.

By 2006, rack densities had reached 6 kW on average, according to the Data Center Users Group® (DCUG) sponsored by Emerson Network Power. Suddenly data center managers were battling hot spots and cooling was limiting the ability of many data centers to add needed capacity. Heat density was named the top infrastructure concern by DCUG members in 2007, 2008 and 2009 (*Figure 1*).

Rank	2007	2008	2009	2010	2011	2012	2013
1	Heat Density	Heat Density	Heat Density	Monitoring Infrastructure Management	Availability	Monitoring Infrastructure Management	Monitoring Infrastructure Management
2	Power Density	Power Density	Energy Efficiency	Heat Density	Monitoring Infrastructure Management	Availability	Energy Efficiency
3	Energy Efficiency	Availability	Monitoring Infrastructure Management	Availability	Heat Density	Energy Efficiency	Heat Density

**Figure 1. Top data center infrastructure concerns from 2007 to 2013 as expressed by members of the Data Center Users Group. Heat density was the top concern in 2007, 2008 and 2009.**

The growth in capacity and density led to an additional concern: energy efficiency. Prior to 2007, energy costs were a non-factor in most IT budgets. Few organizations even bothered to separately meter their data centers, limiting visibility into rising consumption. Data center managers were laser-focused on maintaining the highest possible availability. If that meant keeping the data center 10 degrees colder than necessary, or reserving 20 percent of capacity as a buffer against accidentally overloading resources, those were sacrifices that were willingly made.

But with energy prices and consumption rising simultaneously and environmental concerns growing, the industry could no longer afford to ignore energy consumption. More efficient power and cooling technologies were introduced, best practices were adopted more widely, and IT organizations increasingly began to seek out and decommission unproductive servers in a battle against sprawl.

Most significantly, virtualization broke the connection between applications and physical servers, allowing greater management flexibility and higher server utilization rates. As Emerson's Energy Logic, released in 2007, documented, the most impactful approach to data center energy efficiency is to increase the efficiency of the IT systems that performed the work of the data center, thereby creating a cascade effect that reduces consumption across all supporting systems. By increasing server utilization, virtualization has the potential to increase server efficiency and reduce overall data center energy consumption.

Not surprisingly, virtualization contributed the highest percentage of energy savings in the Energy Logic model.

While virtualization was breaking down the walls between servers, the distinction between voice and data networks was also blurring. Adoption of voice-over-IP continued to grow—according to a Frost and

Sullivan study, less than 25 percent of businesses were still operating analog telecommunications systems in 2013—as businesses and individuals opted to put all of their packets into the IP basket. Most recently, the industry has seen a new class of data centers emerge: hyperscale facilities. These mega facilities are being built by Internet-based businesses, such as Facebook as well as software-as-a-service and cloud providers. With a high priority on keeping costs down and ensuring scalability, hyperscale data centers are driving increased focus on hardware standardization, infrastructure innovation and modular expansion.

They are also spurring a shift in enterprise IT management away from owned IT assets to acquiring computing as a service or utility. How far that shift will ultimately go is one of the key questions surrounding Data Center 2025.

They will definitely need some way to deal with another trend that is emerging today: big data. The amount of data being generated is skyrocketing, and that could have significant impact on data centers and networks in the future as terabytes become zettabytes (one billion terabytes). As KC Mares, CEO and president of MegaWatt Consulting, says in his Data Center 2025 video,

*“When I think back to data centers in the 2000 timeframe, they were mostly driven by processing or compute power. Today, most of our new data center demand is driven by storage and the need to not only store data but access it and use it.”*

How the industry will manage the tidal wave of data now being created by both people and machines is one of the other key questions that must be resolved. Early studies have indicated that data-based decision making can drive competitive advantage. The data center is now at the center of what the *Harvard Business Review* called a “management revolution” (October 2012). Will the industry handle this influx of data as reactively as the growth in computing was managed earlier in this century, or will new tools and technologies enable a more proactive approach?

Throughout its history, the data center has consistently been asked to do more: handle more capacity, deliver more availability and achieve more efficiency. Thanks to the resourcefulness and dedication of the people responsible for managing these business-critical facilities, they have largely responded. The question now is can they continue to do so within the existing paradigms, or are we on the verge of fundamental changes in data center technologies, designs and processes?

# Powering Data Center 2025

Where will data centers get their power in 2025 and how much of it will they need? Like most of the questions relating to the data center of the future, the answers to these depend on multiple other factors, including:

- Will data centers cluster in regions with low energy costs and cool climates, or will proximity to users drive location decisions?
- How will demand for computing and storage change, and how efficient can future generations of technology become?
- Will technology evolve to the point where loads can be shifted quickly to areas with excess power capacity based on time of day or season?

Despite the interdependencies, we have to start the discussion somewhere. Power, the foundation on which data center availability depends, seems like the right place.

A significant majority of participants in the Data Center 2025 survey (64 percent) believe that it will require less energy in 2025 to produce the same level of data center computing performance available today (Figure 2).

## Data Center Energy Consumption Relative to Today

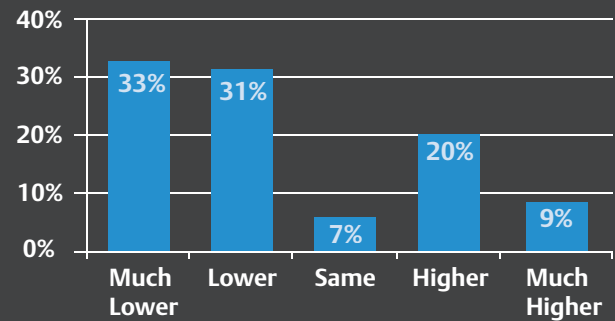


Figure 2. In 2025, how much energy will be required to achieve the same level of data center computing performance available today?

This is surprising only in the sense that the number isn't higher, especially when you consider that **84 percent** of survey participants believe data center infrastructure equipment will become more efficient, and 67 percent believe IT equipment will become more efficient.

It seems likely that some participants were answering this question about relative energy consumption

in terms of total energy consumption. As Richard Fichera, vice president and principal analyst, Infrastructure and Operations at Forrester Research, says in his Data Center 2025 video, *"A data center being built in 2025...is going to be immensely energy efficient."*

The question may, in fact, expose a challenge the industry has yet to address: development of a standard data center productivity metric. The most common efficiency metric, PUE, has proven useful but is flawed in that it does not account for any changes in the amount of the work being performed in the data center. A true productivity metric, supported by an integrated DCIM platform, could enable more informed IT asset acquisition strategies and better workload management.

As to how those efficiency improvements will be realized, participants expressed a broad range of ideas in open-ended survey responses. One of the most common involved a relatively low-technology

solution that is available today: air economization. It seems probable that the use of outside air to cool the data center will grow significantly in the future, although only one in five participants believe it will become the primary method of data center cooling.

Other opportunities to improve efficiency identified by participants include chip-level cooling, increased server efficiency, higher data center temperatures, and streamlined power delivery. In the previous ten years, the technology has emerged to improve end-to-end power efficiencies by 25 percent.

Regarding where that power may come from, Data Center 2025 participants were optimistic about the future of renewable energy, particularly solar (Figure 3). Where solar power accounted for less than 1 percent of power generated in the U.S. in 2012, survey participants project solar to make up 21 percent of data center power in 2025. Asia Pacific and Latin America were more optimistic than the U.S. and Europe on the potential for solar energy, with each of those regions predicting 25 percent of power coming from solar. Western Europe (18 percent) and the U.S. (15 percent) projected lower use of solar.

Solar technology will have to advance considerably in the next ten years for the aspirations of survey participants to be realized. Currently, a square-meter solar panel can generate about 800 kWh per year in the climates of Western Europe and the Northern United States. Supporting power densities of 6.4 kWh/rack would require eight square meters of solar panel for each data center rack without even factoring in cooling or solar cell efficiency. Even with only 20 percent of power coming from solar, the size of the solar array would be almost double that of the data center itself. While the efficiency of solar technology will certainly advance in the next ten years, it will have to make quantum leaps to keep pace with the projected increases in data center power density participants in the study projected. As covered later in the study, average data center power density is projected to reach an extremely ambitious (and possibly unrealistic) 52 kW/rack in 2025 (Figure 4). Even if data center density just doubles in the next ten years, the solar footprint would be four times that of the data center.

### Electrical Energy Sources

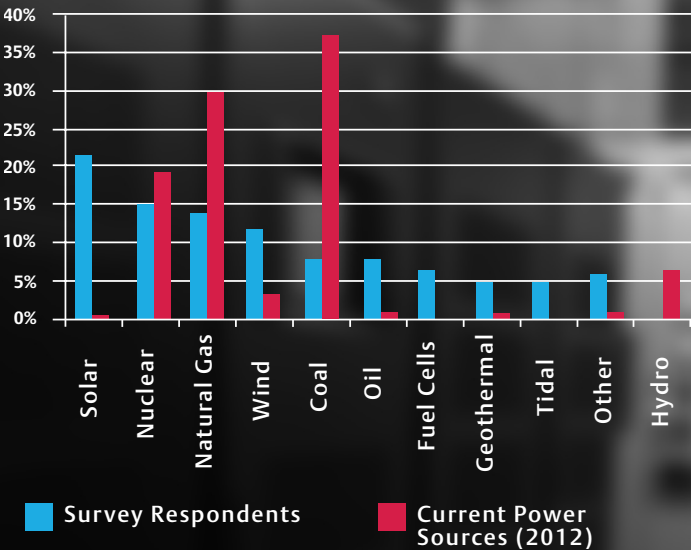


Figure 3. “In 2025 what percent of the electrical energy used by data centers do you expect will come from each of those sources?” compared to sources of electrical power in the U.S. in 2012.

### Projected Power Density

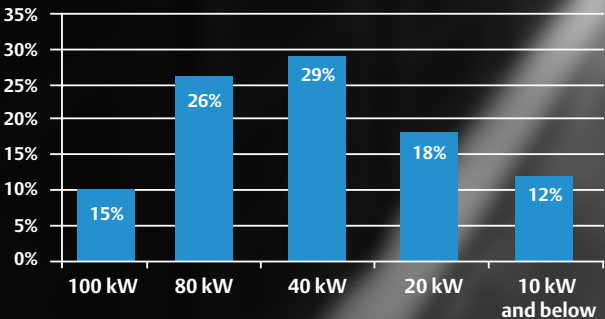


Figure 4. In 2025, what will the average power density of a data center be?



Of course, solar does not represent the only potential for significant change in the future power profile of data centers. Other non-renewable sources could also play a larger role. Sean James, senior research program manager for Microsoft's Global Foundation Services, shared in *Scientific American* (November 2013) that researchers at Microsoft are studying the feasibility of powering a data center entirely by fuel cells integrated directly into the server racks, bringing the power plant inside the data center and minimizing power distribution losses. On- or near-site energy generation, i.e., micro-grids, will benefit from improved end-to-end energy conversion, transmission and distribution efficiencies.

If renewable or alternative energy technologies do account for a higher percentage of data center power, they will likely have to achieve those gains based, at least in part, on their cost effectiveness. The majority of participants predict increased use of private power generation in hyperscale facilities (Figure 5). Sixty-five percent believe private power generation is at least likely and another 23 percent consider it an even odds.

Asia Pacific seems most likely to move to private power generation: 33 percent of respondents in this region believe it will definitely happen, with an additional 44 percent considering it likely. As one participant noted, "Data centers will be co-located with power generation, and likely environmental cooling options—producing their own power and dumping heat into geothermal heat pumps, freshwater containment, or polar installations."

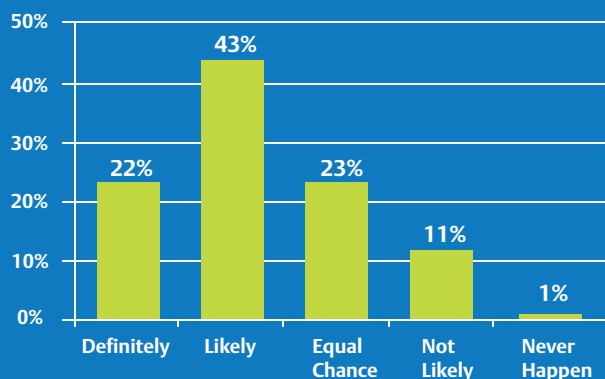
As for backup power, 30 percent of participants expect high-efficiency AC uninterruptible power supply (UPS) systems to be the primary source in 2025 (Figure 6). UPS systems have made significant advances in efficiency in recent years with the introduction of eco-mode and intelligent paralleling and can now produce efficiencies approaching 99 percent, making them less likely, in the minds of participants, to be displaced by competing technologies.

Other hardware approaches that could challenge the AC UPS according to this study include a momentary duty inverter that provides just enough ride-through power to switch to an alternate source (27 percent) and DC UPS (13 percent).

About one in four participants see the potential for software failover to become the new data center back-up paradigm rather than today's UPS / generator combination. Consulting engineer Mark Monroe of DLB Associates voiced the hopes of those envisioning increased software management of data center resources:

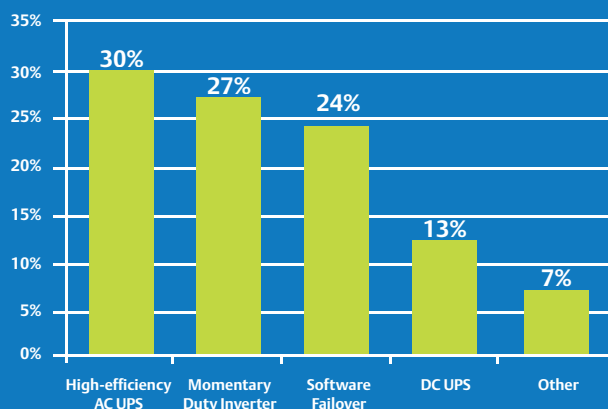
*"We have these 'compute bubbles' that we can move from server to server within a data center, and now we're starting to see those bubbles move from one data center to another. I can see that becoming more common in 10 years, where we move the load to where it is most efficient or cheapest to run it at a given time. That has implications not only for load utilization but for disaster recovery and planning."*

### Chance of Private Power Generation in Hyperscale Data Centers



**Figure 5. What's the likelihood hyperscale facilities will be powered by private generation in 2025?**

### Backup Power Source



**Figure 6. What will be the primary means of delivering backup power to data center equipment in 2025?**

# Computing and Storage in 2025

One of the key questions facing the data center industry today is how and when to take advantage of cloud computing. Most of the participants in the Data Center 2025 initiative expect cloud-based resources to comprise a significant component of computing and storage capacity in the future, but the question of what this will mean to the enterprise data center is harder to answer.

Most (67 percent) participants believe at least 60 percent of computing will be cloud-based in the year 2025 (Figure 7). The need for flexibility was mentioned frequently by Data Center 2025 expert contributors and cloud computing provides the potential for more flexible capacity management. According to Peter Gross of Bloom Energy, the growth of cloud and what he calls “everything-as-a-service” will create fundamental changes in the IT industry and could ultimately result in the decline of the 1 MW–2 MW enterprise data center.

*“Businesses simply won’t be able to justify the investment a data center requires with other alternatives available.”*

This doesn’t necessarily mean the enterprise data center will disappear. As one participant noted, “There will be significantly increased ‘cloud’ storage and computing, as most computing user interfaces will be distributed among mobile or wearable devices. On the other hand, some enterprise computing will always be necessary and may actually increase as more artificial intelligence functions are brought in-house for decision making and productivity.”

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## Percent of Computing in the Cloud

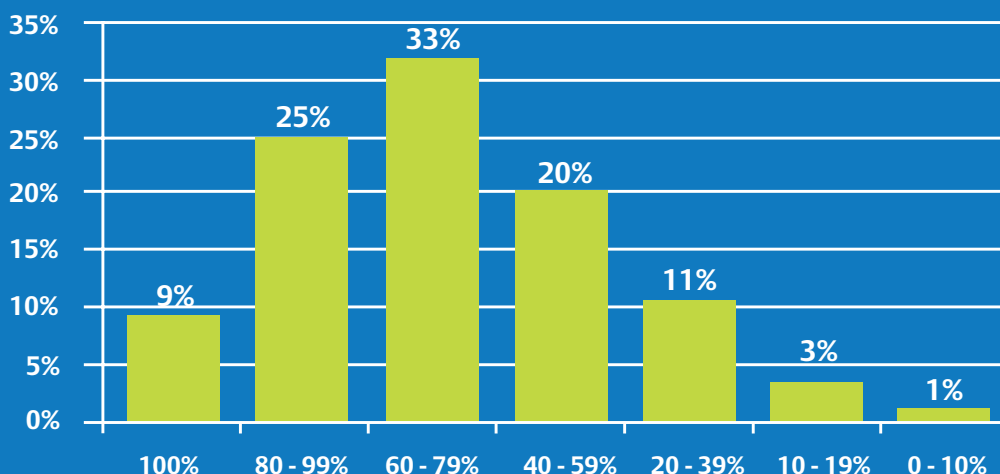


Figure 7. In 2025, what percent of data center computing do you expect will be done in the cloud, rather than by in-house data centers?



According to the Data Center 2025 survey, it seems likely that enterprise data centers will at least shrink in size: 10 percent of participants believe the enterprise data center of 2025 will be one-tenth the size of current facilities, while 58 percent expect that data centers will be half the size of current facilities or smaller (Figure 8). This could make owned resources more competitive in relation to the cloud as smaller, more dense data centers are easier to build and operate as a Tier IV, 2N+1 configuration than very large ones.

The shrinking data center could also provide greater flexibility in data center location, making it feasible to locate data centers in denser urban environments with higher real estate costs. For businesses with suburban campuses, it could enable the deployment of modular or container-based data centers rather than requiring office space be used for the data center.

While the findings suggest enterprise data centers will shrink in size, the overall load of these enterprises will continue to grow. Some may decide to shift their load to larger colocation facilities, while others may place nodes on the thickening edge of the network.

Not surprisingly, participants also expect data center density to increase, although the increase in projected density is greater than the projected decrease in size. This could be because participants believe the increase in compute and storage demand will not be completely absorbed by increased dependence on cloud-based resources. In other words, as noted earlier, the enterprise data center is likely to have more computing and storage capacity in 2025 than it does today, despite increased dependence on cloud-based resources.

The response to the power density question produced a classic bell curve, with 15 percent at the high end of the spectrum predicting power densities of 100 kW and 12 percent at the low end predicting densities below 10 kW (Figure 4).

The average density based on all responses is 52 kW. Considering that density has remained relatively flat since 2006 (Figure 9), reaching that mark will require a dramatic upswing in density that could, if it actually occurs, bring a significant disruption in how data centers are laid out and cooled. In fact, one participant envisioned a data center that was turned “inside out,” with IT equipment lining the perimeter of the room and the center of the facility serving as a plenum for cold air and power distribution.

Change in Data Center Floor Space

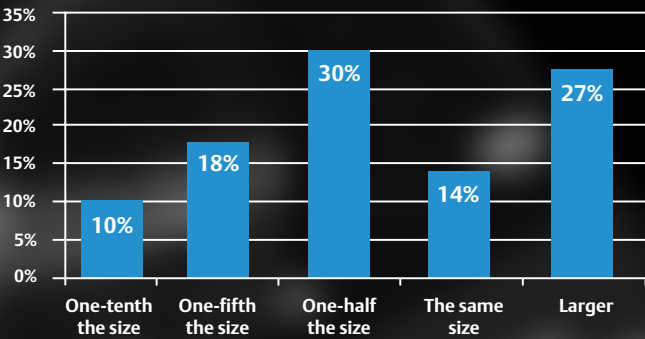


Figure 8. In 2025, how will the floor area of enterprise data centers compare to those of today's facilities?

Power Density—Current vs. Projected

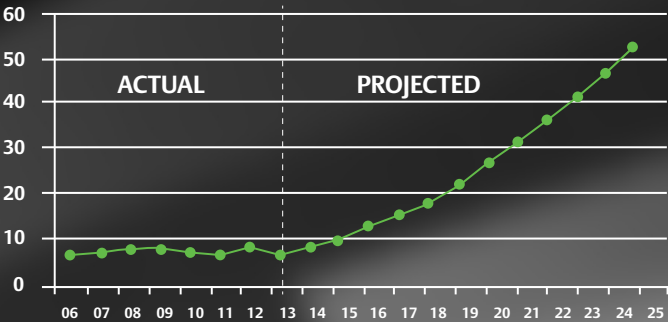


Figure 9. Rack density stayed relatively flat through 2013 (Source: DCUG). Yet Data Center 2025 participants, on average, project densities to reach more than 50 kW per rack in by 2025, requiring a huge upswing in density in the coming years.

Will the equipment inside those higher density racks change dramatically compared to what exists today? Will ARM processors displace x86-based processors? Will photonic racks allow server components to be physically separated, enabling component-level upgrades? Will spinning disks be displaced by solid state drives?

These are all possibilities. But, while the industry has been quick to embrace many innovations, such as virtualization, voice over IP, and high-efficiency UPS systems, others, such as high-voltage distribution and server power management, have been mostly ignored despite their benefits. And, while progress has been made in terms of the efficiency and reliability of both data center infrastructure and IT equipment, the industry is still grappling with the same challenges it faced in 2007: efficiency, scalability and availability.

# Thermal Management in 2025

Cooling has been a lightning rod for the data center since energy consumption first emerged as a serious issue, and it is an area that has evolved dramatically in the last five years. From rack-based cooling to containment to the shift from return air temperature control to server inlet temperature control, data center cooling has become more precise and efficient. Now, even the term “cooling” is starting to feel dated as the focus shifts to “thermal management”—the art and science of removing heat from the data center as efficiently as possible.

For the most part, participants in Data Center 2025 don’t envision radical changes in current approaches to thermal management. Forty-one percent expect a combination of air and liquid to be the primary method of data center cooling.

Only 20 percent see ambient air (Figure 10), or free cooling, emerging as the primary means of thermal management, and 9 percent see the emergence of immersive cooling. Perhaps these are the same participants that see density reaching 100 kW. Immersive cooling, which has previously been used on some

“supercomputers,” can be more effective at removing heat than air in certain applications and may find a home in high-performance computing environments.

There is also the probability that data center equipment simply won’t require as much heat removal in the future either because it will generate less heat or it can tolerate much higher temperatures or both. Chris Molloy, a distinguished engineer at IBM who has overseen more than 7 million square feet of data center floor space, speculated that, “As IT equipment becomes more resilient, we will see ASHRAE A3/A4-based data centers operating with temperatures in the cold aisle rising to above 100° F, reducing the need for cooling.”

This sentiment was echoed by another participant who wrote, “Operating costs will be significantly reduced through the development of more resilient data center equipment, capable of withstanding higher operating temperatures, and the continued implementation of remote servicing/operation. This will eliminate the need for large chillers or other HVAC equipment that maintain temperatures significantly different than ambient temperatures.”

And, at least one participant envisioned a Mad Max type future in which water, rather than gas, becomes a precious commodity. “Water will be much more expensive to obtain, and other ways will be used for space cooling. Data centers may even move underground to take advantage of the cooler temperatures below the surface. There is also the possibility they move off-shore submerged in air-tight underwater structures with access by a platform above the water, similar to an oil rig.”

Method of Thermal Management

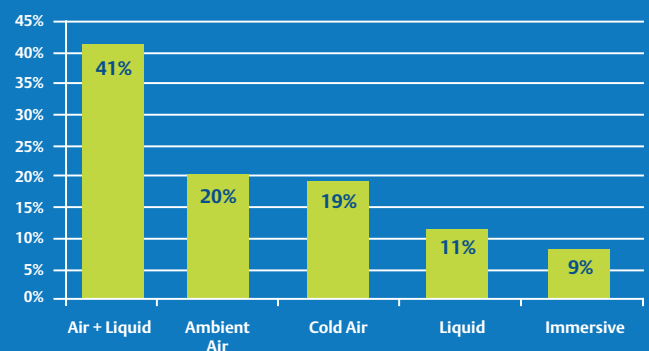


Figure 10. In 2025, what do you expect will be the primary method for thermal management in data centers?

# Managing the 2025 Data Center

Improvements in data center management may prove to be the industry's "silver bullet," finally enabling a proactive response to the challenges of availability, scalability and efficiency.

To categorize progress on the management front so that results could be quantified, the major stages in the evolution of data center management were defined as full visibility across all systems and layers, self-optimizing, and self-healing.

DCIM vendors have apparently been effective at getting their message across, as this is one area where participants expect significant progress: only 3 percent feel management technologies will be the same in the future as today. One quarter of participants expect data center management systems to deliver the control required for self optimization while 43 percent expect the industry to move all the way to self-healing, providing a level of automation and control that will enable an unmanned data center. According to one participant, *"Data centers will be highly automated. All devices will have automatic identification tags and data centers will be operated without human resources or with minimum human involvement."*

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Twenty-nine percent of participants expect at least full visibility across all data center layers and systems to be achieved by 2025 (Figure 11). This seems like a relatively modest outcome based on the state of DCIM today. In one respect, it's actually a little surprising that the industry has come this far without visibility across systems and layers. If you accept the axiom that you can't control what you can't see, data center managers have been essentially flying blind for years.

What will management do with this visibility? It appears they will drive up utilization rates. Seventy-two percent of participants expect IT resource utilization rates to be at least 60 percent in 2025 (Figure 12).

## Future of Data Center Management



Figure 11. Which of the following best describes what you think data center management and control will be like in 2025?

## IT Resource Utilization

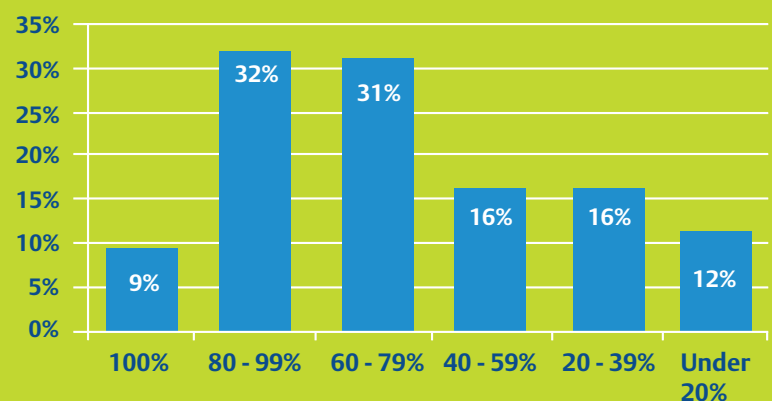


Figure 12. In 2025, what do you expect the average data center IT resource utilization rate to be?

While there is not general agreement as to average utilization rates in 2014, few would put that number above 20 percent. Data Center 2025 participants are expecting major increases in server utilization.

Regionally there were some significant differences in the expectations for management and control. The U.S. and Western Europe were the most pessimistic regions. Six percent of U.S. participants expect no change in management and control technology compared to only 2 percent in the rest of the world. This could be explained by the fact that early adopters of DCIM in North America and Western Europe see less need for change in management systems than regions that have not been as quick to fully deploy DCIM.

In addition, 35 percent of U.S. participants and 32 percent of Western Europe participants put the management and control ceiling at visibility compared to 28 percent in Asia Pacific and 19 percent in Latin America. The optimism of those two regions is evident in the number that see a future that includes self healing, eliminating the need for on-site management. Globally, 43 percent of participants see a self-healing data center becoming a reality. That number is highest in Latin America (53 percent) and Asia Pacific (49 percent) and lowest in Western Europe (33 percent).

Considering the drive for automation and unmanned operation, a large percentage of data center professionals globally (56 percent) expect to be employed in the industry

in 2025. Only 7 percent expect contraction to affect their employment, while 23 percent expect to be retired. The U.S. stands to take the biggest hit from retirement, with 37 percent of professionals expecting to be retired by 2025. Asia Pacific has the highest percentage of professionals that expect to be employed in the industry, at 70 percent.

About half of participants expect server lifecycles to stay in the three to six year range that is common today, with an average response of 6.2 years. If this holds true, a data center being built today will have to support four to five generations of new technology over its 25-year lifespan.

Asia Pacific projected the longest server lifecycles compared to other regions, with 55 percent predicting lifecycles of 7-plus years. This may have more to do with regional attitudes toward technology replacement than changes in technology itself. There is reluctance in this region to replace equipment that is still functioning and businesses tend to hold on to their equipment longer than in other areas of the world.

Regarding server maintenance (Figure 14), only 26 expect the trend toward “disposable” servers that has been pioneered by hyperscale facilities to become the dominant method of server maintenance. An additional 26 percent expect a repair and replace model to be implemented, while 48 percent expect servers to be built for high reliability.

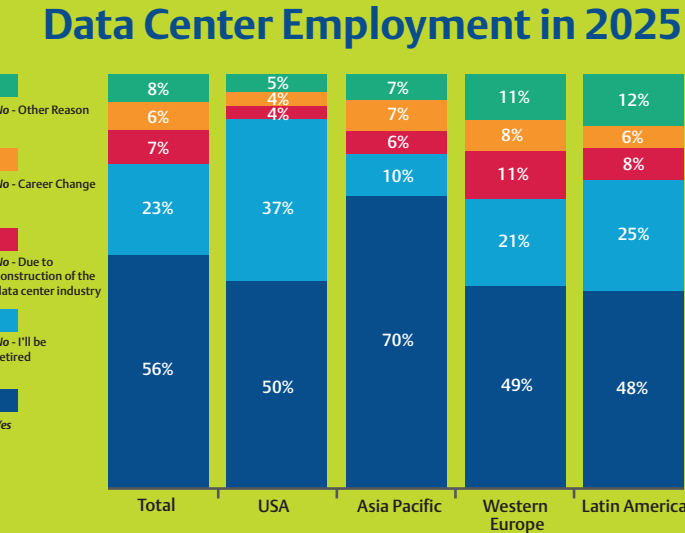


Figure 13. Do you expect to be employed in the data center industry in the year 2025?

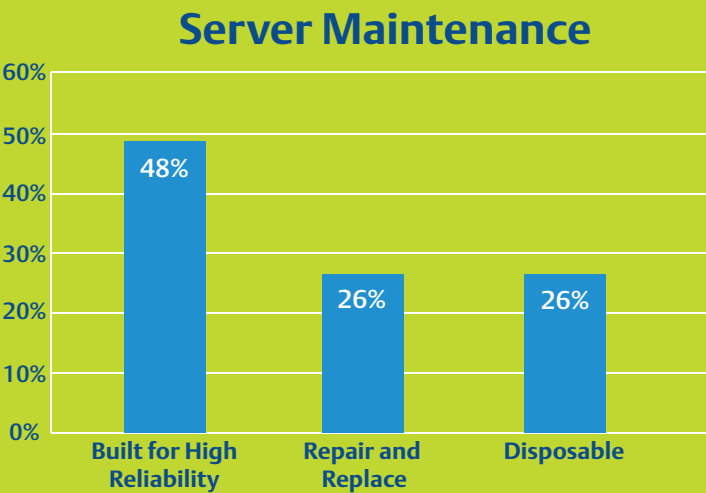


Figure 14. In 2025, what will be the primary way in which servers are maintained?

# The Future of Telecommunications

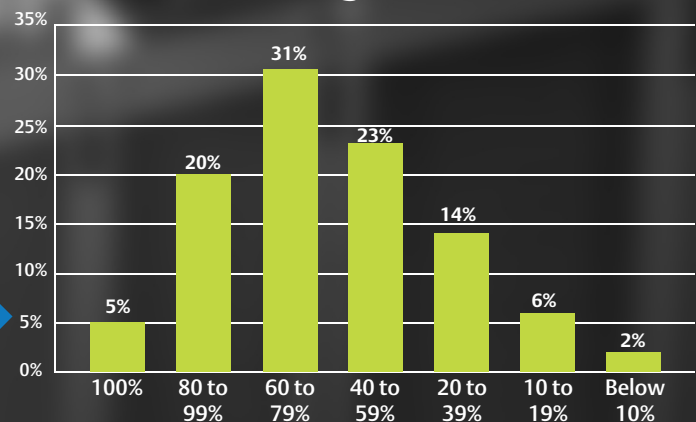
Survey participants were asked what percentage of network facilities will become data centers in 2025 (Figure 15). Only 1 in 20 expect all network facilities to become data centers, but 56 percent globally predict at least 60 percent will. This number is highest in Asia Pacific (61 percent) and lowest in Western Europe (46 percent)

Admittedly this may represent a data center-centric view of telecommunications, as participants were primarily from the data center industry. Some in the telecommunications industry see a future in which centralized data centers are supported by network facilities that bring sophisticated computing capabilities closer to subscribers. In this case, multiple network facilities would support each data center and network facilities would outnumber data centers.

Multiple Data Center 2025 contributors stressed the growing importance of the edge of the network as more compute and storage are pushed closer to the end user to reduce transmission / bandwidth requirements. This may be one solution to the “zettabyte problem” but requires that edge facilities be designed for resiliency and availability as a failure at the edge could limit access to the core.

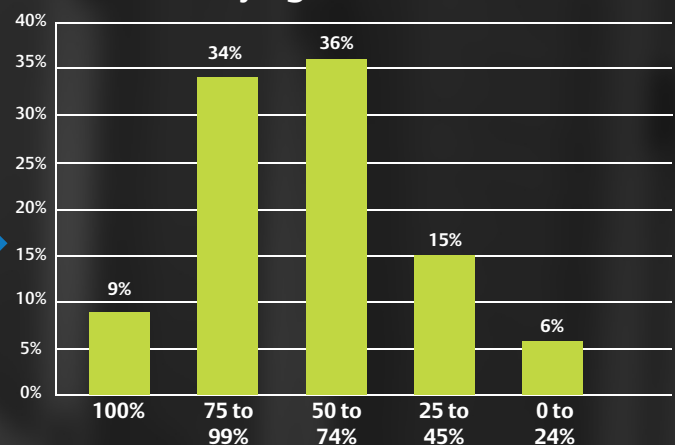
Participants had a similar response to the question of what percentage of telecommunications companies will rely on colocation facilities in their network (Figure 16). Nine percent globally expect 100 percent to rely on colocation while 79 percent predict that at least half will. Competitive conflicts and security concerns could both ultimately limit reliance on colocation.

## Network Facilities Becoming Data Centers



**Figure 15.** In 2025, what percent of network facilities will become data centers?

## Telco Companies Relying on Colocation



**Figure 16.** In 2025, what percentage of telecommunications companies will be relying on colocation facilities in their networks?



As to how close Internet switching centers will ultimately move to users, one in five participants (21 percent) see block-level switching in 2025 while 31 percent envision neighborhood-level switching (Figure 17). Forty-eight percent expect the current paradigm of city-level switching centers to persist in 2025. This number is highest in the U.S. (56 percent) and lowest in Latin America (43 percent). Asia Pacific has the highest percentage, compared to other regions, anticipating block-level switching at 28 percent, while Latin America has the highest percentage anticipating neighborhood-level switching at 32 percent.

The final question focused on telecommunications was one where regional differences were particularly pronounced: identifying the No.1 issue driving change in telecommunications (Figure 18). Performance, which was defined to include latency and reliability, was the number one response globally at 41 percent, although it was rated much higher in Asia Pacific and Latin America (47 percent) than in the U.S. (31 percent).

Bandwidth was the most frequently mentioned issue in the U.S. at 42 percent, but was seen as the No. 1 issue by only 34 percent in Latin America and 30 percent in Asia Pacific. Voice/data convergence was considered the No. 1 issue by the smallest number of participants in each region, but even here regional differences are evident. While 25 percent of U.S. participants named convergence as the No. 1 issue, only 13 percent of Latin American participants agreed.

### Internet Switching Center Location

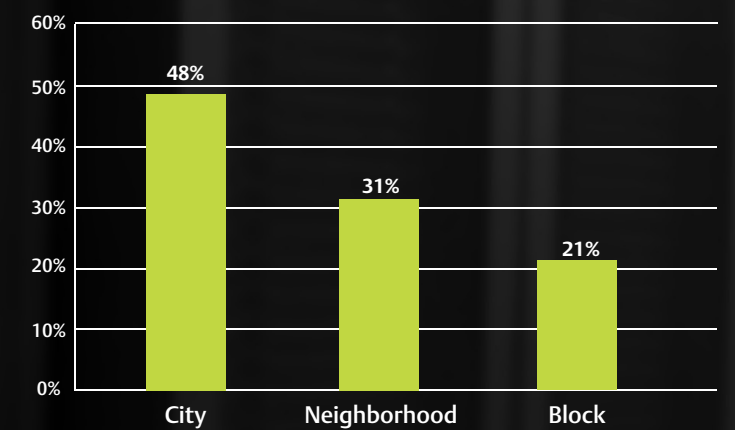


Figure 17. In 2025, how close will Internet switching centers move to users?

### Top Issues in Telecom's Reliance on Data Centers

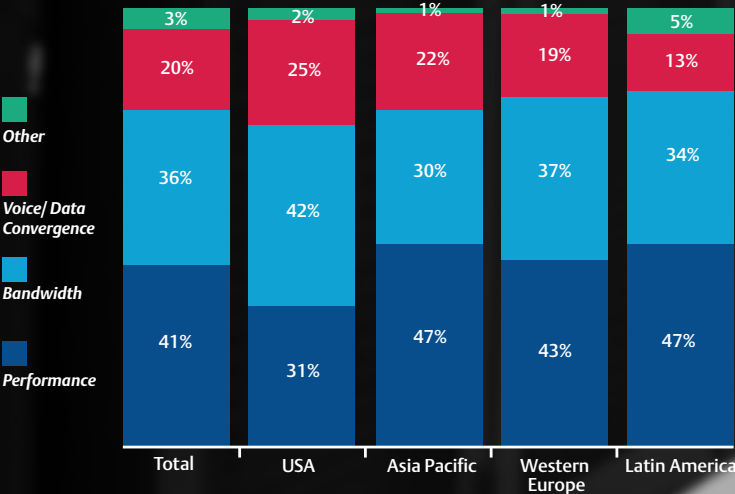


Figure 18. What is the No. 1 issue driving the increasing reliance on data centers in telecom networks?



# Innovation and the Data Center of the Future

One of the most interesting questions posed by the Data Center 2025 survey involved the source of data center innovation. Participants were asked where the most impactful data center innovations would come from and were presented with five choices: software providers, enterprise data centers, infrastructure equipment manufacturers, hyperscale data centers or IT equipment manufacturers.

Globally, IT equipment manufacturers were identified as the most likely source of impactful innovation, although responses were relatively evenly divided across IT equipment manufacturers (28 percent), hyperscale data centers (26 percent) and infrastructure equipment manufacturers (24 percent). Enterprise data centers were selected by 13 percent of participants and software providers by only 9 percent, despite several experts noting that software-based management will be one of the biggest trends shaping the future.

Considering the recent efforts by hyperscale operators to define hardware specifications and experiment with unconventional power and cooling architectures, it wouldn't have been surprising if the industry was looking primarily to hyperscale data centers as the source of innovation; however, that was not necessarily the case.

The U.S. had the most support for software providers at 11 percent and showed a slight preference for hyperscale data centers compared to IT equipment manufacturers (29 percent to 27 percent). The response in Asia Pacific was split evenly across IT equipment manufacturers and hyperscale data centers at 29 percent each. The balance shifts to IT equipment manufacturers in Western Europe, 29 percent to 23 percent, and, even more dramatically, in Latin America with 30 percent for IT equipment manufacturers and 19 percent for hyperscale data centers.

Regardless of where that innovation comes from, it is clear the industry will need to drive and embrace innovation to meet the participants' vision for the 2025 Data Center in terms of power source, resource utilization, power density and management. Participants in the study fell into one of three general categories based on their projections, and from those categories we were able to create several potential visions for the 2025 Data Center (*Figure 19*).

## Participant Category based on Overall Response

Conservatives (37%)	Moderates (41%)	Progressives (22%)
<ul style="list-style-type: none"><li>• Lower energy efficiency</li><li>• Larger enterprise data centers</li><li>• Management: visibility</li><li>• 60% of computing done in the cloud</li><li>• Internet switching: city-level</li><li>• Modest increase in renewable energy</li></ul>	<ul style="list-style-type: none"><li>• Higher energy efficiency</li><li>• 50-80% smaller enterprise data center (vs. today)</li><li>• Management: self optimizing and self-healing</li><li>• 70% of computing done in the cloud</li><li>• Internet switching: neighborhood-level</li><li>• One-fifth of power from solar energy</li></ul>	<ul style="list-style-type: none"><li>• Much higher energy efficiency</li><li>• As much as 90% smaller enterprise data center (vs. today)</li><li>• Management: self optimizing and self-healing</li><li>• 81% of computing done in the cloud</li><li>• Internet switching: block- to neighborhood-level</li><li>• Nearly one-third of power from solar energy</li></ul>

**Figure 19**

The first group, the Conservatives, account for 37 percent of participants. In general (not every participant in each category voted the straight “party line”), the Conservatives expect data center energy efficiency to be lower than it is today, perhaps believing that ultra cheap power sources will reduce the demand for energy-efficient technologies. They envision enterprise data centers becoming larger, data center management systems not moving beyond delivering visibility, and slightly less than 60 percent of computing being performed in the cloud. Internet switching does not move beyond the city level and the use of renewable energy sources increases but does not reach the levels projected by other participants.

This is a vision that represents a data center ecosystem that is similar to the one that exists today, yet larger and less efficient. It envisions incremental progress in some areas and regression in others, as the industry struggles to keep pace with the growing volume of data it will be asked to analyze and store.

The second group, Moderates, represent 41 percent of participants. They expect improvements in energy efficiency and an enterprise data center that is 50 to 80 percent smaller than current facilities. These facilities will be designed with much higher densities, and almost 70 percent of computing will be performed in the cloud.

Enterprise data centers will leverage standard technologies and modular designs to minimize costs and provide much greater flexibility than exists today. They envision self-optimizing and self-healing data centers that get about one-fifth of their power from solar energy and are supported by neighborhood-level switching centers to handle the huge volumes of data moving across the Internet.

The final group, the Progressives, represents 22 percent of participants. They envision data centers that are much more energy efficient than those of today and as much as 90 percent smaller.

Consider the possibilities if the performance of a 5,000 square-foot data center could be housed in just 500 square feet. Of course these data centers would be self-optimizing and self-healing and would be supported by a robust cloud computing infrastructure that delivers 81 percent of necessary computing and storage capacity with 30 percent of the power they consume coming from renewable sources.

Which vision of the data center will become the reality? It's possible that all three could co-exist to some degree. As Andy Lawrence, vice president of Datacenter Technologies and Eco-efficient IT at 451 Research, says in his Data Center 2025 video:

*“The data center of 2025 certainly won’t be one data center. The analogy I like to use is to transport. On the road, we see sports cars and family cars; we see buses and we see trucks. They have different kinds of engines, different types of seating and different characteristics in terms of energy consumptions and reliability. We are going to see something similar to that in the data center world. In fact that is already happening, and I expect it to continue.”*

Those future computing and storage vehicles will likely be more efficient, more powerful and denser than those “on the road” today. But whether those advances will be incremental or transformative depends not only on the innovations that come from manufacturers and operators, but on the industry’s willingness to embrace those innovations.

If the past is any indication of the future, data center operators will be reluctant to embrace any technology or change that compromises or puts at risk data center performance or availability.

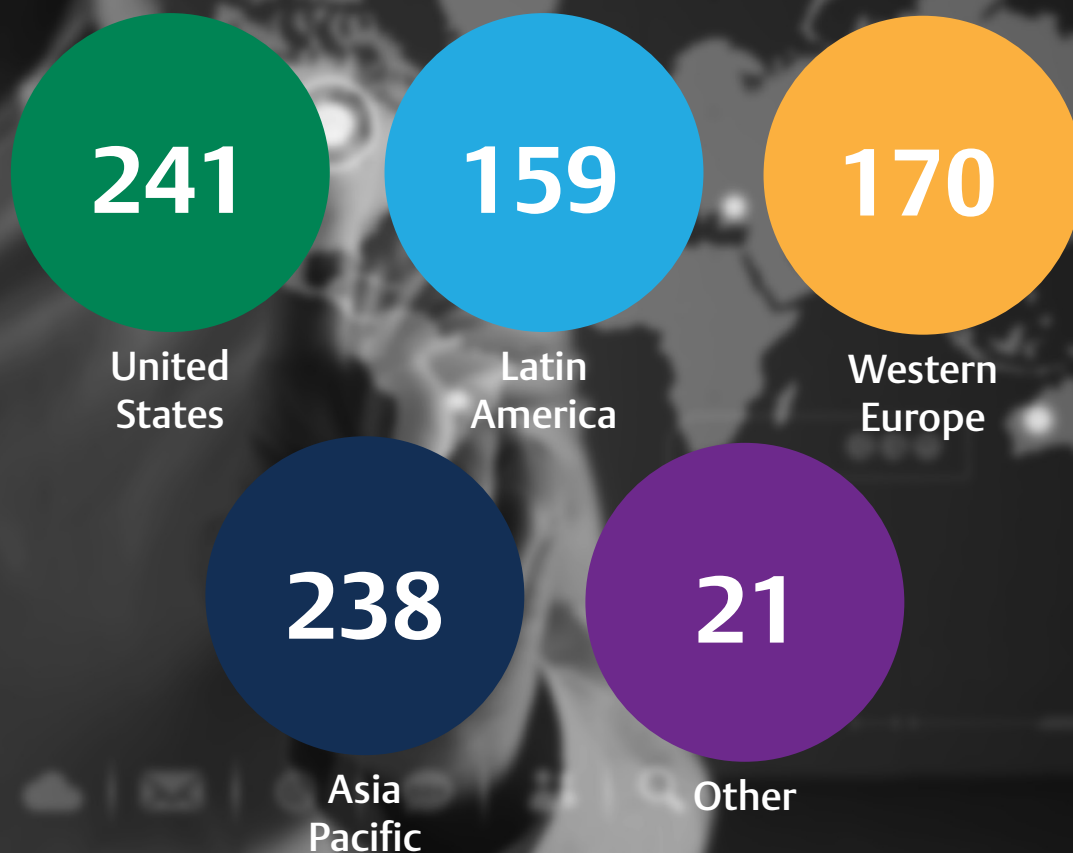
# Appendix: Methodology and Participant Profile

Data Center 2025 included both one-on-one interviews with various industry experts and an online survey. The expert interviews helped shape the questions in the survey and provided additional content for the Data Center 2025 initiative in the form of videos that are hosted on the Data Center 2025 site

[EmersonNetworkPower.com/DataCenter2025](https://EmersonNetworkPower.com/DataCenter2025).

The online survey was conducted among data center and telecommunications professionals in the U.S., Latin America, Western Europe and Asia Pacific. The survey included open-ended questions to collect unbiased expectations about the future of the data center along with close-ended questions to collect quantifiable expectations about changes in technology, business needs, ownership and required skills related to data centers.

The survey produced 829 valid completes, broken down regionally as follows:



A broad range of industries were represented in the survey response with the highest percentages coming from Technology (18 percent), Banking/ Finance (17 percent), Manufacturing (16 percent) and Telecommunications (9 percent). Other industries represented include Energy (5 percent), Government (5 percent), Healthcare (4 percent), Education (4 percent), Construction (3 percent), Transportation (2 percent), Utilities (2 percent), Apparel (2 percent), and Food and Beverage (2 percent).

Forty-two percent of participants were from companies with at least 5,000 employees. An additional 39 percent are from companies with at least 500 employees.

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