BLACK & WHITE PAPER

The Impact of Cloud and the Internet of Things on Datacenter Demand

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COMMISSIONED BY

About this paper

A Black & White paper is a study based on primary research survey data that assesses the market dynamics of a key enterprise technology segment through the lens of the "on the ground" experience and opinions of real practitioners – what they are doing, and why they are doing it.

About 451 Research

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INTRODUCTION

With the growing adoption of public cloud services by enterprises and ever-evolving IT options and priorities – including the growth of mobility and the Internet of Things (IoT) – demand drivers for leased datacenter space have changed, and will continue to change. In the early 2000s, much of the demand for leased space came from either carriers or enterprises. More recently, this has shifted to greater demand from service providers, including public cloud providers, and from enterprises seeking space that also includes higher-level services.

In response to these trends, particularly that of public cloud adoption, some analyst firms, investors and pundits have predicted significantly reduced demand for leased datacenter space going forward. However, many of these negative prognoses seem to exclude the potential demand for leased space from cloud providers themselves and the potential future demand driven by wider IoT adoption. They also may not take into account the demand for hybrid datacenter space, and the fact that not all workloads are shifting to the cloud due to data security, cost or other concerns.

EXECUTIVE SUMMARY

To better understand enterprises' plans and challenges, including those for next-generation edge computing such as IoT, and the resulting impact on datacenter demand, 451 Research polled more than 700 enterprises – specifically, decision-makers who have responsibility for selecting their company's IT and storage services. All respondents were colocation customers; they did not include colocation, hosting or IT service providers. Respondents were from companies of various sizes, with headquarters in the US, Western Europe, China and India, and from a range of verticals. Surveys were conducted online and by phone. (Detailed demographics of the survey are outlined in the Appendix.)

Our goal was to gain a deeper understanding of various factors that could boost demand for leased datacenter space going forward, including enterprise data storage, cloud adoption trends, and the potential impact of the wave of new data generated by IoT applications.

10 TAKEAWAYS AND ACTIONS FOR MTDC PROVIDERS

- **Multi-tenant datacenter (MTDC) providers with interconnection or managed services will fare well amid the growing demand for off-premises deployments.** Providers without either of these (i.e., those offering pure colocation) should consider acquiring or developing additional service offerings to support demand for multiple services under a single contract.
- **Managed services that simplify public cloud use or make it more secure, as well as private cloud options, are becoming more important to customers.** There are still plenty of factors that hinder public cloud adoption or make private cloud appealing. Providers that can offer consultative services to support the migration process and help enterprises move specific applications off-premises, as well as those offering private cloud options and strong security, will be differentiated. Flexible contracts to support shifts to cloud services are becoming more important as customers realize that workloads will fluctuate over time.
- **To support edge computing, MTDC providers should consider opportunities to expand into markets outside the top 10,** through new builds or acquisitions. Colocation customers tend to prefer using the same provider in new geographies rather than launching a separate vetting process. There are also opportunities to establish smaller modular facilities in strategic locations, such as at the base of cell towers, to capture data that will ultimately be sent elsewhere rather than stored on-site.

- **The Internet of Things is no longer a trend that can be ignored by any provider of datacenter capacity services.** Nearly all – a surprising 98% – of our survey respondents have IoT projects either deployed or in the pre-deployment planning stages.
- **The public cloud brings specific challenges that colocation providers and telecom operators are uniquely advantaged to address** based on the number and geographic reach of their points of presence and their local and/or vertical expertise.
- **The emergence of IoT creates a new battleground regarding computing capacity location** and offers numerous opportunities for MTDCs, colocation facilities owners and telecom providers. A well-planned go-to-market strategy to engage smaller enterprises around IoT service delivery is prudent given the overall affinity for colocation and managed services environments as an IoT storage location.
- **Special attention should be focused on those verticals and countries** with the highest proportion of enterprises in the late planning stages for IoT support. These prospects are likely to be considering the capacity impacts of IoT and therefore will be interested in data storage and processing options.
- **IoT will bring applications and workloads that demand near-real-time responsiveness (low latency)**, which dictates the potential placement of computing capacity closer to the network edge or device to minimize transmission latency impact. Within these performance- or latency-sensitive applications, the direct device-to-cloud model is insufficient or uneconomical.
- **The fog/edge computing market will drive significant partnership opportunities** in providing infrastructure to service providers or systems integrators that lack an extensive datacenter footprint. The strategic question for any IT services firm is: "Will I seek 'trusted advisor' status – or am I best positioned as an enabler?"
- **A marketing focus on evangelizing datacenter services that support key fog/edge computing** drivers – such as flexible capacity expansion in leased datacenter locations in urban areas, close to users and 'things' – will be crucial for the next half-decade, since these drivers are not expected to change materially over that time.

Research Highlights

CLOUD ADOPTION CONTINUES

Enterprises continue to shift IT from on-premises datacenters to off-premises colocation, hosted private cloud and public cloud environments. While companies are on average retaining as much as 40% of their workloads in-house and up to 36% of workloads in non-cloud environments, most survey respondents plan to increase their use of private and public cloud over the next two years.

For providers of leased datacenter space, the continued move to public clouds will drive demand under a variety of circumstances, including when:

1. Cloud providers lease datacenter space rather than build it themselves.
2. Enterprises continue to shift workloads and data that are not suitable for public cloud off-premises (e.g., to private cloud).
3. Cloud providers and enterprises seek to install points of presence in network-dense datacenters in order to interconnect with providers, partners and customers.

Regarding #1 above, while this survey focused on enterprises rather than cloud providers, other 451 research has found that cloud providers outside of the top three (Amazon, Microsoft and Google) have a strong tendency to lease nearly all of their datacenter space. Even the top three providers, which have built very large datacenter campuses, tend to lease large amounts of datacenter space from specialized providers, and this tendency seems to have increased in recent years due to strong cloud take-up by enterprises and the need for cloud providers to add global infrastructure quickly. We plan to survey cloud providers separately to track their 'build vs. lease' preferences going forward and which factors influence their decisions.

Regarding #2 and #3 above, our survey found that enterprises are continuing to shift data off-premises to private cloud as well as public cloud environments, and that interconnection capability is a key enabler of this move, as discussed below.

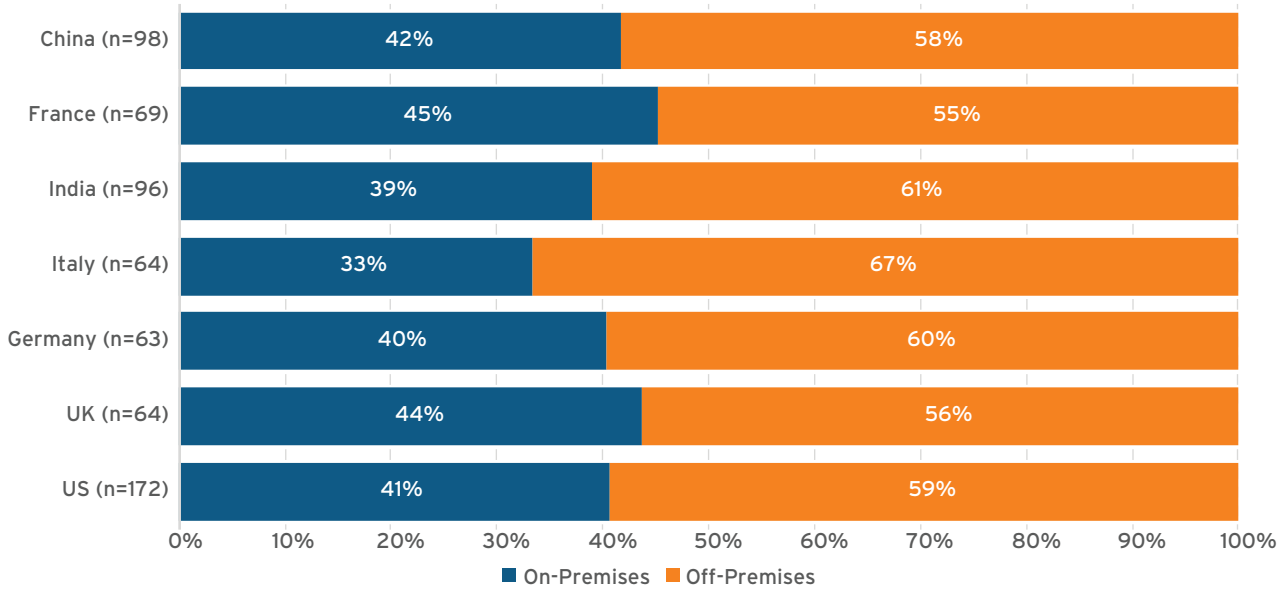
INTERCONNECTION IS ESSENTIAL. DEMAND FOR NETWORK-DENSE DATACENTER SPACE WILL REMAIN STRONG, AND PROVIDERS THAT DON'T OWN CARRIER HOTELS WILL NEED TO PROVIDE CLOUD CONNECTIVITY OPTIONS TO THEIR CUSTOMERS TO STAY RELEVANT.

ENTERPRISES SHIFT TO OFF-PREMISES

The overall shift to off-premises infrastructure has been firmly established. Among the firms that 451 Research surveyed, a majority of workloads now reside off-premises (see Figure 1), which could include any mix of colocation, hosted private cloud, public cloud (IaaS) and SaaS.

Figure 1: On/Off-Premises Workload Distribution, by Country

Q. In consideration of all the workloads your organization runs, approximately what percentage is running in each of the following cloud and non-cloud venues?



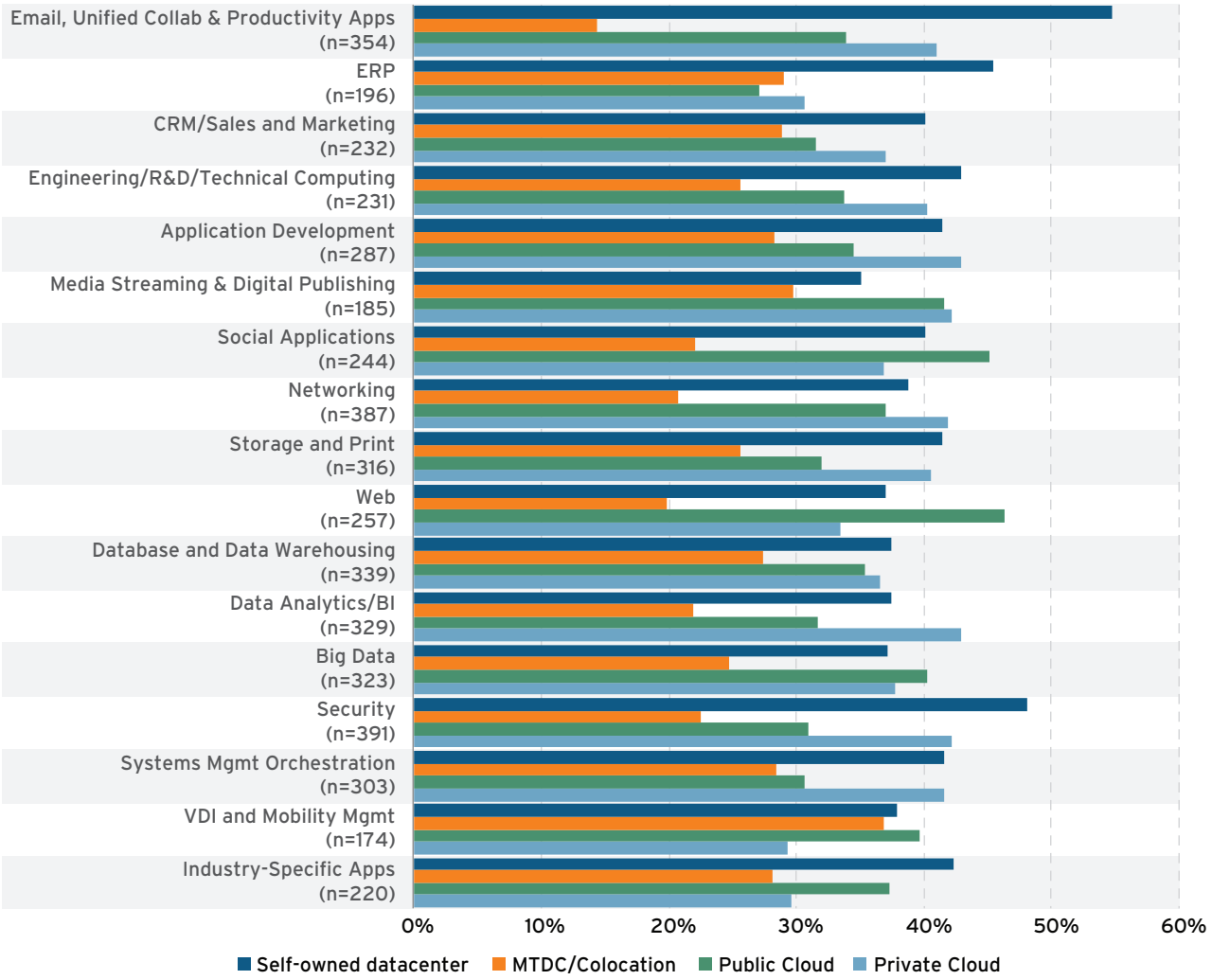
Source: 451 Research

Over the next two years, survey respondents expect a slight decrease in on-premises non-cloud deployments on average, and an increase in on-premises private cloud. For off-premises deployments, respondents expect an increase in hosted private cloud and IaaS/public cloud use, and a slight decrease in SaaS usage.

Regarding the location of data storage – that is, the underlying data necessary for specific workloads – the storage venue varied significantly according to the application/workload. On average, 55% of respondents indicated that email, unified collaboration and productivity applications are still housed in self-owned datacenters, making this the largest workload type housed on-premises. The workloads most likely to be housed in colocation facilities were virtual desktop infrastructure and mobility management (37%) and media streaming/digital publishing (30%).

Figure 2: Current Data Storage Venues by Workload

Q. Considering your organization's applications/workloads, what deployment locations has your organization used for storing data necessary to each workload in the last year? Please select all that apply.



Source: 451 Research

The survey data indicates that public clouds were most often used for social applications and web applications/workloads. When it comes to public cloud deployments, respondents overall cited challenges such as:

- Data security vulnerabilities (72% of respondents)
- Data migration (69%)
- Lack of security visibility (69%)
- Application integration (68%)
- Cloud management (65%)
- Cost management (64%)
- Automation of business processes (64%)
- Determining the right migration approach (64%)

- Reduced application performance (63%)
- System monitoring (63%)
- Data storage management (62%)

In many cases, managed services that help companies work with public cloud (or 'cloud wrapper' services) – e.g., managed security services or migration services – could help offset these challenges, as could a mixture of public cloud and private cloud deployments.

Private vs. Public Cloud

The top reason for considering private cloud over public cloud was security concerns – either real or perceived – associated with public cloud (53% of respondents). Coming in at a distant second, 35% of respondents cited concerns about public cloud costs, while compliance requirements (28%), operational challenges (27%) and network/backhaul costs (25%) were also factors against public cloud.

For many industries, specifically healthcare and financial services, compliance requirements may prohibit the use of public cloud capacity. Most cloud providers avoid liability with regard to compliance and require potential customers to interpret and select the various security options themselves. Some require customers to waive liability of the service provider if the customer is found to be out of compliance, making private cloud more appealing for these industries. Other reasons to consider private cloud over public cloud include operational challenges, network/backhaul costs and the relatively high latency associated with public cloud.

Another consideration for favoring private cloud over public cloud is location. Government regulations around specific types of data (e.g., HIPAA compliance in the US for healthcare patient data, and data sovereignty laws in many countries) and customer preferences may require that data be confined to a specific region or country, for example. Many public cloud services are location-agnostic, and enterprises cannot be certain of the actual location of their data. As governments around the world continue to evolve data regulations for confidentiality, national security and other reasons, location will be an increasingly important factor in public cloud selection. Among enterprises surveyed, 64% specified the geographic location for their cloud deployments. Respondents in India (80%), China (79%) and the US (71%) led the pack in terms of enterprises selecting specific locations, while those in countries in Western Europe were less concerned about location.

While regulatory issues were the main driver for those requiring a specific location (23% of respondents), other factors were at play regarding datacenter location overall. For example, 30% of enterprises surveyed were most focused on the ability to interconnect with customers and other service providers, making data readily available to their own customer base. This favors colocation providers with highly connected facilities or specific ecosystems within their customer base, or providers that can bundle additional services to support colocation or cloud deployments. Distance from an enterprise's headquarters was the main location criteria for 26% of respondents, while 22% of enterprises surveyed were focused on network latency.

CONTINUED ENTERPRISE DEMAND FOR PRIVATE CLOUD DEPLOYMENTS DRIVES DEMAND FOR LEASED DATACENTER SPACE, WHICH WILL COME FROM COLOCATION PROVIDERS THAT ALSO OFFER HOSTING SERVICES OR FROM MANAGED HOSTING PROVIDERS, MANY OF WHICH PREFER TO LEASE.

CONNECTIVITY IS KEY TO CLOUD ADOPTION

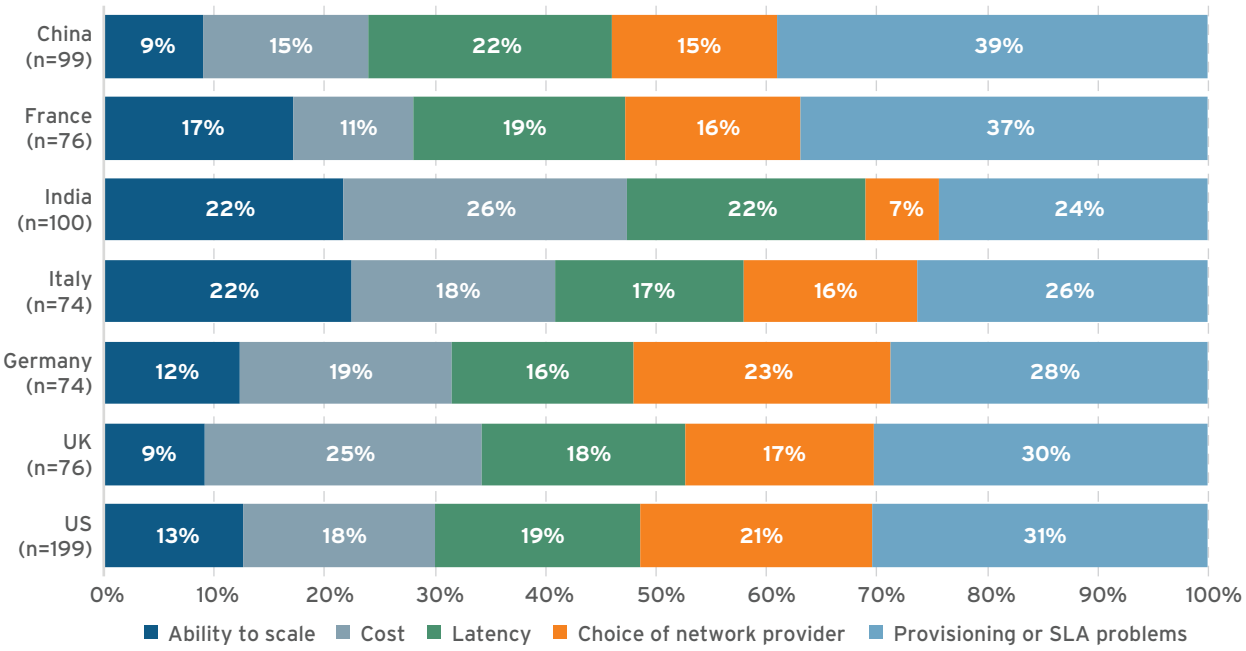
Depending on their geographic location, 30-60% of enterprises surveyed cited latency issues and reduced application performance as a challenge for public cloud adoption (see Figure 3). Reliable connectivity is critical to the overall transition from on-premises infrastructure to off-premises environments.

Additionally, nearly all enterprises surveyed are considering opportunities to interconnect with other service providers' customers within a datacenter – 89% of respondents are evaluating interconnection services of some sort. These services are significantly more important to enterprises in the US and Asia than those in Europe. On a global scale, enterprises are most likely to evaluate security and connectivity costs above all other criteria when considering interconnection services.

Connectivity continues to be a significant challenge for companies leveraging public cloud services. While provisioning lead-time and SLA issues are top-ranked problems overall, other issues include choice of network provider and cost. Public cloud providers in China have the highest rate of failure to meet service-level agreements, while enterprises in India say they are more likely to face challenges in provisioning and latency with their providers.

Figure 3: Datacenter/Public Cloud Services Connectivity Issues

Q. Please rank the following issues surrounding your datacenter connectivity/network as it relates to your public cloud services. (Rank order with 1 being the biggest issue.)



Source: 451 Research

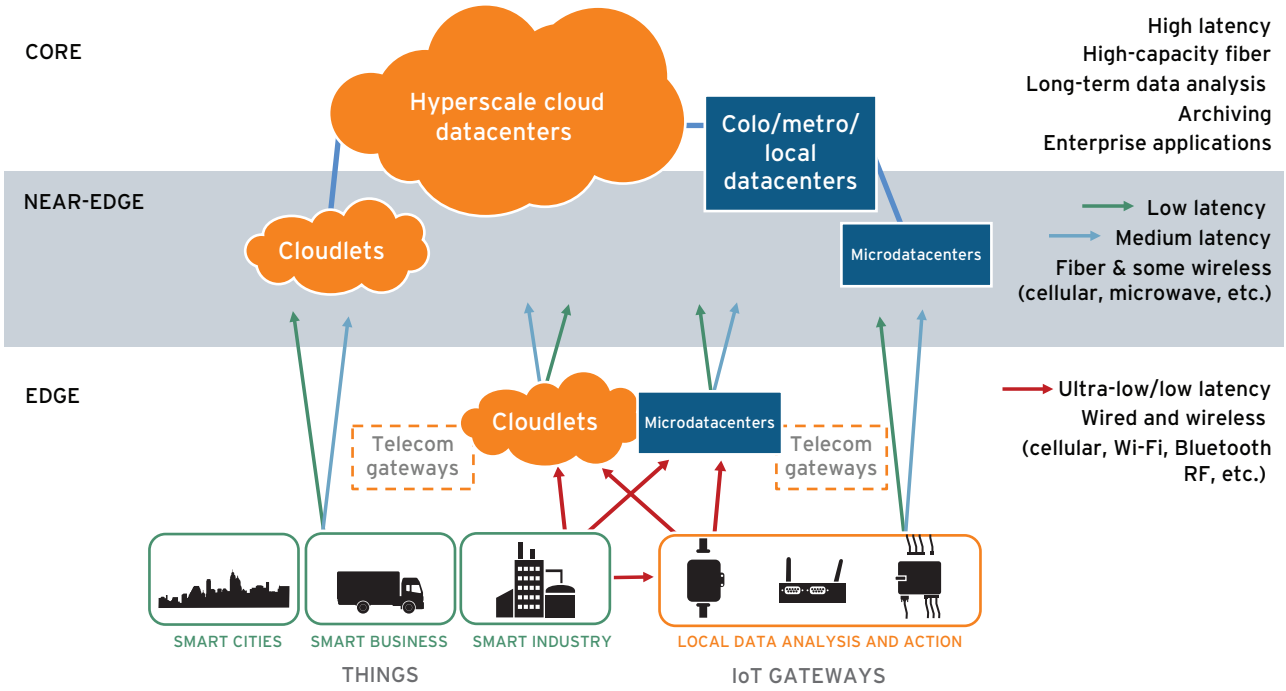
Connectivity is critical for successful cloud adoption, while interconnection is essential to cloud providers and, increasingly, to enterprises. Demand for network-dense datacenter space will remain strong, and datacenter providers that do not own carrier hotels will need to provide cloud connectivity options to their customers in order to stay relevant.

IoT WILL DRIVE DATACENTER DEMAND

Many IoT projects will require a number of locations for IoT data analysis and storage, including: endpoint devices with integrated compute/storage; nearby devices that perform local computation; intelligent gateway devices; and on-premises datacenters, managed hosting sites, colocation facilities, and/or network providers' point-of-presence locations. The diversity of edge computing locations reflects the diversity of markets for IoT.

Even within similar IoT use cases, network architectures and datacenter types will vary (as shown in Figure 4). It does, however, seem likely that a number of IoT deployments will end up storing, integrating and moving data across a combination of public cloud and other commercial facilities, including colocation sites, with both distributed micro-modular datacenters and very large centralized datacenters (including those of public cloud providers) playing a role.

Figure 4: Datacenters for the Internet of Things



Source: 451 Research

For providers of leased datacenter space, IoT is expected to drive demand if/when:

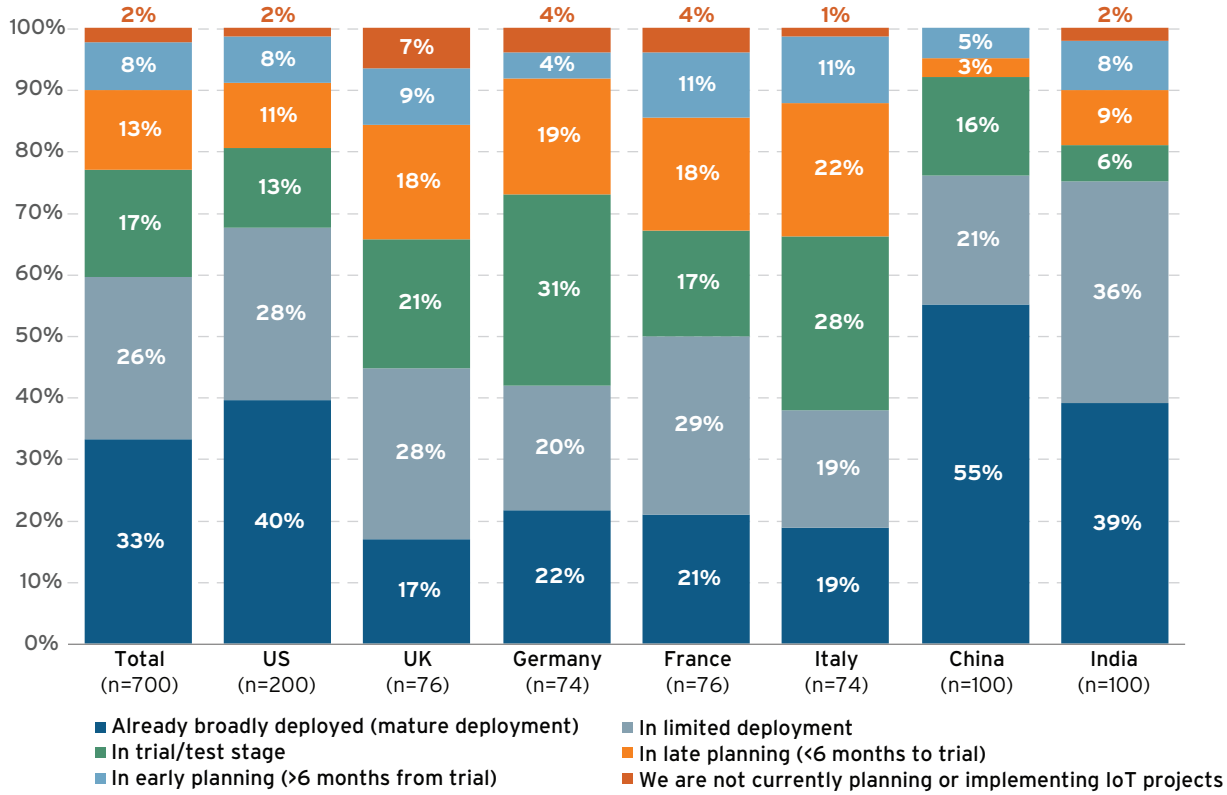
1. There is strong local adoption of IoT projects.
2. The IoT projects generate large amounts of data that must be processed, integrated or stored beyond the devices ('things') or IoT gateway devices – often in datacenters close by.

Regarding #1 above, we were surprised by the nearly universal IoT adoption activity among our 700 survey respondents. In total, 98% of the enterprises in our survey base have at least some IoT activity under way. However, we are clearly at the early stages of the IoT maturity curve, with 64% of respondents identifying their current stage of IoT activity as 'limited deployment' or in test or planning (see Figure 5).

Those respondents citing 'broad IoT deployment' were largely in the US (40% of the country total), China (55%) and India (39%), while those in European countries tended to mostly have limited deployments or trial/test projects under way.

Figure 5: Current Stage of IoT Adoption by Geography

Q: What is your current stage of implementing Internet of Things projects?



Source: 451 Research

Regarding #2 above, the availability and cost of bandwidth are key factors for analytics-heavy IoT applications; IoT data processing and integration needs to occur relatively close to the devices, users or things (at the 'near edge'). This demand is likely to be met by micro-modular datacenters installed at the near edge and/or by colocation datacenters in those locations, including in urban areas.

Security, privacy and data sovereignty will also come into play. The results of our survey show that data storage is already a challenge for many firms, and they are starting to move data off-premises. The ramping of IoT projects with potentially large volumes of data is likely to compound the enterprise storage issue.

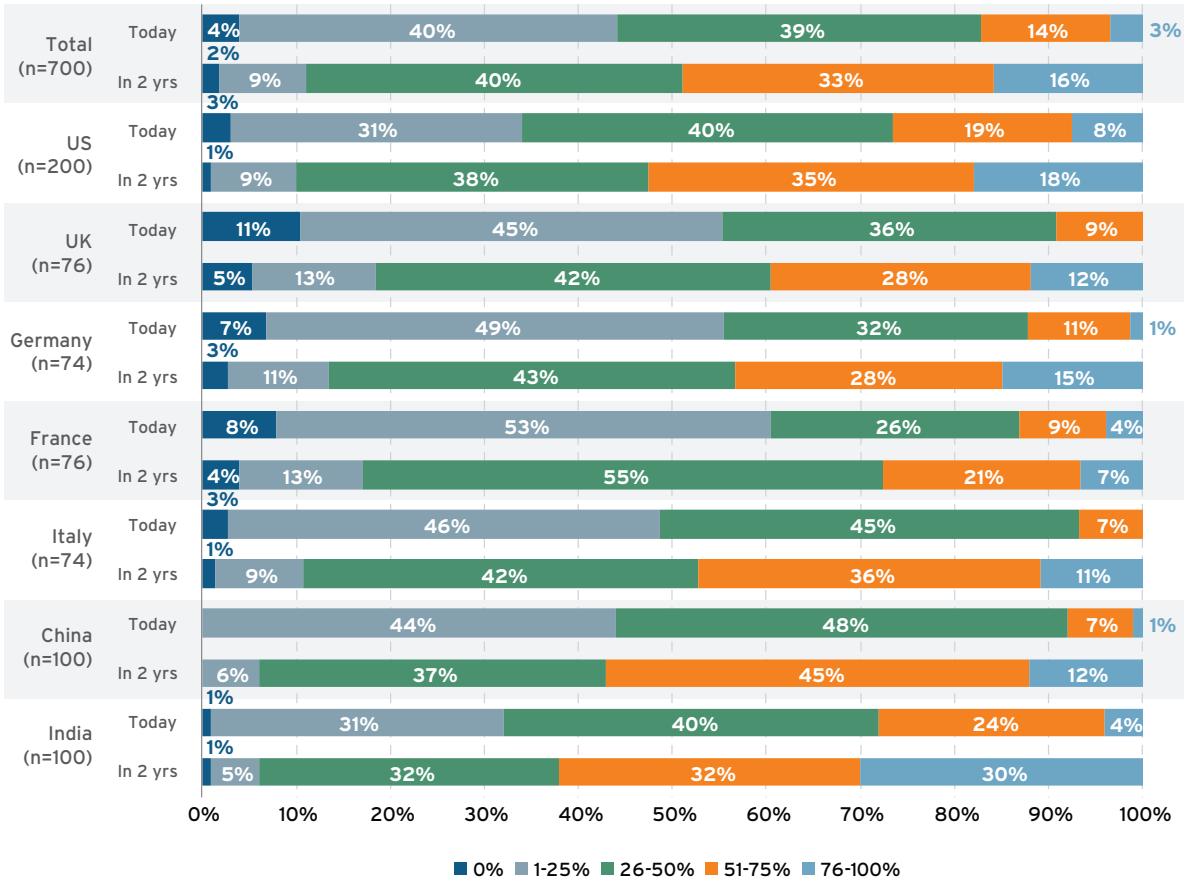
IoT DATA STORAGE MOVING AWAY FROM ON-PREMISES

Given that most IoT projects are still in early or mid-stage development, we were surprised at the amount of datacenter/cloud capacity already being used to support IoT initiatives. The impact that IoT data will have over the next 24 months is projected to be significant (see Figure 6).

In aggregate, 54% of respondents indicated that 26-75% of their current IT capacity supports IoT initiatives. When we asked for this estimate in two years' time, a whopping 73% of respondents expect that up to 75% of datacenter/cloud capacity will be used to support IoT initiatives. IoT is *already* a top driver of IT capacity needs, and this impact is expected to rise dramatically in the short and medium term.

Figure 6: Percentage of IT Capacity Used in Support of IoT Initiatives

Q. What percentage of your organization's datacenter and/or cloud capacity supports IoT (Internet of Things) initiatives? Currently vs. in two years.



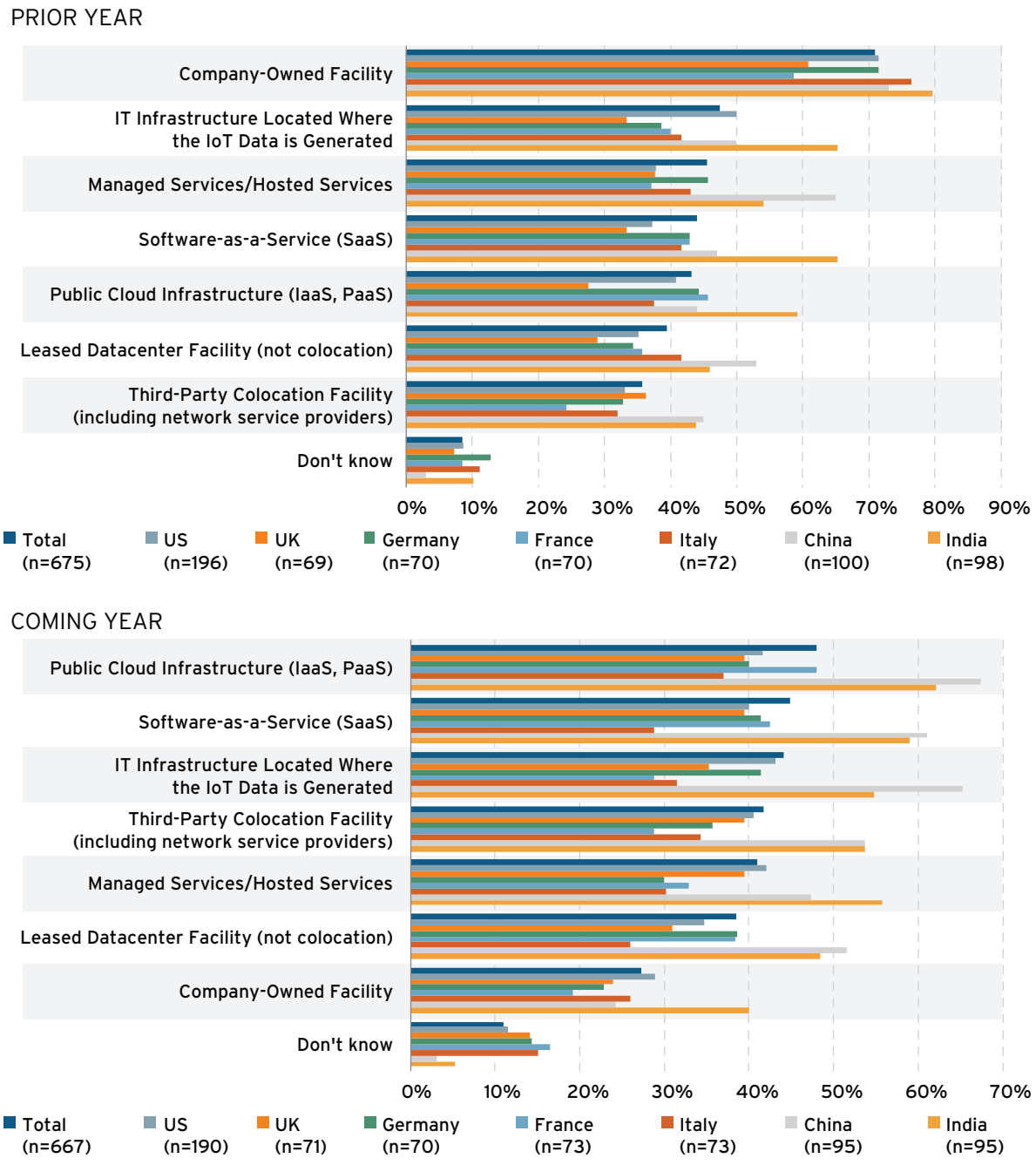
Source: 451 Research

We asked a series of questions related to IoT data storage and analysis that covered physical location, facility ownership and operating models, as well as expected providers for off-premises capacity. The data gathered provides ample evidence of the types of market shifts that can generate significant new revenue opportunities for datacenter service providers (see Figure 7). When analyzing the responses, we discovered:

- **The most drastic transition related to IoT data storage is the move away from company-owned facilities**. While 71% of all enterprises surveyed currently store IoT data on-premises, this figure is projected to drop to just 27% storing IoT data on-premises in a year's time.
- **Respondents in China are the most aggressive in using colocation** as an IoT data storage environment in the coming year.
- **While public cloud infrastructure (IaaS/PaaS) will grow as an IoT data storage location, popular alternatives bode well for colocation opportunities.** IT infrastructure positioned close to where data is generated is expected to be used by 44% of enterprises next year, while 42% say they will use third-party colocation facilities.

Figure 7: IoT Data Storage Locations: Now vs. Next Year

Q. Which deployment locations has your organization used for storing IoT data in the past year, and which locations do you plan to use for storing IoT data in the coming year? Please select all that apply.



Source: 451 Research

The expected surge in IoT data volumes is driving companies to use a wide mix of execution venues, including IaaS and SaaS, but also IT infrastructure close to IoT data generation, colocation facilities, network operator infrastructure, MTDCs and hosted services infrastructure. This is true for data storage and especially for compute resources.

ANALYTICS WORKLOADS DRIVE COMPUTING DEMANDS, BRING NEW OPPORTUNITIES

In addition to storage, IoT data processing presents an excellent new opportunity for datacenter providers. Similar to the results for data storage, 'public cloud' is currently the most popular location (39% of survey respondents) for analysis of IoT-generated data. But the results were fairly distributed across the other top venues, including:

- Colocation facilities (30%)
- Local computing devices attached to data generators (30%)
- Within network operator infrastructure (31%)
- On-premises datacenters (35%)

Other options included intelligent gateway devices, on the IoT device itself, and on stand-alone 'generic' servers in non-datacenter environments, with each of these options selected by at least 25% of respondents.

WORKLOADS AND PROVIDERS

The type of IoT workload also affects the location for IoT data storage and processing. Quality control/tracking systems, at 48% of survey respondents, were the most commonly cited workloads to be processed close to the source of data. Micro-modular datacenters are likely to be deployed to meet this requirement, in addition to MTDCs that are located in relatively close proximity. Other IoT workloads that our survey respondents identified as requiring a near-edge presence included collision avoidance and manufacturing execution, as well as analytics to identify alert conditions.

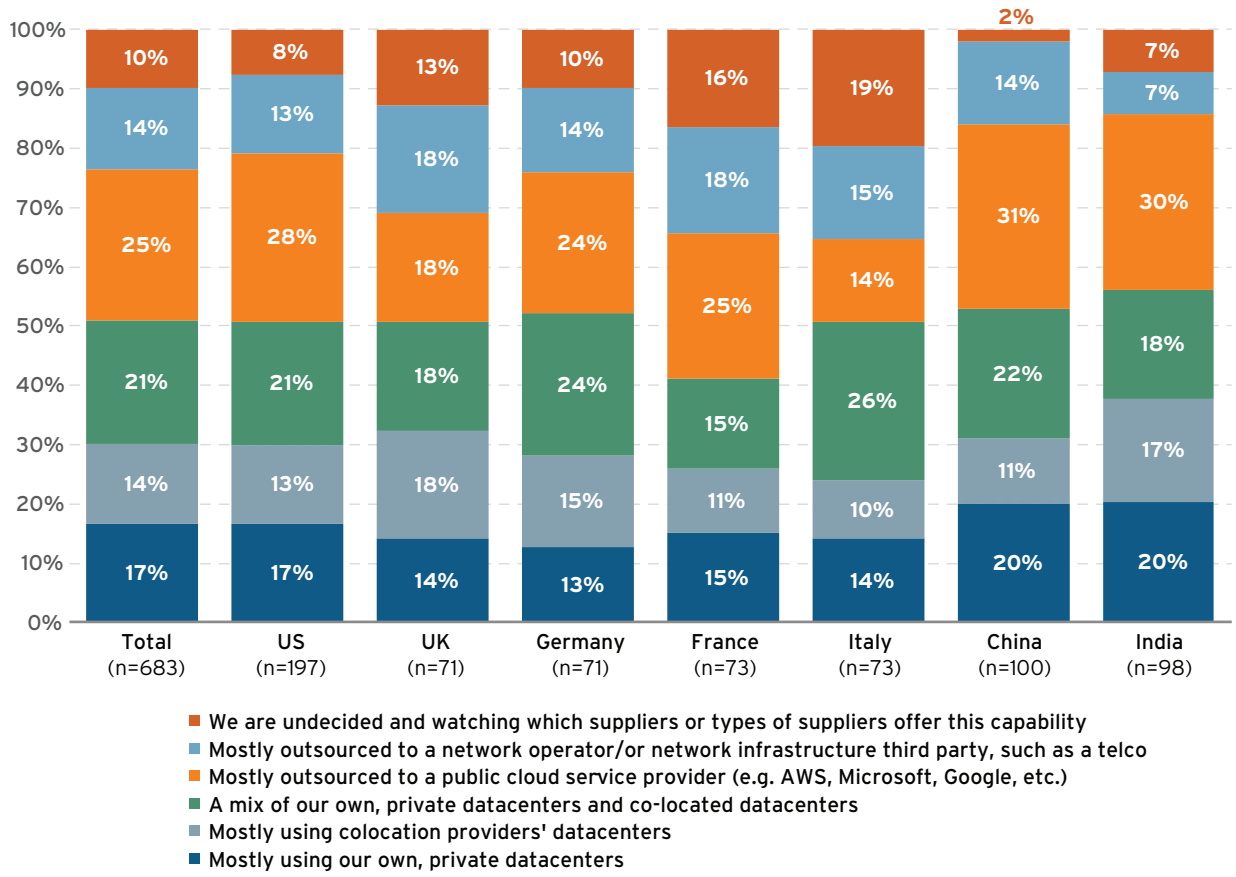
THOSE ENTERPRISES STILL UNDECIDED WHEN IT COMES TO IOT INFRASTRUCTURE SUPPLIERS REPRESENT AN OPPORTUNITY FOR MTDC AND MICRO-MODULAR DATACENTER PROVIDERS.

When it comes to infrastructure suppliers, public cloud providers were cited by 25% of respondents as the top choice for IoT storage and processing. We noted a fairly even split, though, between public cloud and respondents choosing a mix of public, private and colocated datacenters (21%). And 28% of total respondents chose either network operators (14%) or colocation providers (14%).

Meanwhile, a sizable pool (10%) of respondents are still undecided when it comes to IoT infrastructure suppliers. This represents a real opportunity for MTDC and micro-modular datacenter providers.

Figure 8: Strategy for Processing IoT Data Close to Its Source

Q. For any data that will need to be processed close to its source or user for an Internet of Things initiative, which of the following best describes your likely datacenter strategy for the next 2-3 years? [Single select]



Source: 451 Research

FOG COMPUTING AT THE EDGE

The OpenFog Consortium defines fog computing as: "A system-level horizontal architecture that distributes resources and services of computing, storage, control and networking anywhere along the continuum from Cloud to Things." Fog nodes, which are computing facilities that sit between IoT data generators and the centralized cloud, can include micro-modular datacenters, as well as larger datacenters located near to end devices (things), including colocation and other leased facilities, and intelligent IoT gateways. Fog nodes can handle IoT workloads generating massive data volumes that are inefficient to transport to a centralized location, as well as IoT workloads that require low latency.

We were surprised by the overall level of awareness of fog computing expressed by respondents to this survey – overall, 45% rated themselves as either 1 or 2 out of 5 (1=very familiar). The countries most in tune with fog computing concepts were India (63% rated 1 or 2) and the US (52%).

The key market driver for fog computing is real-time analytics on data streams, selected by 26% of respondents. The next most-popular drivers were reduced network backhaul costs (24%) and increased application reliability (21%). The support of low-latency applications was cited as a major driver by only 17% of respondents.

None of these top responses saw a significant percentage swing between the current figures and the projected figures in five years, as cited by the survey participants. However, certain vertical markets will require more low-latency application support going forward – for example, manufacturing (19% now vs. 22% in five years) and healthcare (14% vs. 22%).

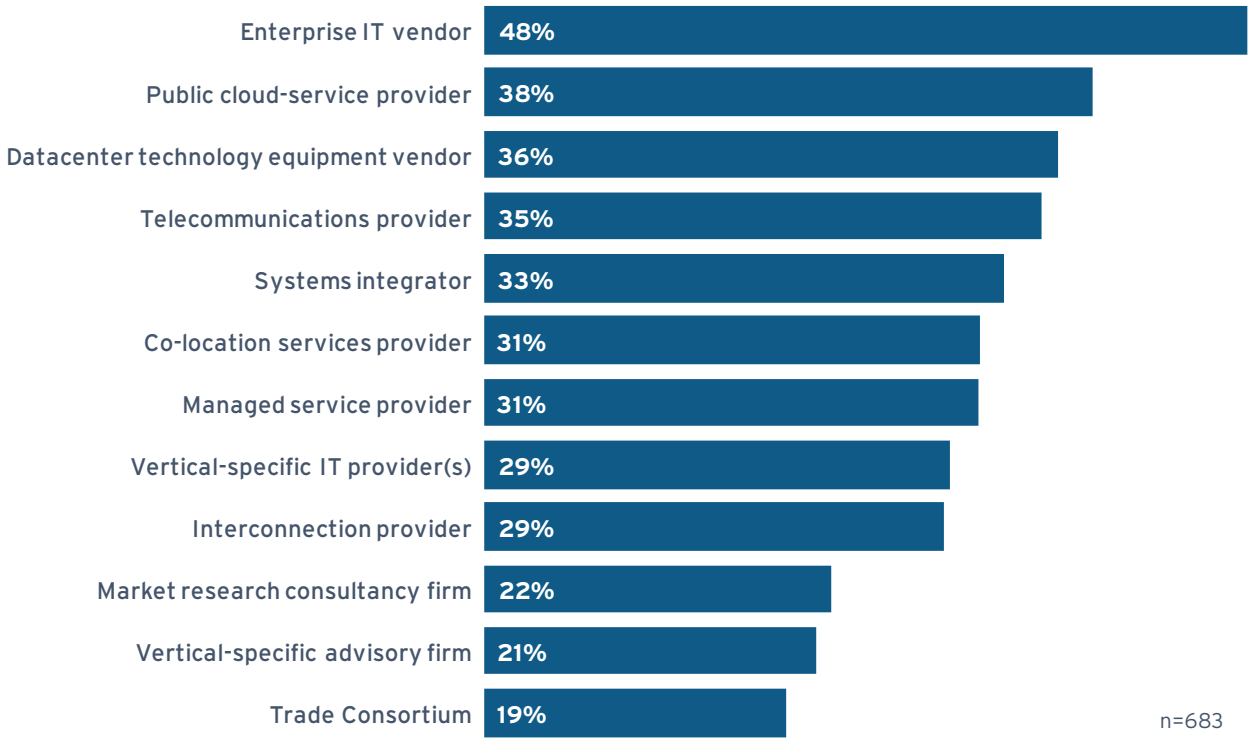
On the other side of the coin, the biggest challenge for fog implementation is the lack of evidence that it's viable, which was cited by 29% of respondents. The next-biggest challenge according to the survey base was the cost and complexity of managing edge/fog infrastructure. Other obstacles to fog adoption noted were the lack of internal skills to manage fog/edge architecture and the unclear ROI/business case. These challenges effectively represent opportunities for service providers that can demonstrate they have the required skill sets and provide examples of fog deployments that have worked for other customers.

We asked enterprises about potential trusted advisors for fog/edge infrastructure. Enterprise IT vendors stood out, with 48% of respondents considering them as trusted advisors. Telecom operators (35% of respondents), systems integrators (33%), datacenter equipment vendors (36%) and colocation providers and managed service providers (31% each) ranked similarly highly.

The strategic question for any IT services firm is: 'Will I seek 'trusted advisor' status – or am I best positioned as an enabler?' The fog/edge computing market will drive significant partnership opportunities around providing infrastructure to service providers that lack a localized physical footprint (enterprise IT or public cloud) or to those that are best positioned as catalysts for digital transformation initiatives (SIs or managed service providers).

Figure 9: Potential Edge/Fog Trusted Advisors

Q: Which of the following types of providers would your organization be most likely to consider as a trusted advisor for your datacenter infrastructure including FOG/edge computing? (Select all that apply)



Source: 451 Research

Latency, cost, privacy, bandwidth cost/availability and data sovereignty requirements for IoT will drive increased demand for colocation and other commercial datacenter capacity, as well as for micro-modular datacenters. Centralized public and private clouds in large datacenters will also play a role in IoT deployments. While the location of IoT data analysis varies by vertical market, applications that fall under the sub-15-millisecond ultralow-latency threshold naturally demand localized analytics.

THE STRATEGIC QUESTION FOR ANY IT SERVICES FIRM IS: 'WILL I SEEK TRUSTED ADVISOR STATUS - OR AM I BEST POSITIONED AS AN ENABLER?

Colocation providers, managed hosting providers, MTDCs and network operators should be planning to target and capture additional capacity demand driven by IoT deployments. Looking at the survey data by vertical market, government (25%) and higher education (26%) respondents were most likely to be in the planning stages of IoT deployments, which make them strong targets for datacenter service providers. Across all vertical markets, healthcare is the leader in reporting broad IoT deployments (41%), while manufacturing firms lead when combining mature and emerging deployments (64%).

In terms of IoT adoption by revenue range, enterprises with more than $1bn in annual revenue are 2.5 times as likely to have broad deployment of IoT as those with revenue below $100m. However, almost a third of respondents with revenue below $100m are in the advanced planning stages for IoT adoption, and should be particularly receptive to IT capacity options, since they are deep in IoT planning but likely have not made IT architecture decisions yet.

Figure 10: Current Stage of IoT Adoption by Industry Vertical and Revenue

Q: What is your current stage of implementing Internet of Things projects?

	Already broadly deployed (mature deployment)	In limited deployment	In trial/test stage	In late planning (<6 months to trial)	In early planning (>6 months from trial)	We are not currently planning or implementing IoT projects	Valid N
Total	33%	26%	17%	13%	8%	2%	700
US	40%	28%	13%	11%	8%	2%	200
UK	17%	28%	21%	18%	9%	7%	76
Germany	22%	20%	31%	19%	4%	4%	74
France	21%	29%	17%	18%	11%	4%	76
Italy	19%	19%	28%	22%	11%	1%	74
China	55%	21%	16%	3%	5%		100
India	39%	36%	6%	9%	8%	2%	100
Financial Services	36%	28%	14%	10%	9%	3%	140
Healthcare	41%	18%	24%	12%	3%	2%	140
Higher Education	27%	26%	15%	19%	9%	3%	140
Manufacturing	31%	33%	19%	10%	6%	1%	140
Public Sector/ Government	30%	27%	14%	14%	11%	4%	140
250-999	24%	28%	21%	15%	10%	3%	297
1,000-4,999	41%	28%	17%	10%	1%	3%	213
5,000+	39%	22%	13%	13%	12%	2%	190
<$100M	20%	26%	22%	17%	10%	5%	153
$100-$499M	25%	31%	21%	14%	6%	2%	221
$500-$999M	40%	25%	15%	10%	10%	1%	134
$1B+	48%	23%	11%	10%	6%	3%	192

Source: 451 Research

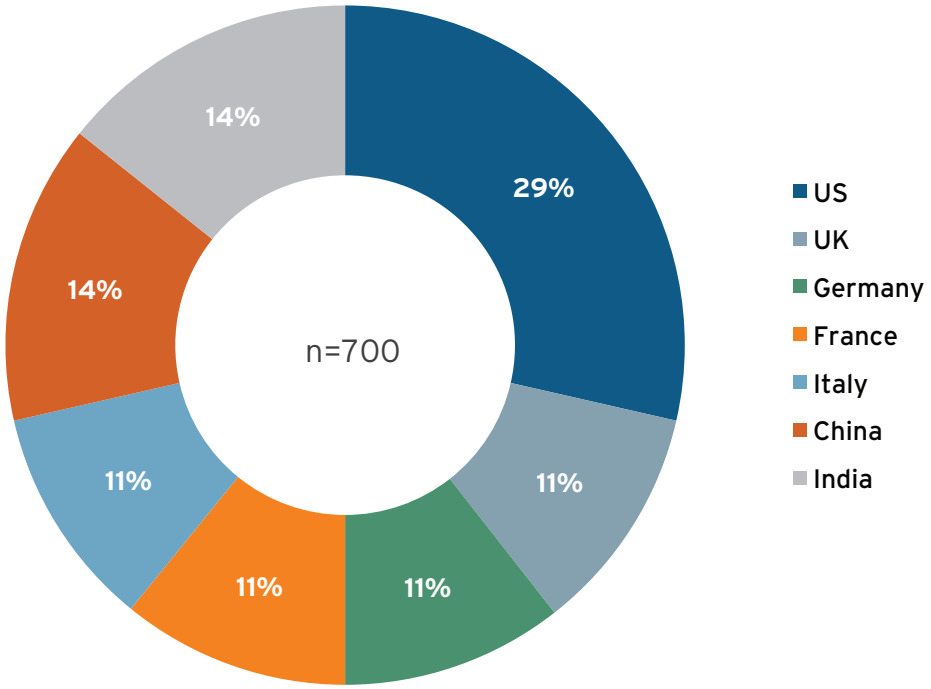
Appendix

451 Research conducted more than 700 interviews with enterprises – specifically, decision-makers who have responsibility for advising on or directly selecting their company's IT and storage services. All respondents were colocation customers; none were colocation, hosting or IT service providers. Respondents were from the US, Western Europe, China and India. They came from a range of market sectors, and spanned various company sizes, as illustrated in the charts below. The surveys were conducted online and by phone. Where anomalies were detected in online surveys, respondents were subsequently reached by phone to clarify their responses.

SURVEY DEMOGRAPHICS

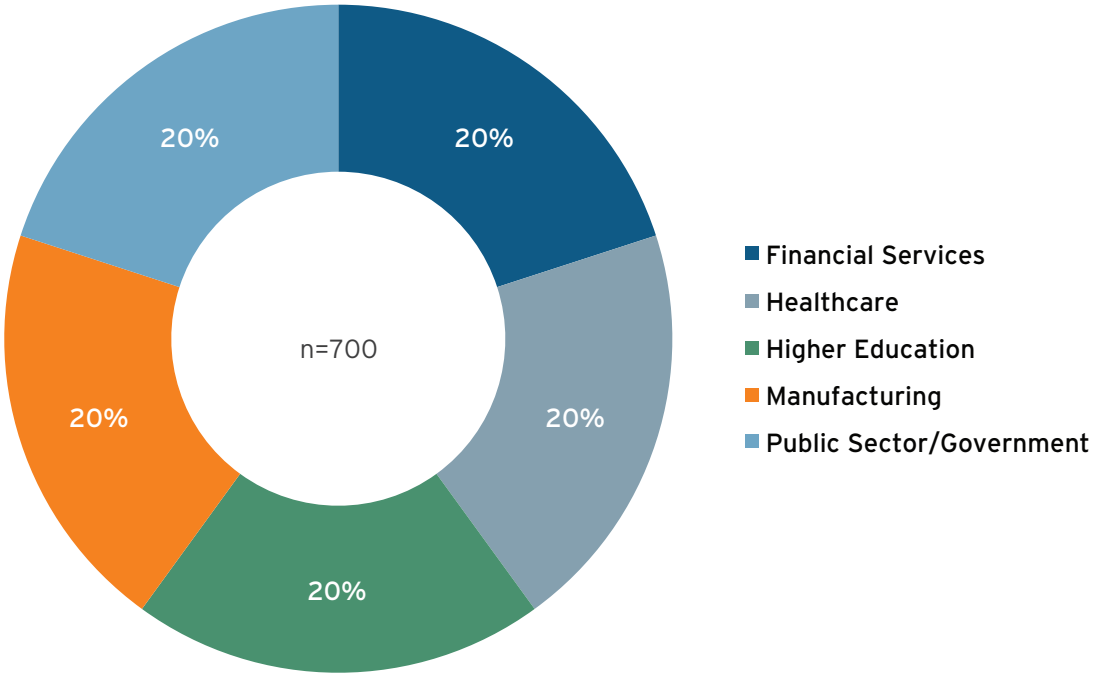
Global HQ Country

Q. Where is your company's global HQ?



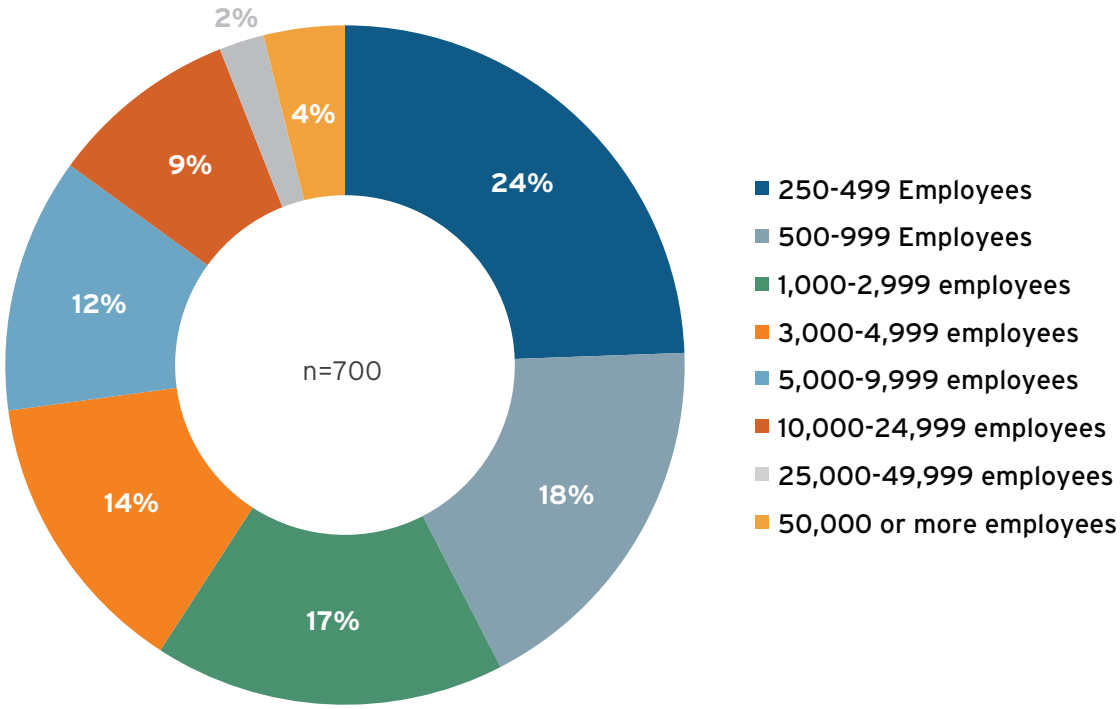
Company Industry

Q. Which of the following best describes your organization's primary industry?



Worldwide Company Employees

Q. Approximately how many full-time employees work in your entire company? (Please include all subsidiaries, divisions and branches worldwide.)



INTERNET OF THINGS: DEFINITION AND MARKET TAXONOMY

The 'Internet of Things' is a useful term to describe a vast ocean of industrial, enterprise and consumer digital transformation activity driven by the deployment of systems designed to transform machine, human, environmental and biological data into actionable insight. The underlying concept of IoT is simple: Connect the objects of the physical world using Internet technology to securely enable data creation and collection; which allows the objects themselves to become 'smart,' or allows users to become smarter about their physical environments.

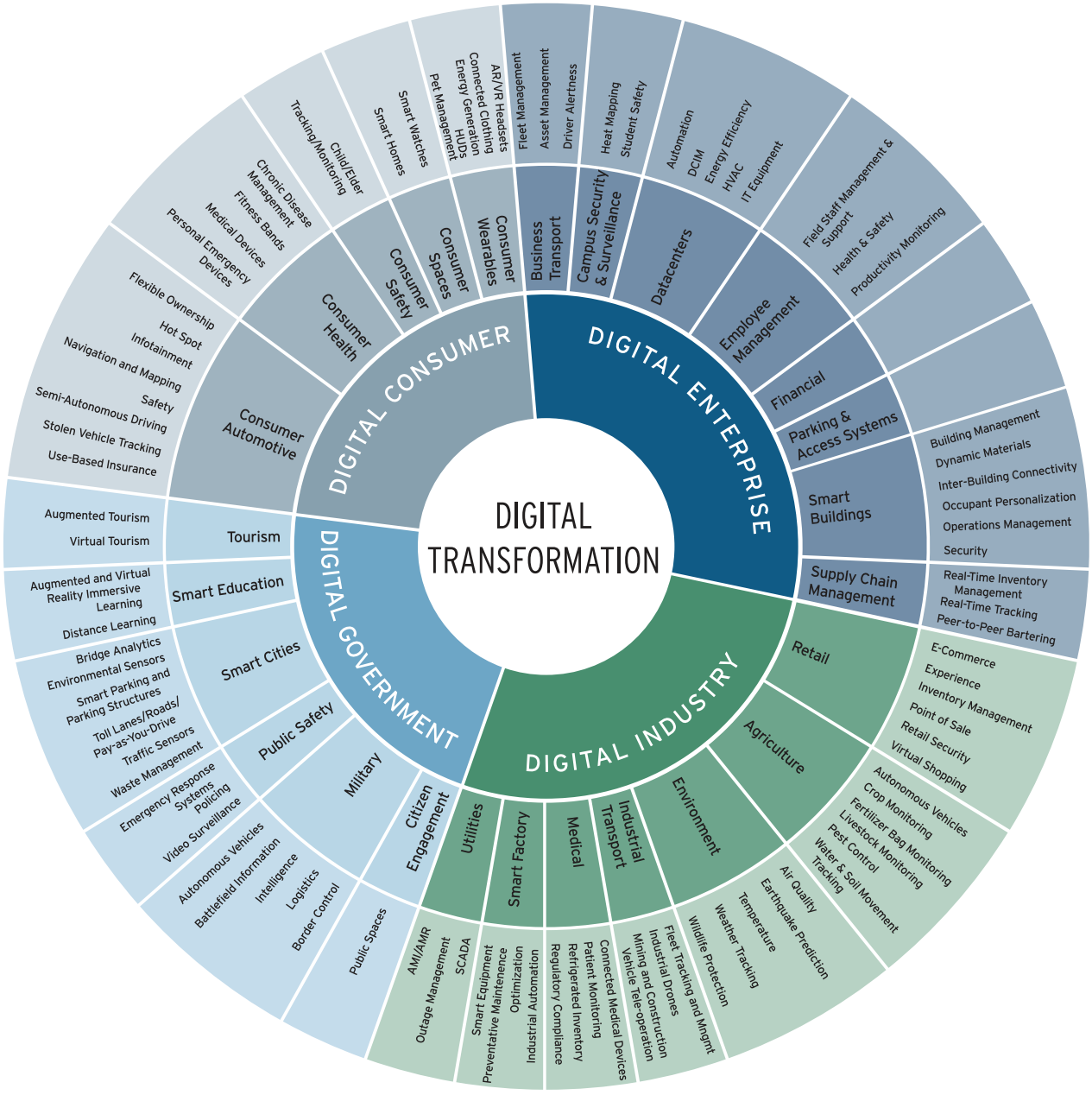
In this way, the physical world becomes digitized and virtualized, allowing for seamless interaction with existing digital systems of record and platforms. For instance, the enterprise CRM system used to monitor customer relationship health can integrate via APIs to an IoT platform that connects with on-board sensors to monitor the health and reliability of the products they have purchased.

Armed with this intelligence, enterprise users derive benefits from more efficient and reliable systems; new or enhanced business models supporting connected products; and increased quality of life by tightly integrating the physical and digital worlds so they can be logically managed in a cohesive system. The vision for IoT boils down to transforming entire industries through unprecedented connectedness at massive scale to deliver valuable data insights. The term IoT becomes less useful when it comes to the 'real-world' technology discussions, since no one 'buys IoT' – they seek connected solutions to business problems enabled by IoT.

Some of those solutions are very 'vertical' in nature, such as an automated crop irrigation and monitoring solution in agriculture. They can also be 'horizontal' in that various types of enterprises might realize efficiency, security and financial benefits from smart-building technologies, such as environmental monitoring or campus surveillance solutions.

The 451 Research Market Taxonomy for IoT provides a sense of the scale for the possibilities of IoT across consumer, government, industry and enterprise. This taxonomy only scratches the surface of what is already possible.

Figure 13: 451 Research Internet of Things Market Taxonomy



Source: 451 Research

Interest and 'pre-scale' Internet of Things adoption continues to grow across all vertical markets and industries. IoT has taken off in support of use cases like manufacturing automation and optimization, and telematics in transportation for fleet routing and logistics. Adoption has also accelerated in healthcare, agriculture, smart cities, retail and security.