Leading with Edge Computing

How to reinvent with data and AI

Contents

Introduction

What drives business today? Most executives ask this question. The answer they invariably turn up, time and again, is innovation.

Timely innovation can unleash the next wave of performance—extraordinary productivity, unprecedented value and exceptional experience—and create a sustainable source of resilience. For innovation to flourish, enterprises need to continually reinvent themselves.

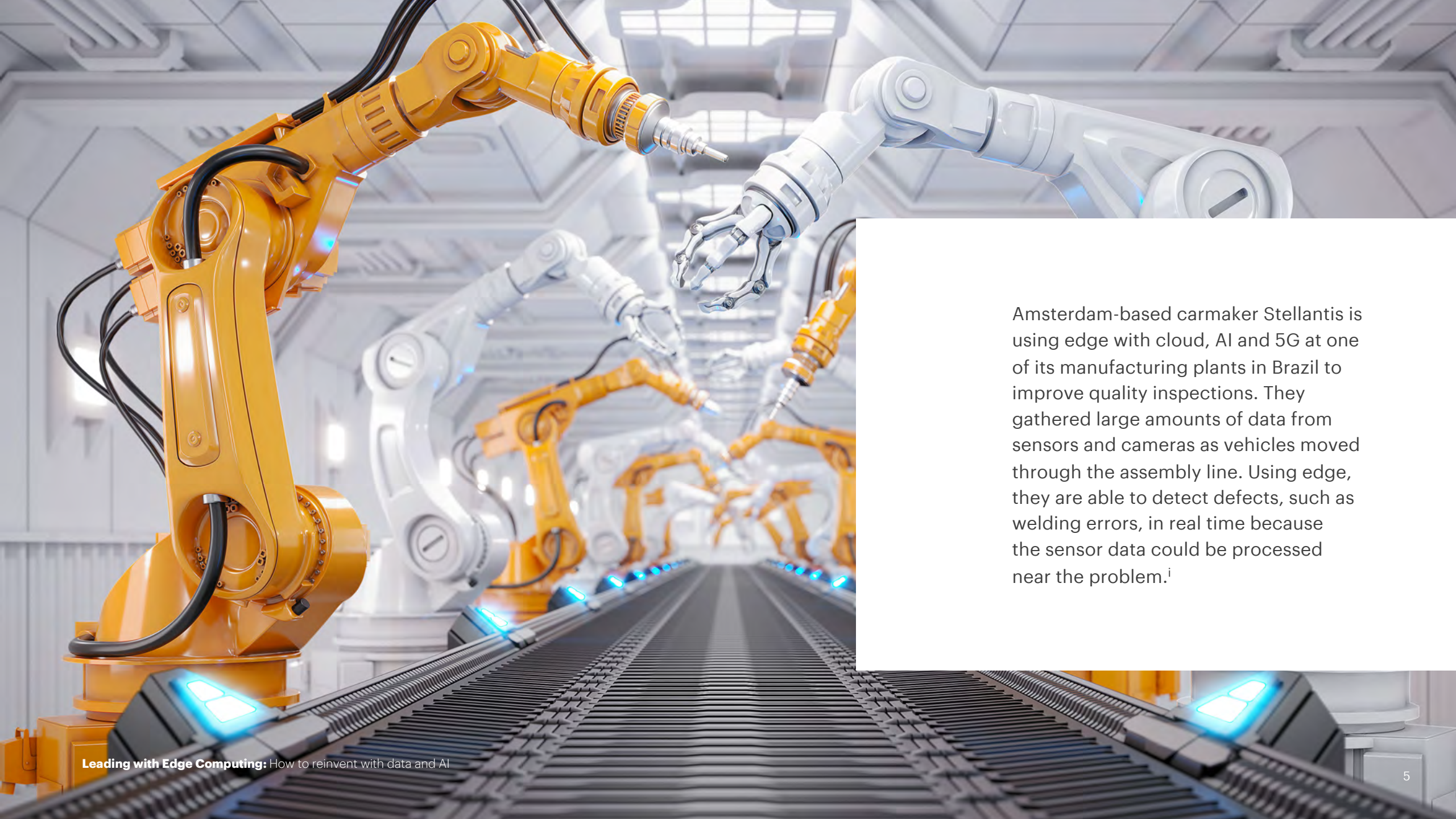
Edge computing is bending the reinvention curve by dramatically improving production and service applications that run business. It moves computing to the edge of the enterprise network where it is closest to users and devices—and most critically, where the data is created. This includes all types of data, from IoT sensor data to user-created data, to unstructured interaction data in virtual metaverse environments to synthetic data, to metadata created specifically to catalog and manage other enterprise data. Enterprises already are creating staggering amounts of data in branch offices, retail stores, remote oil rigs, hospitals and even satellites that, in many cases, are impractical to move back to a central data center for analysis. By the end of the decade, a substantial amount of enterprise-critical data is projected to be produced and acted upon at the edge.

Edge sits at the critical intersection of physical and digital. Think complex data analytics that are happening directly where data is being generated and applied at lightning speed on, say, factory-floor machinery, train-track signals or store-checkout hardware. Or a short prompt on a smart phone that can instantly produce text, images, sounds and other media, as edge works with generative artificial intelligence (Figure 1).

Under the radar thus far, edge is set to become a ubiquitous lever of scale and reinvention as artificial intelligence (AI)—including gen AI—driven applications become pervasive in enterprise functions and operations. AI can be trained on edge data to look for local patterns in real time, making training models simpler and substantially improving the performance of consumer and business applications. As a result, enterprises are shifting their data center strategy to include edge in order to meet and scale AI's compute requirements.

What is edge computing?

We define edge computing as a new capability that moves computing to the edge of the network where it is closest to users and devices—and most critically, as close as possible to data sources. Edge computing is designed to take advantage of the growing number of smart devices operating at the network perimeter by enabling more complex data processing at the point of collection.



Amsterdam-based carmaker Stellantis is using edge with cloud, AI and 5G at one of its manufacturing plants in Brazil to improve quality inspections. They gathered large amounts of data from sensors and cameras as vehicles moved through the assembly line. Using edge, they are able to detect defects, such as welding errors, in real time because the sensor data could be processed near the problem.[i]

Edge drives new value at the data source

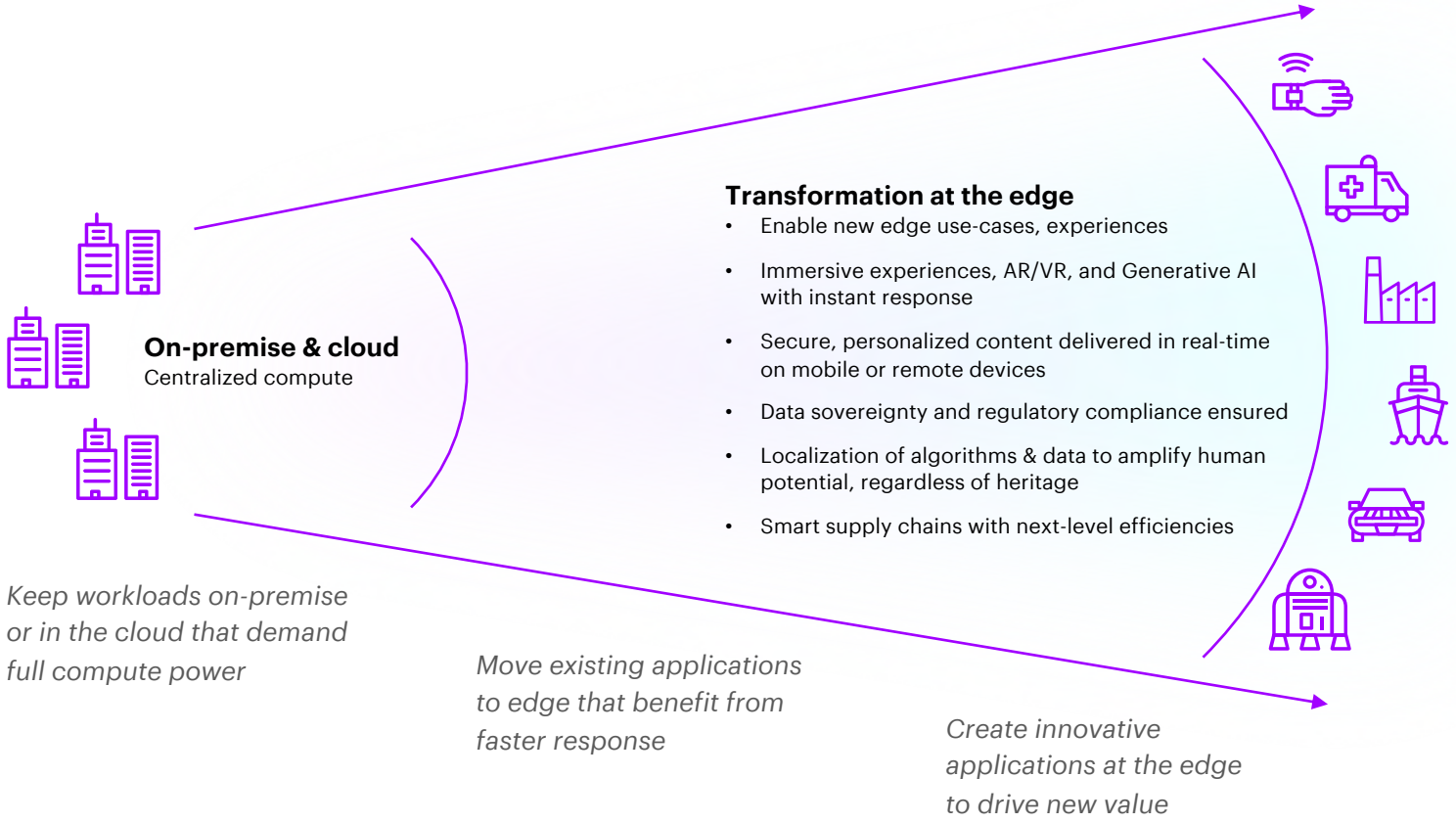


Figure 1

Business at the edge

Edge computing could include devices such as smart watches, phones, IoT devices on oil fields or robots on factory floors to analyze data in real time, on location.

Edge moves computing **to the edge of the network,** where it's closest to users and devices, **as close as possible to data sources** – e.g., where digital meets physical.

Our recent survey of 2,100 C-level executives in 18 industries across 16 countries found that **83% believe that edge computing will be essential to remaining competitive in the future**. Meanwhile, 81% think failure to act quickly can lock them out from the full benefits of the technology.

Still, only 65% of companies are using edge to some degree today. Of these, only half have deeply integrated edge with their digital core.

We found edge adoption is challenging conventional management thinking. Based on our cluster analysis, the first wave of companies whose edge adoption was led by a centralized IT are not seeing the greatest benefits. Nor are the companies that are investing more in edge compared to their peers to address specific business needs.

Many of them view edge as a standalone technology, using it in ad-hoc projects with the goal of achieving quick impact on the bottom line. These groups, comprising half of those using edge, are caught in a chasm of lackluster outcomes.

The other half applies edge across all parts of their business. These companies take a cloud-based, data and AI-oriented approach, extending the value and agility of their digital core. They view edge as a key differentiator to bring artificial intelligence into their core business, embedded in their products, services and workforce. And they are seeing better outcomes: accelerated innovation leading to new revenue opportunities, reduced costs resulting in higher efficiency and better customer experiences.

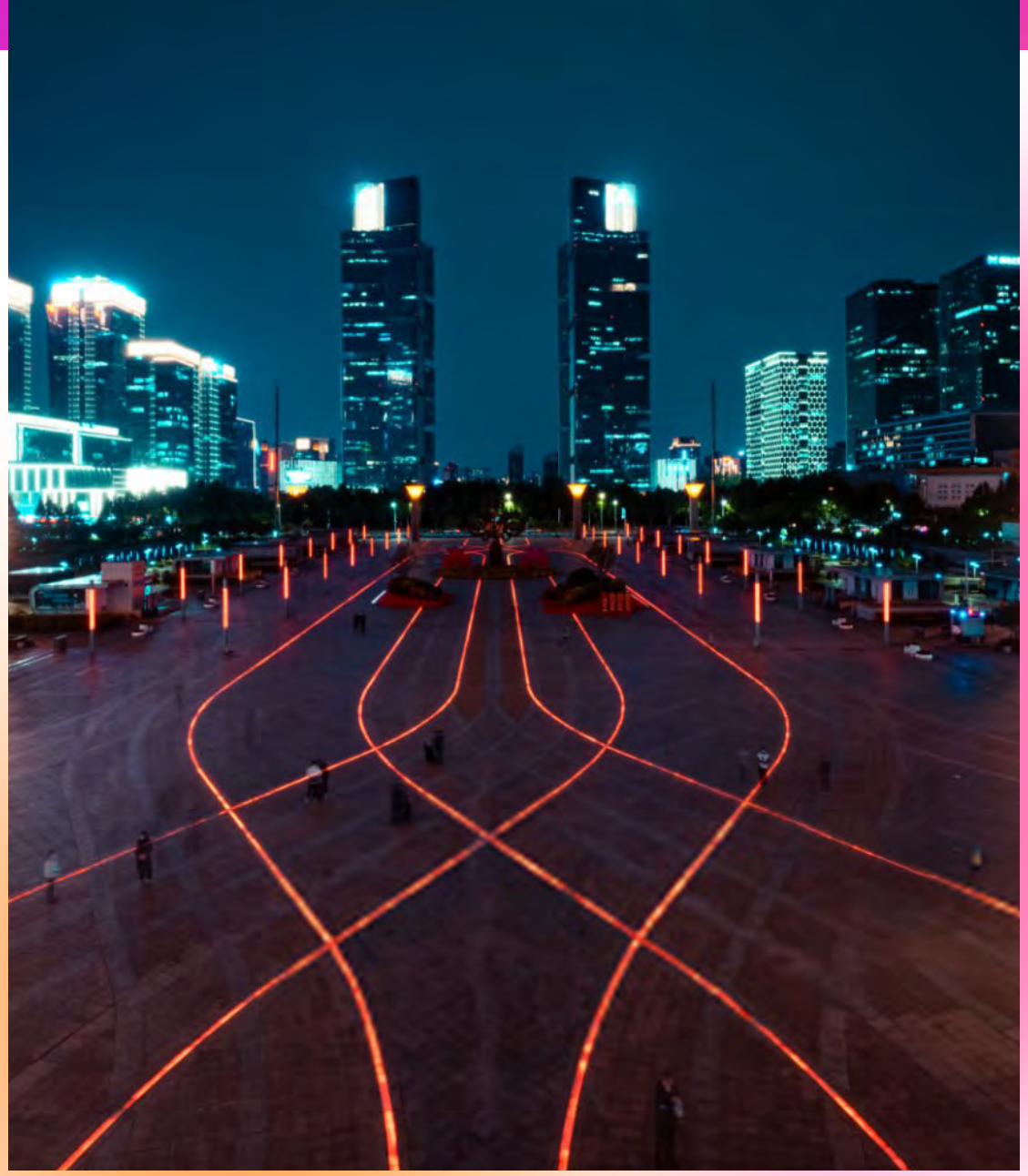
Our research uncovered that the most advanced users of edge, are **4x** more likely to achieve accelerated innovation, **9x** more likely to increase efficiency and nearly **7x** more likely to reduce costs.

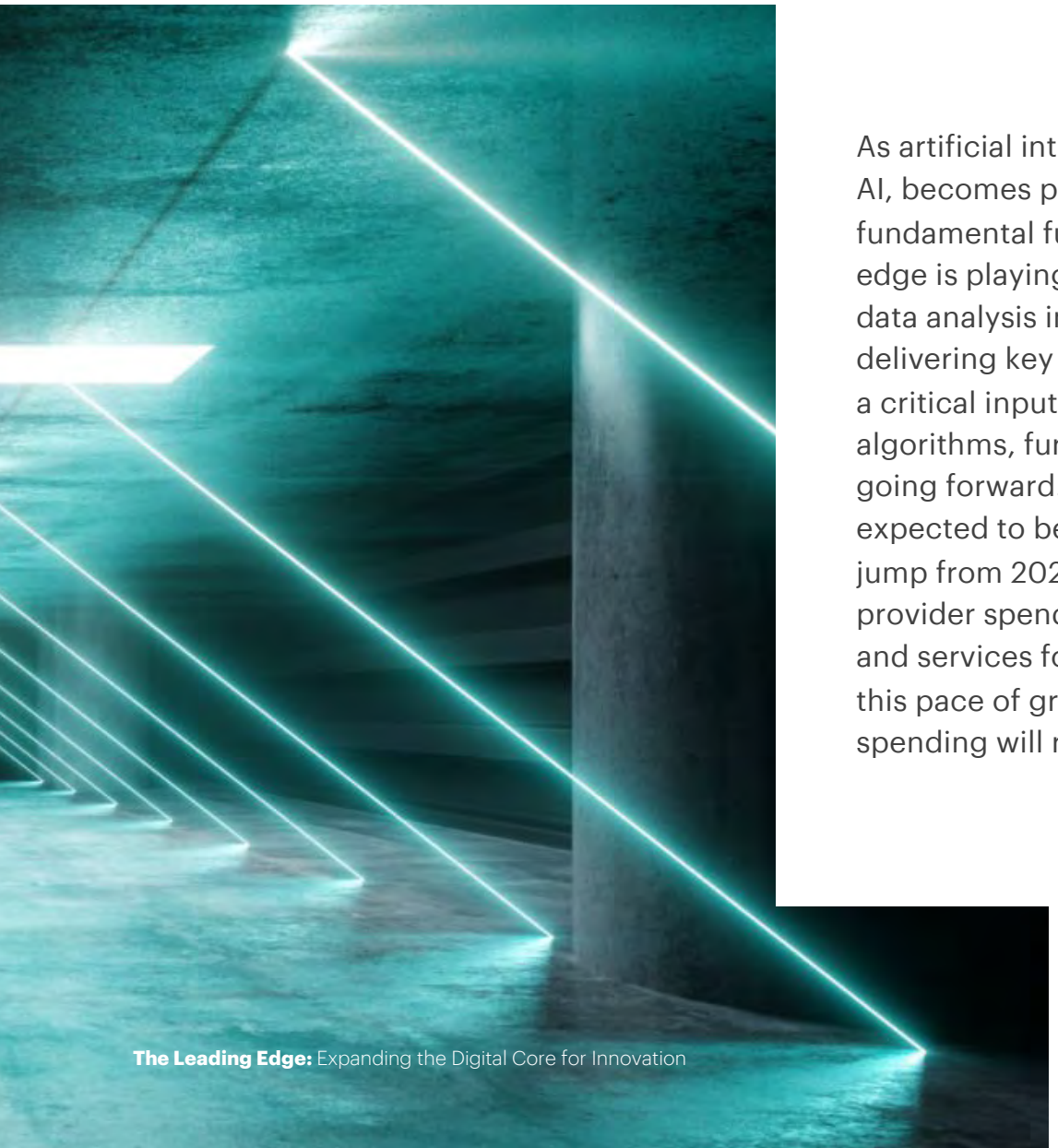
They also can mitigate some of the challenges faced by their peers, possibly because of the resilience that having a robust digital core grants them.

Regardless of industry, what differentiates these companies is their strategic approach to edge and their integration of edge with their broader cloud strategy.

In this report, we'll explore the four different enterprise approaches to edge adoption and their outcomes. We'll also provide a framework for how companies should build up their edge capabilities in the next few years to attain the most value from their deployments and achieve their business objectives.

Enterprise approaches to data, AI and edge





As artificial intelligence, including generative AI, becomes pervasive and data becomes the fundamental fuel of digital transformation, edge is playing a critical role by enabling data analysis in real- or near-real-time and delivering key business insights. It serves as a critical input to rapidly evolving AI algorithms, further adding to its importance going forward. Global spending on edge is expected to be $208 billion in 2023, a 13.1% jump from 2022. Enterprise and service provider spending on hardware, software, and services for edge is forecast to sustain this pace of growth through 2026 when spending will reach nearly $317 billion.[ii]

Our research found four main enterprise approaches to edge (Table 1). These approaches can be viewed as relative to their integration of edge into the digital core, which leverages the power of cloud, data, AI through a set of interoperable systems that allow for the rapid development of capabilities.

These four edge approaches—Ad Hoc, Tactical, Integrated and Super Integrated—are largely driven by factors such as the strategic implementation to support business capabilities, the ability to scale across the organization and the maturity of the technology.

Table 1

Four approaches to edge

Type 1 Ad Hoc	Centralized IT-led edge deployers – *413 respondents*
Type 2 Tactical	Specific-need adopters of pre-packaged solutions – *275 respondents*
Type 3 Integrated	Integrates with cloud and scales widely – *684 respondents*
Type 4 Super Integrated	Ties edge to business in transformative adoption – *88 respondents*

*Of 2,100 respondents, 1,372 have adopted edge. Type 4 is a sub-set of Type 3.

**The remaining 728 respondents have yet to execute on their edge adoption plans. We refer to this group as Pre-Adopters

In each of these approaches, companies make different sets of choices to create and capture value from edge (Figure 2). Those using Ad Hoc and Tactical approaches are the least successful adopters. Their edge deployments are one-off or are otherwise not integrated with the enterprise's systems, hobbling their efforts to scale the technology or integrate it with other technologies for maximum return.

The Integrated approach scales edge and integrates it deeply with cloud, data and AI. Those applying the Super Integrated approach are the most transformational adopters with, in some cases, their whole business at the edge, realizing the highest value. Using the digital core's range of technologies—starting with cloud and layering in data, AI, applications and platforms—they use edge to make quick innovation decisions. They develop an ecosystem of vendors externally and the talent internally to bolster their technology stack with human ingenuity.

A cloud-integrated approach to edge results in the highest percentage of outcomes achieved

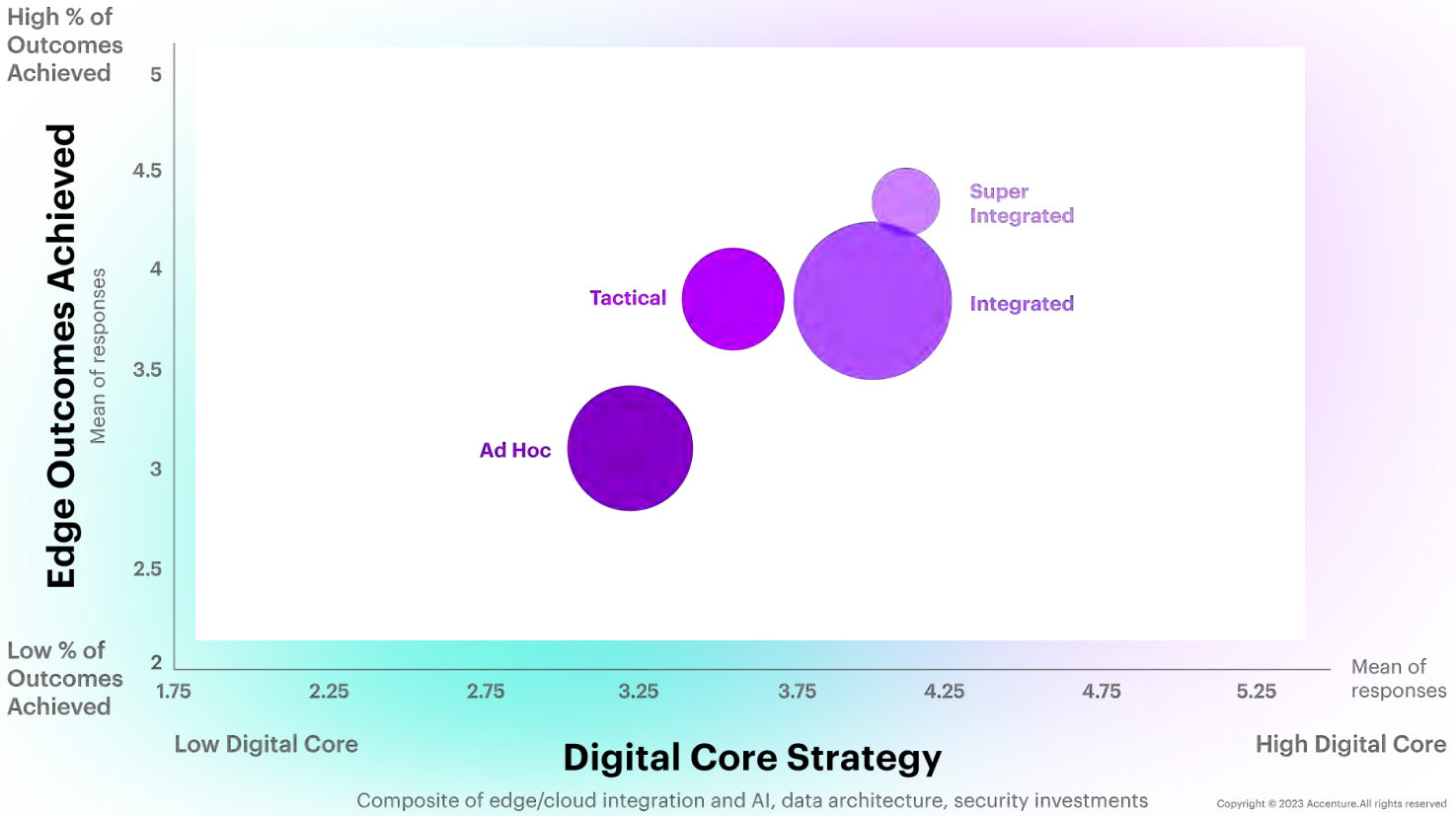


Figure 2

Edge in the digital core

Super Integrated organizations are seeing the most success, in part because they build edge on their digital core, integrating it with cloud, data, AI and interoperable applications and platforms.

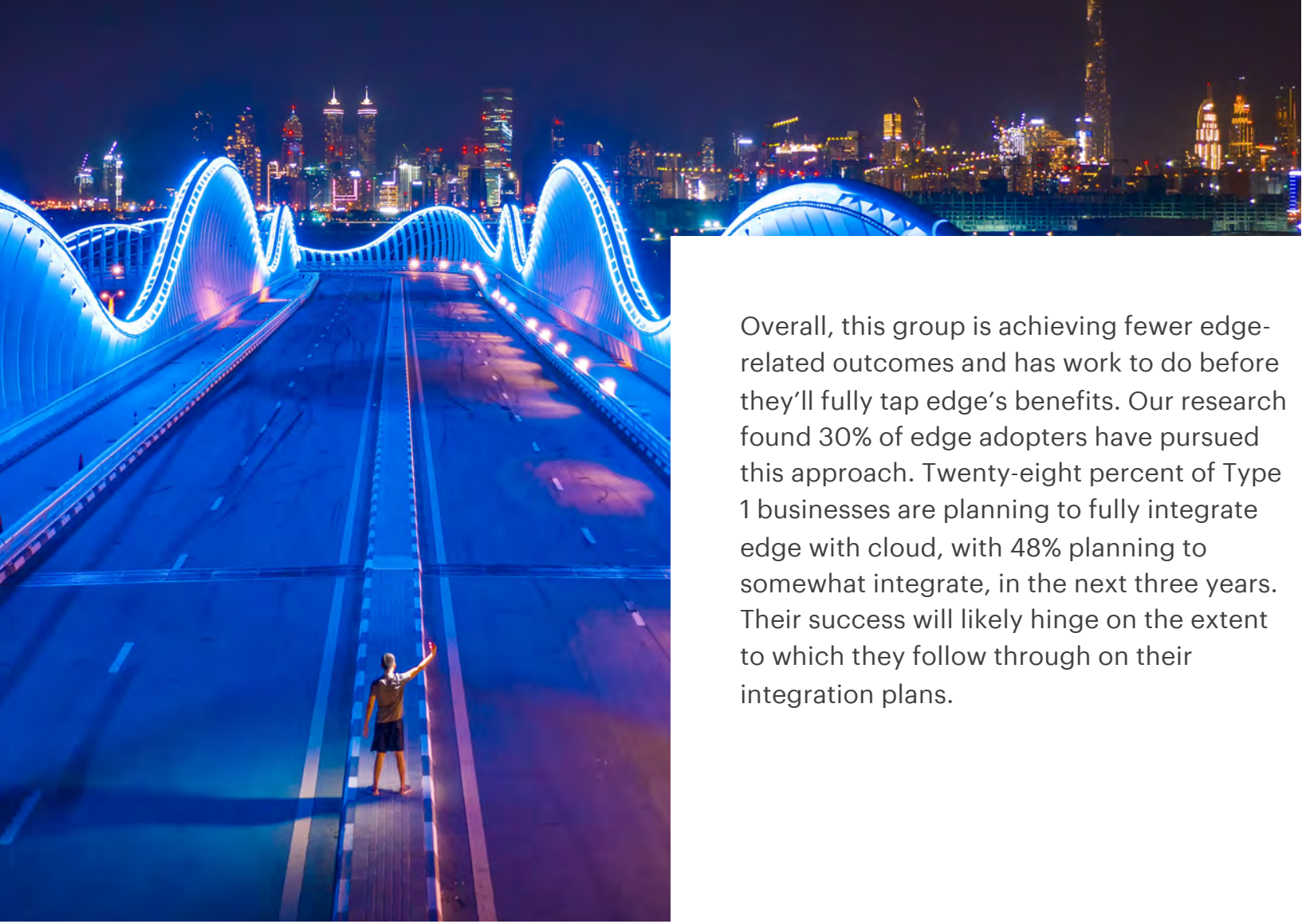
Type 1: Ad Hoc

Many companies using this approach have started with device management, virtual machines (VMs) and evolving to internet of things (IoT) and containers at the edge. Their edge adoption is led by a centralized IT.

Although they are spending relatively more on edge as a portion of total IT budget, the Ad Hoc firms are mostly scoping out how to integrate cloud with their businesses. Consequently, their edge deployments are not well-integrated either.

A major pharmaceutical firm, for instance, is implementing edge in one-off projects without a strategy that integrates edge and cloud. Whether it's within their labs, manufacturing, or even highly specialized high-performance compute—each deployment is custom, and decisions are made and managed by a single line of business. The company is having difficulty managing its combination of sprawling legacy and interim cloud infrastructure. And that's largely because it doesn't have a mature cloud strategy in place, or the talent base required for this kind of complex integration. The result: lackluster edge outcomes.

The Ad Hoc firms' interest in procuring edge-as-a-service also significantly lags compared to the other types. This mirrors their experience in cloud: **Less than 30% say they are using cloud to drive their business operations** and only 11% are using cloud to innovate. They also are behind in partnering with vendors for edge deployments.



Overall, this group is achieving fewer edge-related outcomes and has work to do before they'll fully tap edge's benefits. Our research found 30% of edge adopters have pursued this approach. Twenty-eight percent of Type 1 businesses are planning to fully integrate edge with cloud, with 48% planning to somewhat integrate, in the next three years. Their success will likely hinge on the extent to which they follow through on their integration plans.

Path forward: Without a mature cloud strategy that incorporates data and AI with edge, these firms will continue to overspend while getting disappointing returns. Stuck maintaining legacy applications on aging infrastructure, their ability to find value in ad-hoc edge deployments is limited. To extract the most from edge, companies using this approach must develop an IT modernization strategy that migrates workloads to a modernized cloud continuum that manages in together centralized to distributed compute. Doing so will enable them to efficiently manage applications at the edge (e.g., with the use of containers), and tap into unique data to power new AI use cases.

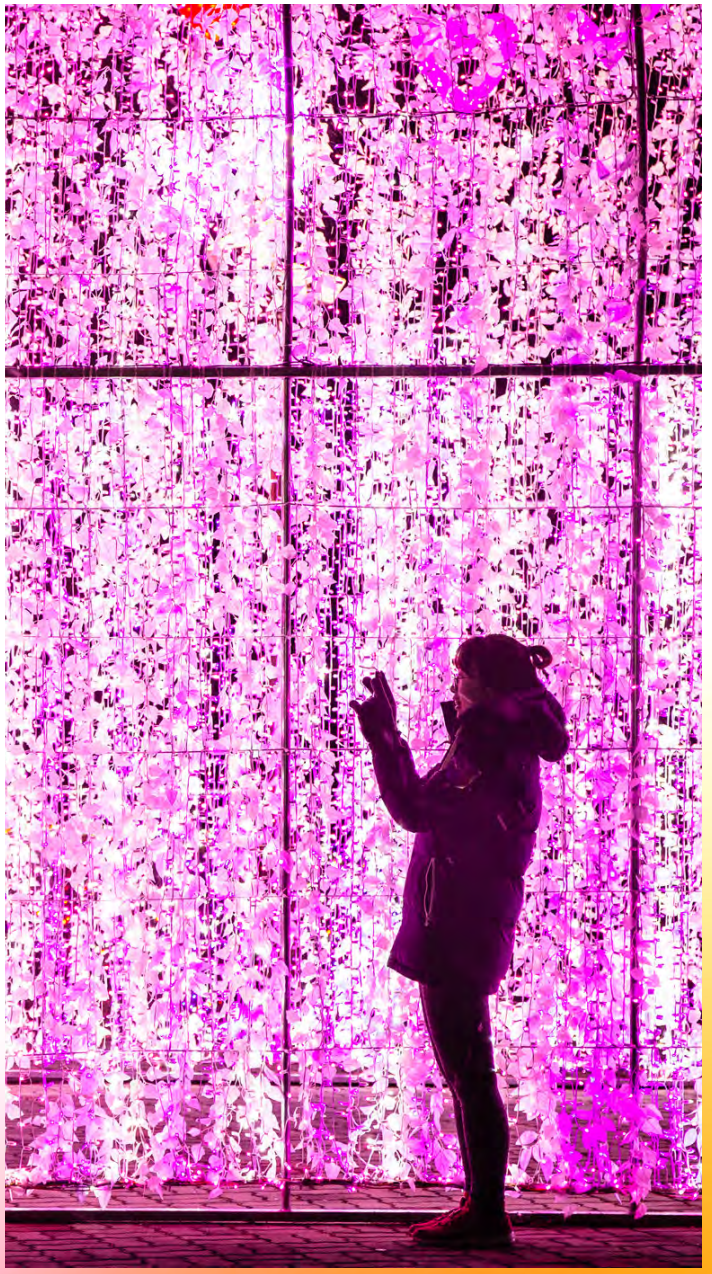
Type 2: Tactical

This is not a strategic approach but one where companies use edge to address specific needs in shorter time frames. Many buy full-package edge solutions from independent software vendors (ISVs), with minimal customization possible, for use-cases such as smart point-of-sale.

Tactical adopters are led by their business needs and have tactical deployments in specific areas that make them difficult to replicate, risking fragmentation. This results in technical debt and diminished returns.

These companies significantly lag in implementing edge across multiple enterprise functions. Many of these companies have challenges scaling and see less successful outcomes overall. However, in edge projects with modest ambitions, some are able to adapt and achieve success, to a greater degree than Type 1s.

Only **28% of the Tactical firms have partially or fully integrated their edge strategies into their cloud strategies,** whereas by contrast the **Super Integrators are at 67% today.**



Our research found 20% have adopted the Tactical approach. The majority of this group plans to integrate edge into their cloud strategy fully (24%) or somewhat (63%) in the next three years.

One global retailer built out its point-of-sale edge capabilities early on so that employees and customers in the store could get real-time information about products from servers in the retail location's back-office. The initiative was based on a need to build resilience in case credit card services were temporarily lost, which had occurred in the past. However, the retailer had limited success with edge overall—partly because it worked with a small ecosystem of partners that didn't have the capabilities needed to scale edge across different countries with different requirements. The fact that the retailer didn't establish edge-specific KPIs to measure progress made it difficult to track or expand value.

Path forward: The challenge for organizations taking the Tactical approach is to modernize their edge capabilities with a clear plan that is aligned with their cloud strategy and incorporates migration pathways for the existing architecture. An updated software architecture will allow these firms to more quickly stand up, operate and maintain their solutions to ensure optimal value. And they need to make edge part of their digital core, integrating security across the Cloud Continuum, for example, for maximum effectiveness. Today, the global retailer is working to strengthen its system capabilities—making security a priority in its edge implementation. For instance, it is transferring aggregated data between edge and cloud only at select times, in large volumes, to reduce exposure to attacks.

Type 3: Integrated

When organizations integrate edge with their digital core—including cloud, data, AI, applications and platforms—they can more easily standardize operations on a common platform across regions, locations and deployment types. As a result, they can experiment and scale faster. This approach is typically used by the second or third wave of edge adopters. Integrated organizations view edge and cloud as part of their overall business strategy. And they are seeing better outcomes and satisfaction.

Inventec, a Taiwan-based electronics manufacturer, is modernizing its operations with a combination of AI, cloud, digital twins, edge computing and networks. It has scaled a "smart factory" solution across its six locations, combining real-time computer vision and digital twins to get a comprehensive view of the manufacturing process.[iii] It also has deployed smart IoT devices to improve automation and communication along the assembly line. Inventec can now quickly deploy cloud-native workloads locally on its IoT edge devices. This combination of dataflows also gives more power to the line employees: They can use augmented reality (AR) glasses to troubleshoot any machine failures or production issues with a technician in real time. The glasses provide the employee an overlay of where to make the adjustments on the machine, and the real-time, digital twin data gives the remote technician a complete understanding of potential causes of disruption and where to guide the employee.

By obtaining detailed analytics of every component of the process and stepping up automation, Inventec has decreased mistakes in the production process, reduced inspection times, increased first production yields and improved overall efficiency.[iv]

Our research found that **nearly 50% of edge adopters take this integrated approach, with 79% planning to fully integrate edge with cloud in the next three years**. Companies with high levels of tech adoption appear to prefer this route, as most of them already use cloud extensively. With organizations in this cohort, we found the greatest impact on business functions including supply chain, manufacturing, operations and R&D; their emphasis is on speed, efficiency and innovation.

These organizations leverage or plan to leverage edge-as-a-service more than the other groups, reflecting their established cloud practices and experience with cloud cost efficiencies.

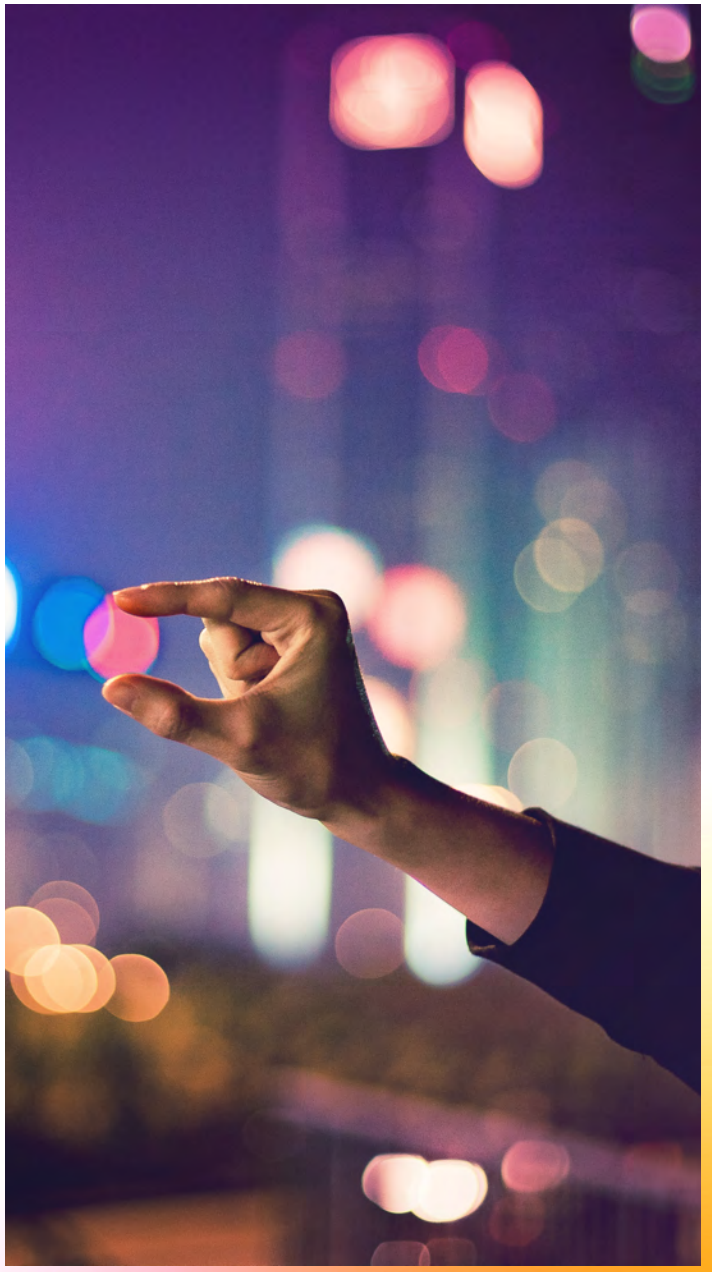
Path forward: These firms' advanced cloud maturity and incorporation of edge into their digital core positions them to unlock significant value. To further grow the benefits of edge, these firms will need to strategically consider more expansive, enterprise-wide implementations that fit their business goals. They also need to invest more in talent and connect with partners who can take them to the next level. In the case of a large consumer goods company, it was initially difficult for them to find the right talent to build out the desired manufacturing edge use cases. They were able to lean on ecosystem partners to help bridge the gap.

Type 4: Super Integrated

A small group of companies, just over 6% of edge adopters, have not only integrated edge with their digital core like Type 3s, but have gone even further. They recognize that edge is not a standalone technology but a topology that integrates centralized and distributed architectures needed to differentiate their core business—whether this is embedding intelligence within a product or a place. They intertwine edge deeply with their digital core and overall business strategy—investing in the appropriate talent and building an ecosystem of partners to get the most out of their edge efforts.

Super Integrated firms also show a much higher adoption of industry-specific software or services related to edge, a sign of adoption maturity relative to their industry. Not all companies can, or even need to, aspire to a Type 4 approach. But those that do realize the highest percentage for the following:

- Developing a business champion for edge adoption
- Increasing collaboration between IT and lines of business
- Investing in Artificial Intelligence (AI) / Machine Learning (ML) capabilities
- Hiring trusted partners to deploy edge



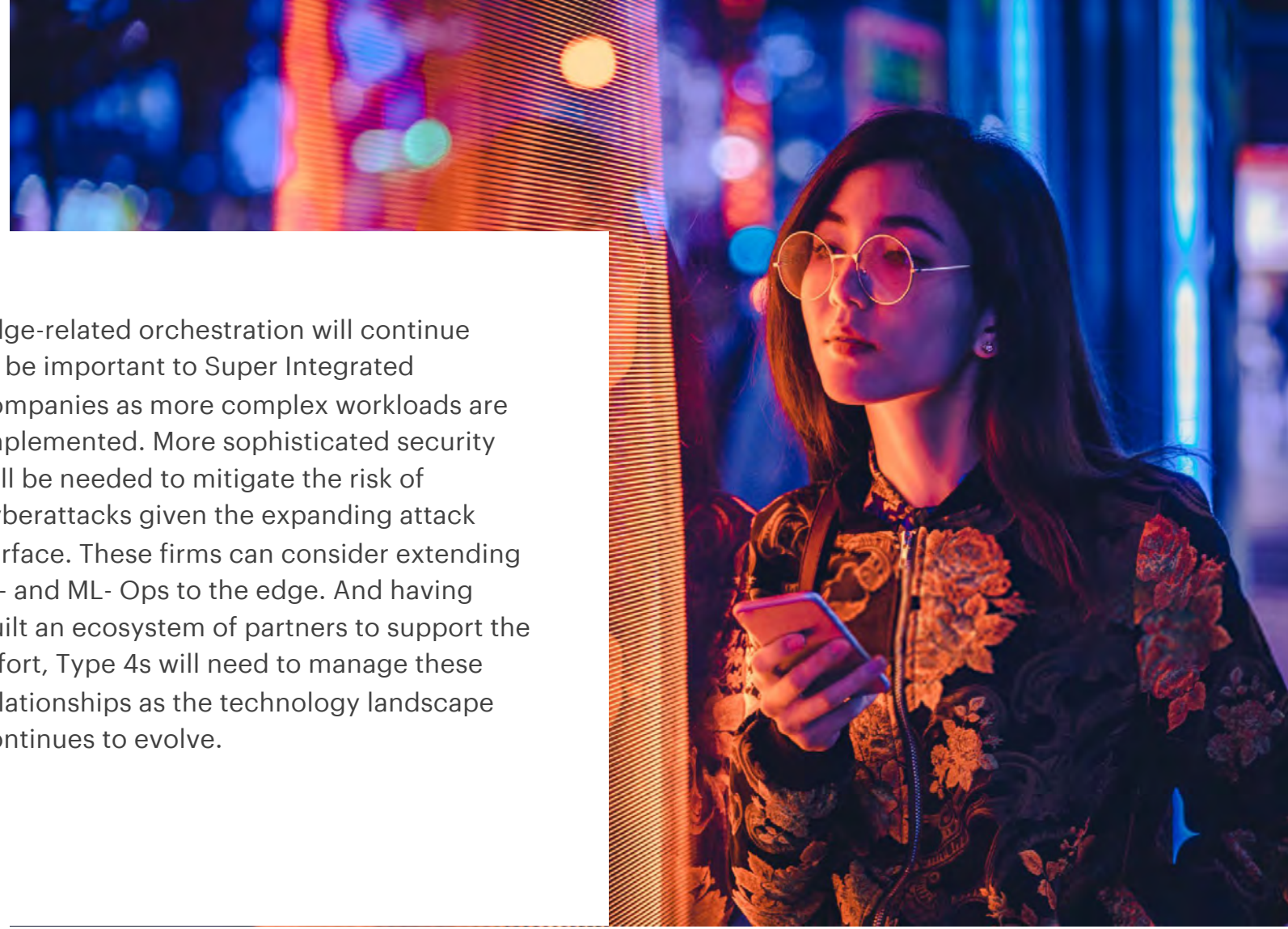
Organizations who opt for this approach are seeing better outcomes (Figure 4). For example, compared with Ad Hoc firms, Super Integrated companies are 4x more likely to achieve accelerated innovation, 9x more likely to increase efficiency and nearly 7x more likely to reduce costs. They also can mitigate some of the challenges faced by their peers, possibly because of the resilience that having a robust digital core grants them.

We see this within the automotive industry, where Tesla has created its own chipset to custom build a supercomputer that trains the AI systems within the car, which will rely on data from at-scale AI training across their fleet.[v] Waymo, another autonomous vehicle firm, relies on LiDAR sensors, cameras and radar to develop a continuous understanding of its surrounding areas and find the most efficient route.[vi] Edge computing runs on the car and the cloud provides the heavy analytical support on the back end.[vii]

In retail, Starbucks, the global coffee chain, combines in-store IoT capabilities with cloud computing to run real-time analytics on the espresso and other machines used by baristas.[viii] The chain gets improved predictive maintenance for the machines and can personalize orders by customer.[ix]

Path forward: Because they have been the most ambitious, Super Integrated firms face issues regarding data architectures and use-case scaling that the other groups have not had to deal with yet (Figure 5). Many of them use platforms that are intrinsically dependent on the capabilities of edge, and therefore have naturally and intentionally built single cloud-to-edge architecture.

Edge-related orchestration will continue to be important to Super Integrated companies as more complex workloads are implemented. More sophisticated security will be needed to mitigate the risk of cyberattacks given the expanding attack surface. These firms can consider extending AI- and ML- Ops to the edge. And having built an ecosystem of partners to support the effort, Type 4s will need to manage these relationships as the technology landscape continues to evolve.



Super Integrated adopters show the most successful achievement of edge outcomes

Type 1: Ad Hoc	Type 2: Tactical	Type 3: Integrated	Type 4: Super Integrated
Adapt cloud capabilities to implement smart edge capabilities, but stuck in Web 2.0	Typically buy pre-packaged and defined use cases from ISVs that limit flexibility and innovation	Integrate edge with whole IT strategy to create data-driven products and services	Integrate edge with business strategy and work with innovation partners to create an edge-first business
VMs, containers at the edge	ISV packaged solutions, example, smart point-of-sale	Cloud, Data, AI, software framework / end-to-end	Edge may drive the business & cloud strategy
Digital Core Index: 3.4/5 IT-driven adoption of technology that does not permeate throughout the enterprise.	**Digital Core Index: 3.78/5** Business-led adoption with limited integration across enterprise functions & their digital core.	**Digital Core Index: 4.06/5** Implementing and experimenting with various technologies across the enterprise.	**Digital Core Index: 4.37/5** Taking the next step and driving innovation with technology adoption across the enterprise.
Edge Realization: 3.22/5 Achieve lower outcomes across the board and are more skeptical of the future success of edge.	**Edge Realization: 3.55/5** Achieves cost reductions using edge but lags relative to peers in other areas such as innovation and productivity.	**Edge Realization: 4/5** Highest outcomes in keeping data at the edge and accelerating innovation.	**Edge Realization: 4.11/5** Higher outcomes across the board with highest levels of satisfaction with their edge deployments.

Figure 3

Advancing edge in the digital core

Type 4 includes a small group of companies that have heavily integrated edge into their digital core in the cloud, buttressed with an ecosystem of partners and talent, for rapid scaling of innovation and highest performance outcomes.

The Digital Core Index measures responses about cloud strategy, investment in data architecture, investment in AI, edge adoption levels, hiring trusted partners for edge deployment, edge integration with cloud, partnering with vendors for edge deployment and developing appropriate KPIs for edge deployment.

Edge Realization measures how much organizations have achieved their expected outcomes

More than other adopters, Super Integrated firms are seeing value from edge

Q: To what extent has your organization already achieved your expected outcomes from edge computing?

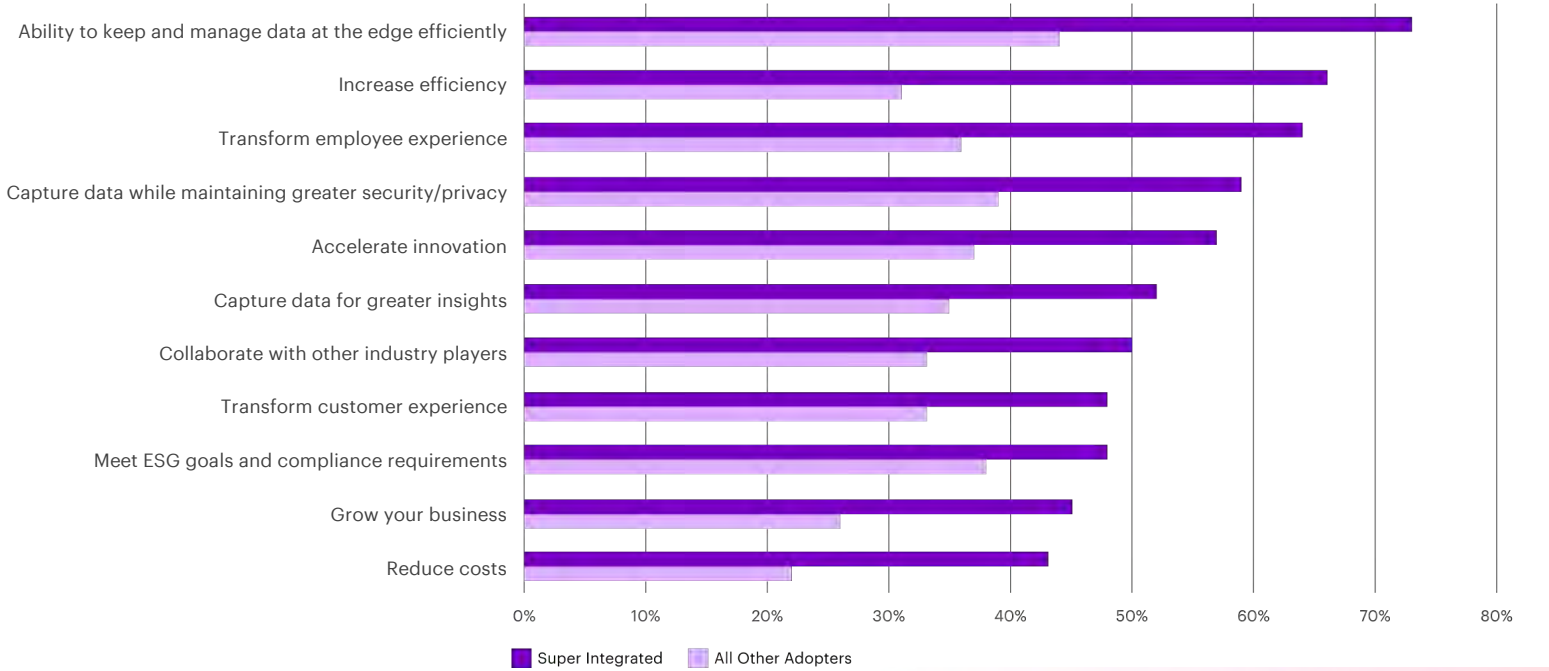


Figure 4

Edge outcomes

Super Integrated organizations see accelerated innovation, higher efficiency, lower costs and transformed customer experiences, among other outcomes.

Super Integrated firms' challenges resemble other groups, with some notable differences

Q: What are the top three challenges to scaling edge computing across your organization?

Challenges	Super Integrated	Other Adopters
Digital security / data privacy concerns	53%	50%
Edge-specific talent is difficult to find internally / expensive to obtain externally	52%	51%
Diverse, location specific requirements / scaling across sites	25%	31%
Difficulty forming the business case / understanding ROI	32%	34%
Lacking key infrastructure	22%	32%
Level of investments required to deploy successfully	20%	20%
Lack of supporting application ecosystem	20%	22%
Lack of data architectures needed to support edge computing	27%	20%
Scaling use cases (e.g., POC to full deployment)	32%	22%
Lack of executive / business champion for edge computing	16%	17%

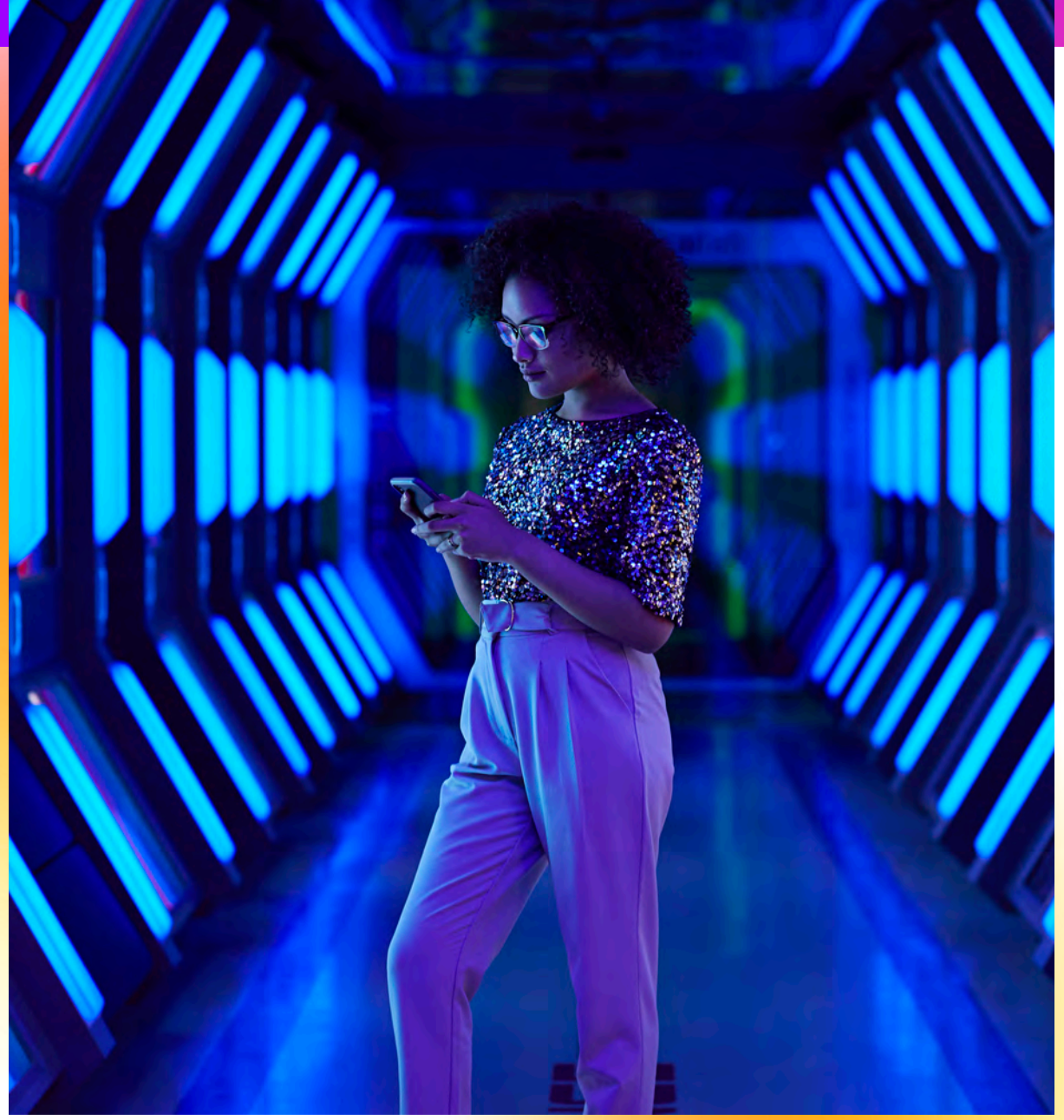
Figure 5

Challenges with achieving optimal edge value

Different approaches notwithstanding, all companies face headwinds in the edge market today (Figure 5).

Super Integrated firms show less of a challenge around **infrastructure-related issues** (location-specific requirements, required key infrastructure).

Their more ambitious edge adoption leads to greater struggle with **needed data architectures** and the **ability to scale use cases.**



How to innovate with edge


To unlock the value of edge, we have developed a three-step framework for all adoption types.

01

Strategize for edge

Approach edge as a foundational capability, not as a bolt on. Our research shows that companies having the most success with edge view it as a key component in a broader business strategy that leverages cloud, AI and data—the digital core.

For initial deployments, adopting a strategic approach to edge that identifies the opportunities and provides some guardrails will help set the right course. The plan should strive to create a common base on which innovation can be trialed and developed and that avoids the risks of fragmentation or becoming stuck in a cycle of proof-of-concepts. As edge components become more standardized, this will become easier.

A large, well-established products firm has made digital transformation one of its top priorities and sees edge as a key part of that strategy, along with cloud, AI/ML and cybersecurity. It views this strategy as critical to remaining competitive in the market and driving significant growth in the future.

One of the firm's primary goals is to automate processes that are inefficient today. With a substantial amount of its manufacturing equipment distributed across locations around the globe, often in rural areas with poor connectivity, it would like to implement edge to collect and analyze data from this equipment on the spot, without needing a network connection. The data can later be transferred back to a central data center if required. But it's not just about being more efficient. As part of its larger data strategy, the company has also piloted new digital services, based in part on data generated by its equipment at the edge, that could be sold to customers.

02

Scale across the enterprise

Build out edge across the enterprise on the back of cloud and integrate with enterprise data and AI applications, not just ad-hoc projects. Rather than investing in one-off projects that lead to siloed results, the most successful edge adopters take steps to scale implementation across businesses. They look for ways to standardize around successful use cases while leveraging partners for help.

A global oil and gas enterprise, a Super Integrated adopter, realized early on that deploying edge had to initially be geared towards local conditions, where the use case would be customized to factors such as geographic location and weather. The challenge was to take a successful edge use case and scale it across multiple locations in the company's global footprint. The company has created a horizontal function that focuses strategically on standardizing use cases, and now it has approximately 40 edge assets in the third year of its edge journey. The company has a large ecosystem of supplier and service partners that it leveraged in its edge adoption. It used multiple providers for cloud services as well as outside consultants for edge implementation and turned to key technology OEMs for edge-related systems and devices. The result: reduced unplanned downtime, which can cost the company up to 10% of its revenues. "Anything that moves the needle by even 1% or 0.5% uptime is worth the investment," said a senior executive of the company.

Edge implementations often begin with relatively narrow objectives but should be designed with broader applications in mind. Edge will be a key part of the oil and gas company's broader strategy in the future, which includes AI as well as blockchain and IoT. With these technologies, they hope to achieve their goal of being a net-zero energy business by 2050.

03

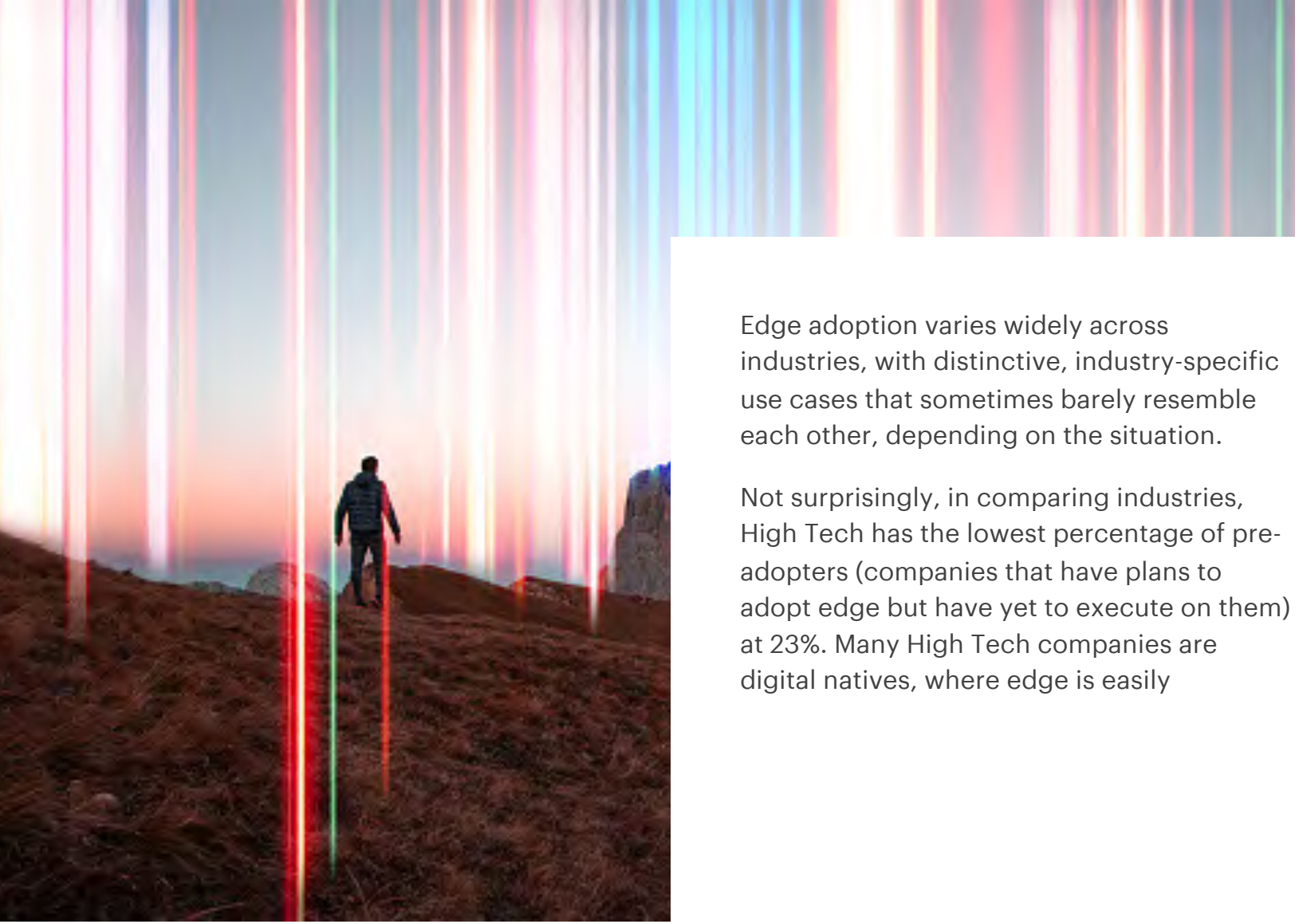
Strengthen capabilities

Ensure all employees and processes are prepared for edge. Edge is closer to the users and data, where physical actions are translated into digital data. So, it impacts the experience of employees across the organization and not just the IT department. For example, with edge, production workers or laboratory workers will get more information than before about the state or quality of production or be able to utilize AI directly.

When CEOs prioritize human-machine collaboration, they must create a culture that nurtures human creativity, flexibility and insight and that can optimize these digital tools in terms of their precision, speed and scale. This requires appropriate job classifications, vetted qualifications, training and career advancements—all in a trust-based learning environment. This holds true for edge-human collaboration as well. Edge-related job postings have jumped 62% since 2019.[x]

Due to edge's deep integration with the overall technology stack and heavy local presence, there is a role for both centers of excellence (COEs) and local talent. COEs allow for specialized talent to develop the technology and ensure interoperability across the organization, especially the digital core. This results in standardization during deployments, cutting down time and unexpected costs. Local talent is closest to the devices and processes; they can help guide change management and identify potential pitfalls before they occur or adapt deployments better once in the field.

The Super Integrated oil and gas firm mentioned above launched its edge talent strategy by working with a leading systems integrator, while simultaneously establishing an edge COE to build a pool of relevant internal talent. This approach gives the firm the flexibility to adjust the internal/external talent ratio as conditions warrant. Other Super Integrated edge adopters say that they combine their edge talent pool with their cloud talent pool to form a single, integrated COE.



Edge adoption varies widely across industries, with distinctive, industry-specific use cases that sometimes barely resemble each other, depending on the situation.

Not surprisingly, in comparing industries, High Tech has the lowest percentage of pre-adopters (companies that have plans to adopt edge but have yet to execute on them) at 23%. Many High Tech companies are digital natives, where edge is easily integrated into their digital core. In contrast, Natural Resources, Metals & Mining has the highest percentage of pre-adopters at 60%, likely because of the capital-intensive nature of their business that requires a longer planning period.

Industry use of edge

Integrated is the most common adopter type across industries

	Pre-Adopter	Ad Hoc	Tactical	Integrated	Super Integrated
Aresospace & Defense	26%	30%	13%	31%	2%
Airline, Travel, Transport	48%	21%	6%	25%	3%
Automotive	34%	14%	15%	37%	7%
Banking	26%	26%	11%	37%	8%
Capital Markets (Including Investment Banking)	35%	23%	16%	26%	5%
Chemicals	31%	10%	6%	52%	6%
Communications, Media, Entertainment	29%	19%	18%	34%	5%
Consumer Goods	34%	25%	7%	34%	6%
Energy	31%	27%	13%	29%	4%
Health (Excluding public health care)	42%	14%	20%	24%	2%
High Technology	23%	26%	23%	29%	2%
Industrial Goods and Equipment	27%	27%	7%	40%	7%
Insurance	34%	13%	21%	32%	3%
Natural Resources, Metals & Mining	60%	13%	7%	20%	1%
Pharmaceuitical, Biotech, Life Sciences	31%	20%	10%	39%	3%
Retail	41%	18%	11%	30%	4%
Utilities	39%	13%	12%	36%	4%
Public Service	37%	16%	18%	29%	1%
Total	**35%**	**20%**	**13%**	**33%**	**4%**

***Note:** Super Integrated is a subset of Integrated*

Table 2

Edge, cloud, and industries

Integrating edge with cloud for scale, Integrated is the top approach across industries, although levels may vary according to business models. Among industries, High Tech has the lowest percentage pre-adopters who have yet to execute on their plans, while Natural Resources, Metals, & Mining has the highest.

A high percentage of edge use cases related to IoT and connected devices have been implemented across all industries. For example, assembly line monitoring, quality control and worker safety. In fact, for many industries, IoT and data security/ privacy are the most common use case type. But a variety of other edge use cases are also underway.

Retail

Common use cases: Robotic assistants, point-of-sale, smart building apps

Retailers thrive when they can deliver delightful experiences to customers while maintaining efficient operations in the background. For many retail firms, edge offers a path to both. Leading US-based convenience food chain Taco Bell, for example, has implemented edge over the past several years to improve its service as it manages an omni-channel delivery model across in-store, drive-through and delivery options. The chain has put 100% of its digital operations in the cloud but realizes that it needs to have compute capabilities available on-premise as well, to meet its customers' needs, even if network connectivity is a problem.[xi]

With COVID pushing more customers to seek the convenience and safety of food delivery services, Taco Bell has developed custom algorithms to draw on customer orders—both digital and in-person—and to determine when food needs to be cooked so that it is warm when the delivery driver is ready for pickup. This entails rapid analysis of local data that may be moved to the cloud but can be acted on at the edge—in this case, a Taco Bell store.[xii]

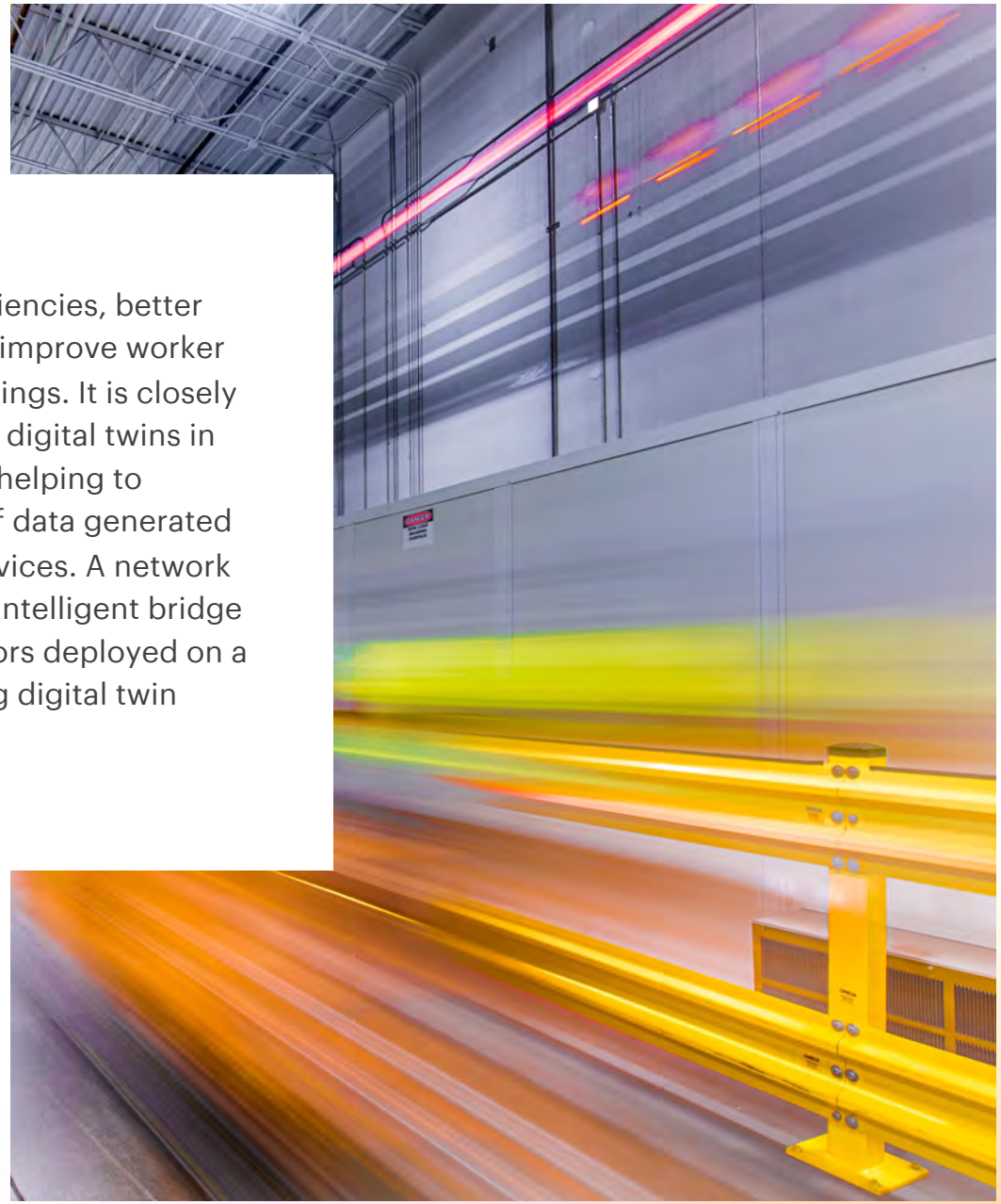
As with Taco Bell, our research showed that more than two-thirds of retail edge adopters are deploying edge in point-of-sale use cases. Meanwhile, a similar percentage is using edge-based robotic assistance to scan store shelves to manage inventory, detect areas that need cleaning and provide security.[xiii]

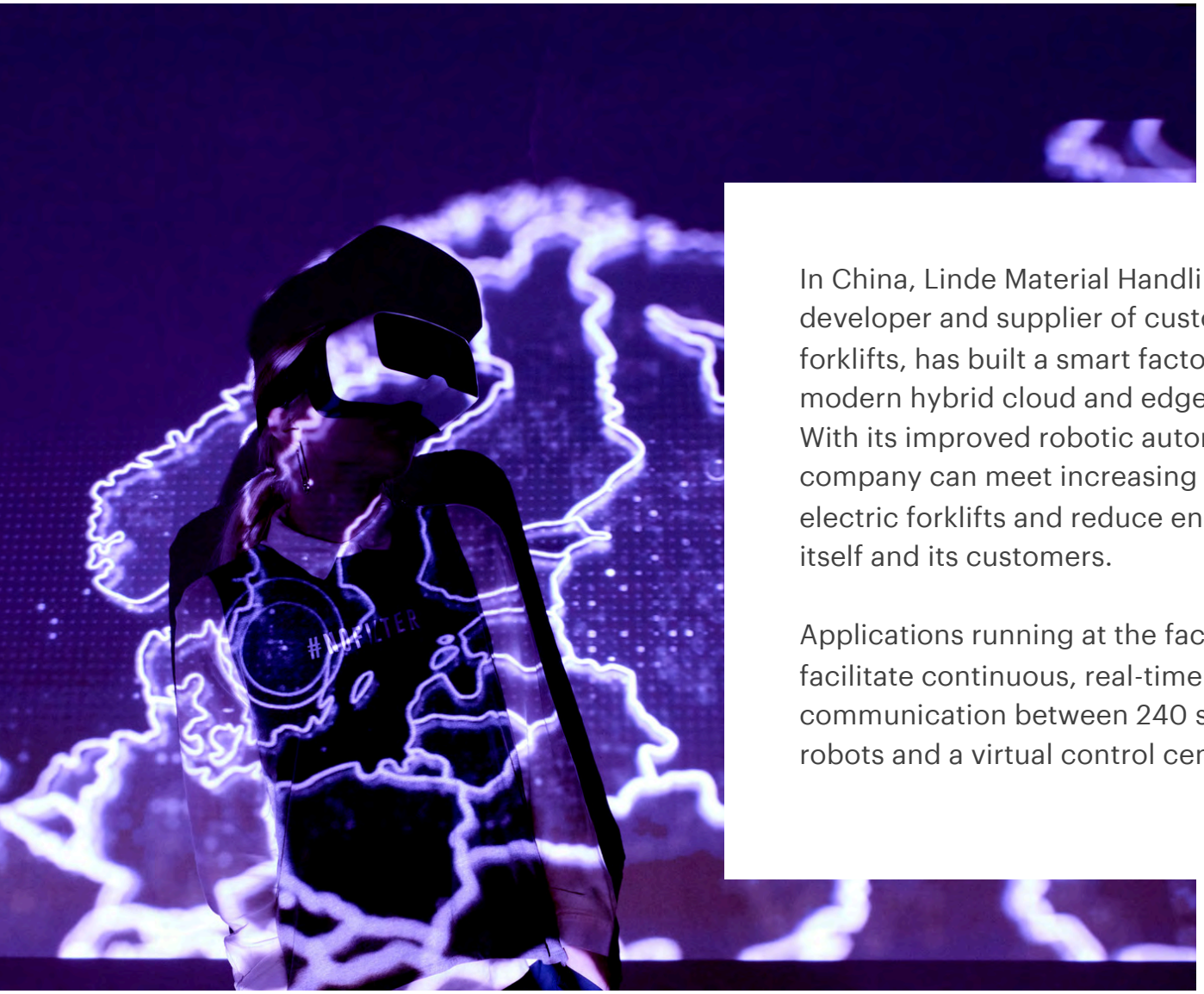
Manufacturing

Common use-cases: IoT, robotic assistants, data security/privacy apps

Many manufacturing strategists expect that edge computing will accelerate the convergence of information technology (IT) with operational technology (OT). This will finally bring together the world of data and analytics with the systems that run machines, devices and processes. And clearly this is already underway. Manufacturers large and small have been implementing the technologies associated with the Industrial Internet of Things (IIoT) for many years. The next important advance will be the production-level application of AI, which is also well underway.

Edge can drive greater efficiencies, better product quality control and improve worker safety in manufacturing settings. It is closely tied to the increasing use of digital twins in factories and other locales, helping to manage the huge amount of data generated by sensors and other IoT devices. A network of edge devices can be the intelligent bridge between thousands of sensors deployed on a factory floor and an evolving digital twin located in the cloud.[xiv]





In China, Linde Material Handling, a leading developer and supplier of customizable forklifts, has built a smart factory on a modern hybrid cloud and edge solution. With its improved robotic automation, the company can meet increasing demand for electric forklifts and reduce energy use for itself and its customers.

Applications running at the factory site facilitate continuous, real-time communication between 240 sensors on robots and a virtual control center that maintains a real-time digital twin of the factory in the public cloud. AI-powered processes running on the edge and in the public cloud continuously map the most efficient paths for robots and send directional instructions back to the robots' sensors.

All told, the implementation has improved output by 27%, sped up error detection by 30% and cut energy use by 28%, according to company officials.[xv]

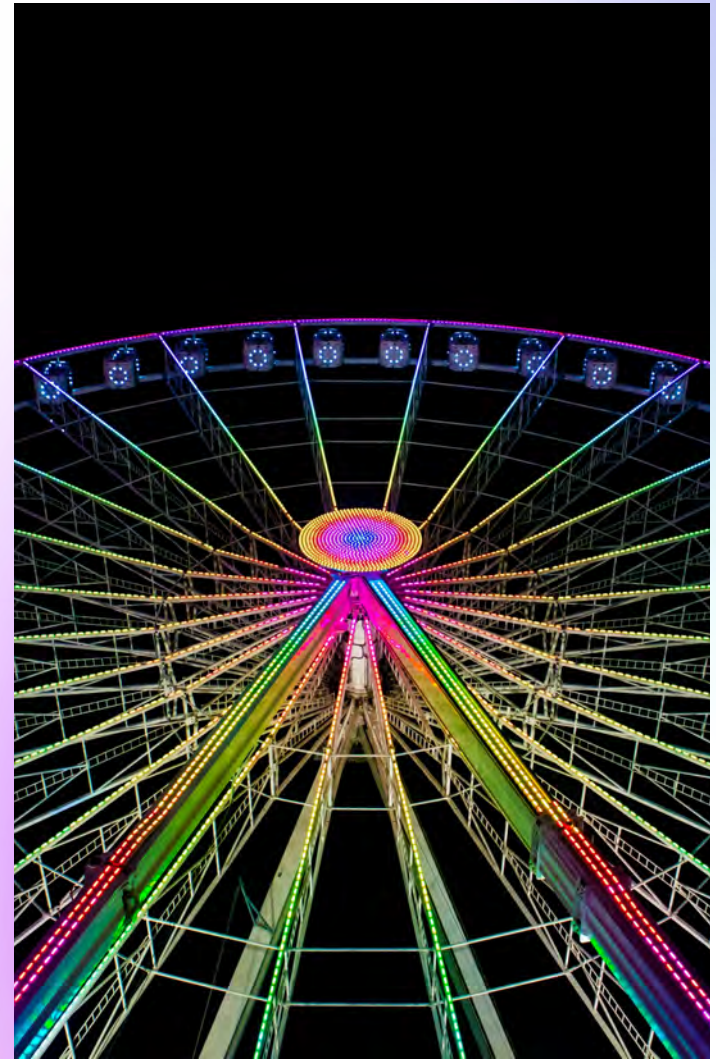
Distributed Telco, Media, and Comms

Common use cases: Content delivery apps, personalized consumer experiences

Visitors to Disneyland Park in Anaheim, California can board Mickey & Minnie's Runaway Railway, which blends Disney attraction design with technology to turn a two-dimensional cartoon world into a multidimensional environment. Industrial controls and other high-rate data feeds (audio/video) require a hybrid solution for optimal data management and edge computing at the attraction.

Disney streams data at very high speeds—500 times per second to thousands of times per second. From both a performance and cost perspective, this capability is important as the firm rolls out its digital-twin analysis tools, which are being employed to do real-time analysis of the Audio-Animatronics figures. Edge arms Disney's engineers and maintenance personnel with a thorough and real-time understanding of the operations of the trackless ride system to keep it running at peak efficiency.[xvi]

In our survey, 82% of firms in the Telco, Media and Comms industry have implemented edge-based content delivery applications.

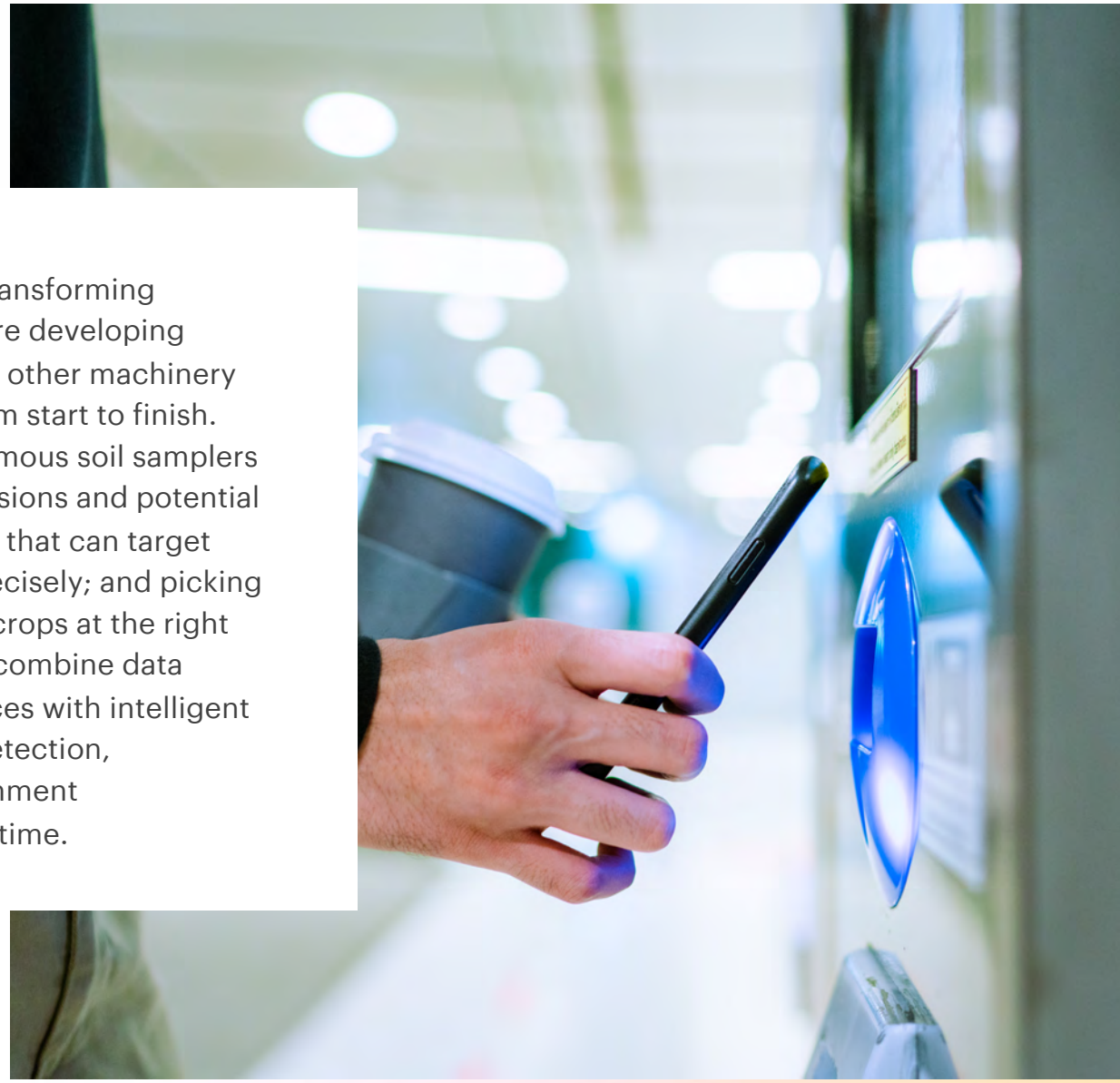


Transport and Auto

Common use cases: Personalized consumer experiences, autonomous vehicles

Travel and transportation businesses are rapidly adopting edge for their own purposes. Authorities at Heathrow Airport in London are experimenting with employing AI combined with 3D scanning on edge to prevent illegal wildlife trafficking.[xvii] Delta Airlines meanwhile is piloting a large flight information board in airports that will show personalized information to up to 100 different passengers in parallel. The edge system identifies customers through their scanned boarding pass, allowing the system's sensors to track them, even as they walk around the display, and show them their personalized flight information.[xviii]

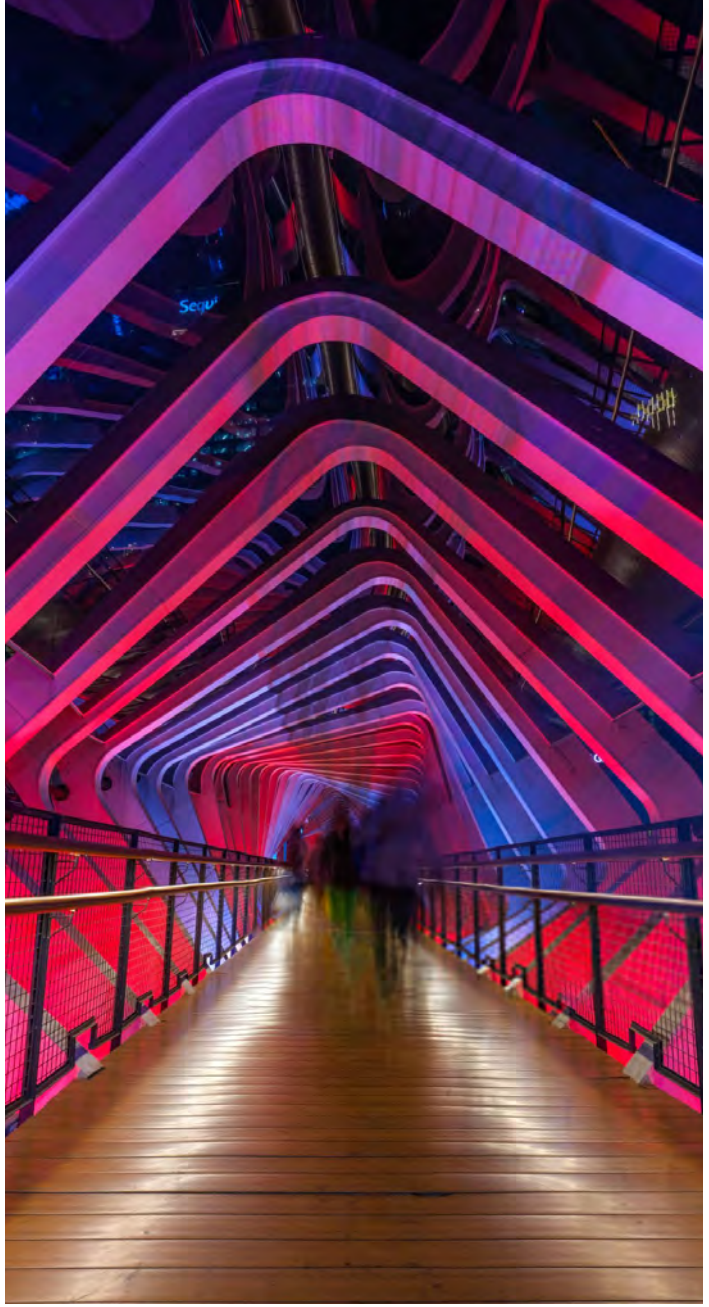
Edge computing is also transforming agriculture. Companies are developing autonomous vehicles and other machinery that augment farmers from start to finish. Examples include autonomous soil samplers that can inform crop decisions and potential yield calculations; drones that can target pesticide sprays more precisely; and picking equipment that can pick crops at the right time. All these machines combine data from sensors on the devices with intelligent capabilities, like image detection, to operate in their environment while sharing data in real time.



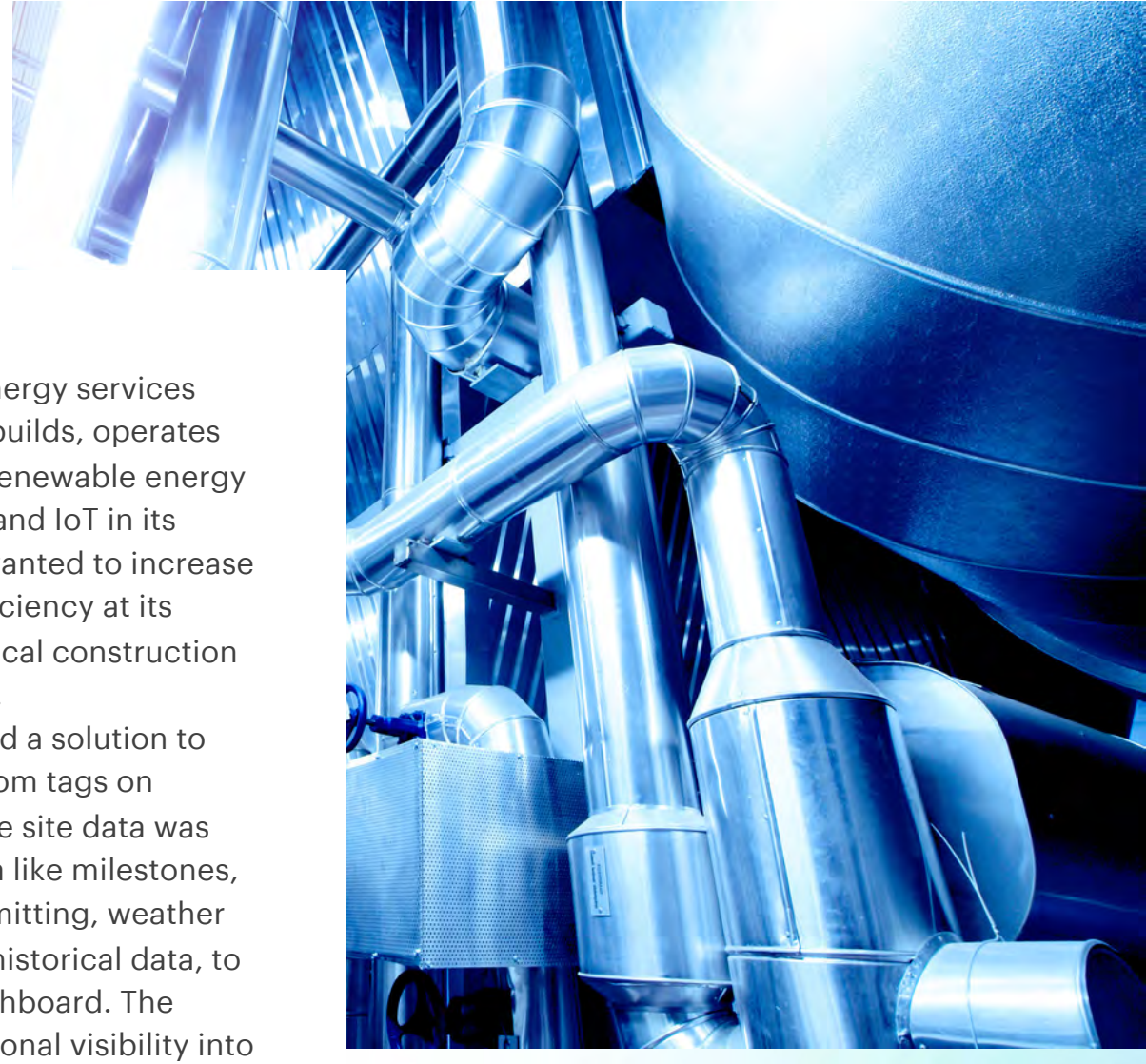
In a much different venue, a Formula One racing team leverages edge computing to make and keep its cars competitive on the track. The team's cars, which travel more than 200 miles per hour, act as high-speed edge devices on the track, streaming tens of thousands of data points a second. The data collected at the team's trackside edge data center is securely tied to high-performance computing (HPC) capacity at the firm's headquarters for closed-loop performance analysis. Meanwhile, team engineers at each event carry mobile phones that give them secure access to data at trackside as it's created.

With this data, the Formula One team also streamlines race car aerodynamics using data-driven 3D digital twin and 3D printing models. Through continuous rapid prototyping, the cars' performance improves, and they are made more competitive.

While the agricultural machinery and the Formula One cars are exceptional examples, more than three-quarters of our survey respondents in the automotive category indicated that they have implemented or begun to implement an edge-related autonomous vehicle use case. A lower percentage—about 1 in 5—indicated that they are working on a farming & agriculture-related edge application, but this space is just beginning to be explored.



Oil and Gas



Common use cases: Remote offshore

Almost three-quarters of survey respondents from the energy industries (oil & gas, coal, renewables and other) indicated that they are working on remote offshore edge-related applications. When network connectivity isn't available, an oil installation far out at sea that uses edge technology can continue to conduct operations. When connectivity is resumed, data can be sent back to installations onshore.

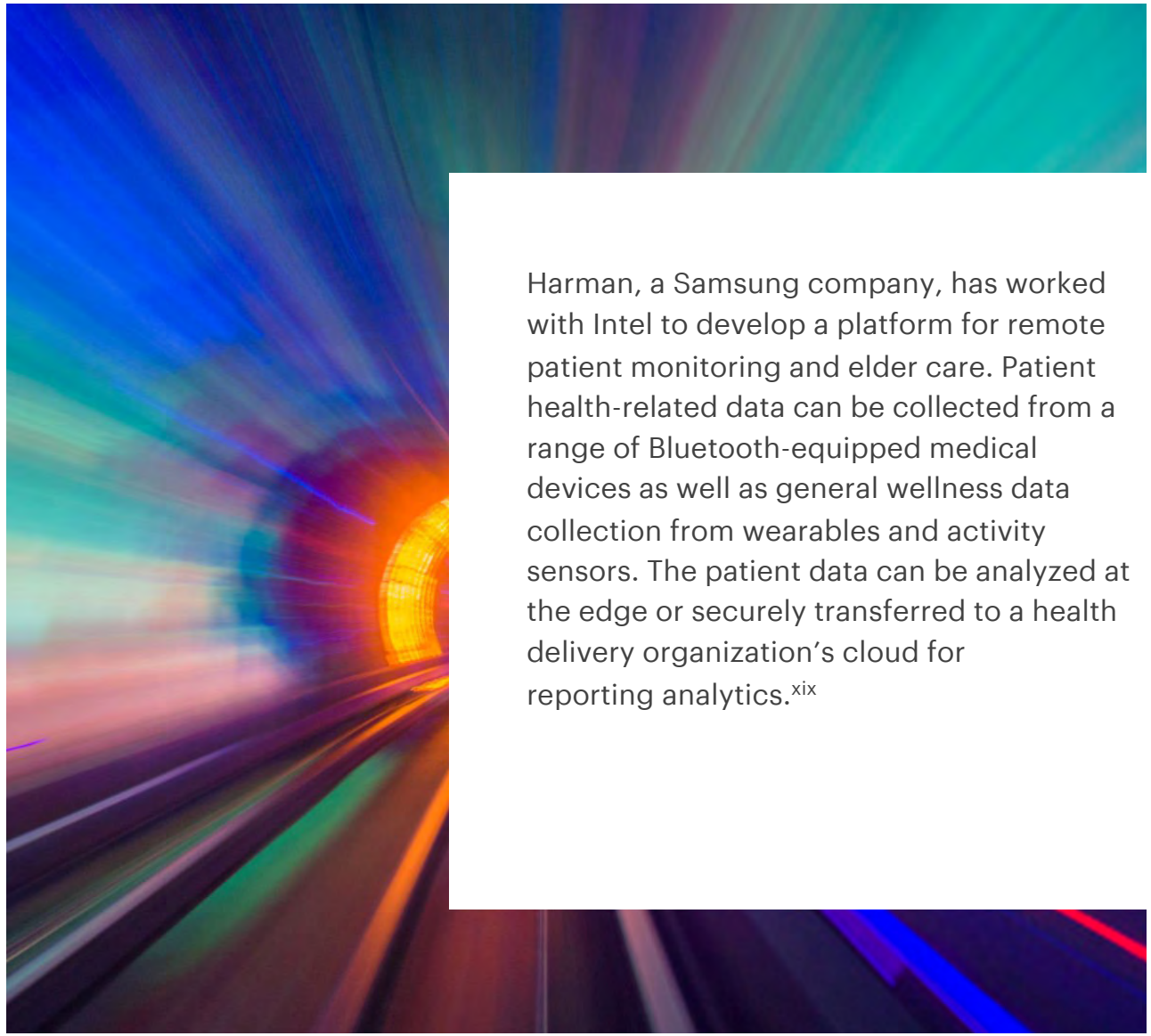
Using IoT sensors and other gear on oil rigs can also help improve worker safety, with the ability to monitor for dangerous situations and automated response at the site if things go wrong.

A UK-based international energy services company—which designs, builds, operates and maintains oil, gas and renewable energy assets—is leveraging edge and IoT in its operations. The company wanted to increase safety, productivity and efficiency at its project sites during the critical construction and commissioning phases.
The company co-architected a solution to collect and transmit data from tags on workers and equipment. The site data was integrated with project data like milestones, productivity, planning, permitting, weather and documents, as well as historical data, to provide a live, one-stop dashboard. The dashboard provides operational visibility into precise details of the project, all accessible in one place.

Healthcare

Common use cases: Point-of-sale and personalized consumer experiences

The potential benefits from edge computing may be most dramatic in healthcare. For remote care applications, or “telecare,” sensor-equipped medical devices can deliver a stream of data to better understand a patient’s status and ensure that the right medication is being delivered. Smart operating rooms can provide surgeons with real-time updates on a patient’s condition, while smart ambulances can alert a hospital to a specific patient’s needs before they arrive at the emergency room. The need for low or no latency is critical when it comes to saving a human life.



Harman, a Samsung company, has worked with Intel to develop a platform for remote patient monitoring and elder care. Patient health-related data can be collected from a range of Bluetooth-equipped medical devices as well as general wellness data collection from wearables and activity sensors. The patient data can be analyzed at the edge or securely transferred to a health delivery organization's cloud for reporting analytics.[xix]

Another edge tool under development promises to put real-time analytics into the operating room and other medical settings: Magic Leap's latest augmented reality (AR) headset eliminates the need for doctors and surgeons to look at computer screens by overlaying key data as 3D visuals. Doctors wearing the device, currently under review by the Food and Drug Administration, will be able to access live clinical information, charts and visuals for important procedural walkthroughs. They can monitor vitals, device positions and organs in real time. The tool is set to reach markets in late 2023.[xx]

The future is at the edge

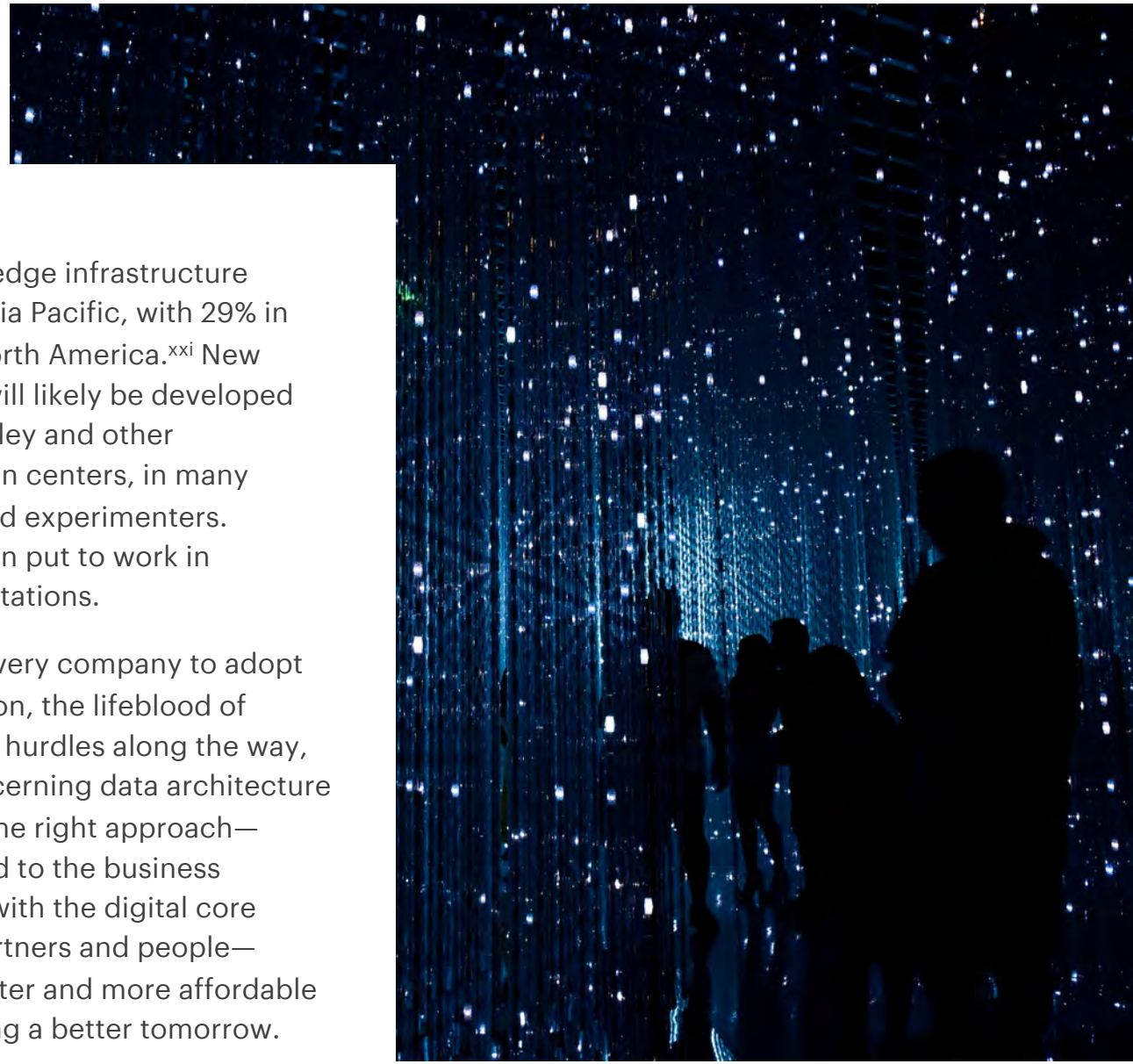
In a rapidly evolving landscape, the need to process data where it is created can only grow. Edge will be a differentiator—a technology that enables real-time decisions and differentiated experiences for customers and employees. The expansion of decentralized data processing and computing—in the classroom, on the factory floor or worn on your wrist—promises to be visible and swift.

More than half the Super Integrators and even the Ad Hoc firms, who have yet to scale edge, believe it will be a transformative technology—one that leads to new business models or change existing business models in the next three years.

All signs point to edge becoming global phenomenon.

By 2028, 38% of the edge infrastructure footprint will be in Asia Pacific, with 29% in Europe and 21% in North America.[xxi] New ways of using edge will likely be developed outside of Silicon Valley and other established innovation centers, in many cases by non-IT skilled experimenters. Edge has already been put to work in satellites and space stations.

Now is the time for every company to adopt edge to fuel innovation, the lifeblood of growth. There will be hurdles along the way, including issues concerning data architecture and talent. But with the right approach—where edge is aligned to the business strategy, integrated with the digital core and supported by partners and people—edge can support faster and more affordable innovation for building a better tomorrow.



About the Research

Methodology

We employed a multi-method research approach that included included a quantitative survey with cluster analysis to identify different types of edge adopters. We also conducted qualitative interviews with edge adopters across a mix of industries and geographies to identify future edge developments. We used Natural Language Processing (NLP) to analyze public conversations about edge computing and edge technology (e.g., corporate earnings calls and articles) for volume and sentiment analysis. Our patent analysis also revealed trends in edge-related patent filings.

Demographics

2,100

Between November 2022 and January 2023, we surveyed **2,100** C- level and Director-level executives globally across 16 countries and 18 industries. Executives were split evenly – **1,050** IT Executives and **1,050** Business/Non-IT Executives.

We also conducted 10 in-depth interviews with executives across countries and industries.

16

Countries

18

Industries

17

Titles

About the Authors

Ram Ramalingam

Managing Director, Global Lead – Software & Platform Engineering and Intelligent Edge

Ram Ramalingam is a Managing Director at Accenture, where he is the global lead of Intelligent Products & Platforms. He has over 25 years of technology leadership experience selling and delivering engineering projects across multiple industries around the globe. Ram specializes in innovative solutions that focus on bringing change, increasing productivity and accelerating growth for customers.
He enjoys applying his deep engineering experience in building modern platforms and facilitating client journeys to the Platform Economy.

Teresa Tung

Managing Director, Global CTO, Cloud First, Data & AI

Teresa is the Global CTO, Cloud First, Data & AI, assisting clients in their data strategy and technology transformation to cloud. She brings strategic expertise in helping our clients apply and scale new technology capabilities to create a differentiated digital foundation. Recent areas of focus include data mesh, digital twin, distributed trusted compute. Teresa is Accenture's most prolific inventor with over 250 patents filed or granted. Teresa holds a Ph.D. in Electrical Engineering and Computer Science from the University of California at Berkeley.

Research Lead

Douglas Chandler

Project Team

Toms Bernhards Callahan

Gargi Chakrabarty

Joanna Duff

Mila Faber

Donovan Griggs

Michal Hadrys

Ryan Keawekane

Linda King

Mark Klinge

Catalina Rodriguez

Janine Stankus

Ezequiel Tacsir

Melina Viglino

Christine Yiannakis

References

i Stellantis, TIM and Accenture Collaborate on 5G Industrial Application in Brazil, Accenture, October 2021, https://newsroom.accenture.com/news/stellantis-tim-and-accenture-collaborate-on-5g-industrial-application-in-brazil.htm

Ii New IDC Spending Guide Forecasts Edge Computing Investments Will Reach $208 Billion in 2023, IDC, February 2023, https://www.idc.com/getdoc.jsp?containerId=prUS50386323

iii Applications in Inventec 5G Smart Factory, Inventec, September 2022, https://www.youtube.com/watch?v=pbQs9Fr7GXI

iv Inventec Improves Manufacturing Efficiencies with Azure Private 5G Core, Microsoft, July 2022, https://customers.microsoft.com/en-us/story/1528823537179838731-inventec-manufacturing-azure-private-5g-core

v Tesla Starts Production of Dojo Supercomputer to Train Driverless Cars, The Verge, July 2023, https://www.theverge.com/2023/7/19/23800854/tesla-driverless-dojo-supercomputers-production

vi Waymo Diver, Waymo, https://waymo.com/waymo-driver/

vii Taking a driverless Waymo in Phoenix over the holidays was fun but unsettling, CNBC, January 2022, https://www.cnbc.com/2022/01/08/heres-what-it-was-like-to-ride-in-a-waymo-with-no-driver-in-phoenix.html

viii Starbucks turns to technology to brew up a more personal connection with its customers, Microsoft, May 2019, https://news.microsoft.com/source/features/digital-transformation/starbucks-turns-to-technology-to-brew-up-a-more-personal-connection-with-its-customers/

ix How Starbucks Is Using AI and More to Better Serve Its Customers, Future Stores, https://futurestores.wbresearch.com/blog/starbucks-ai-serve-customers-strategy

x Accenture Job Posting Analysis

xi Edge Computing Helps Feed Taco Bell's Digital Business, Wall Steet Journal, October 2022, https://www.wsj.com/articles/edge-computing-helps-feed-taco-bells-digital-business-11666302278

xii Taco Bell Satisfies Customer Delivery Demand with Serverless on AWS, Amazon AWS, 2021, https://aws.amazon.com/solutions/case-studies/taco-bell/

xiii The Connected Restaurant: How Edge, IoT and E-commerce Can Transform the Industry, Hospitality Technology, July 2021, https://hospitalitytech.com/connected-restaurant-how-edge-iot-and-e-commerce-can-transform-industry

xiv 5 minutes with: Simon Michie, Pulsant CTO, Manufacturing Digital, September 2022, https://manufacturingdigital.com/technology

xv Intelligent Innovation, Smart Factory, Dell, July 2022, https://www.dell.com/en-us/dt/case-studies-customer-stories/linde-china-internet-of-things.htm#collapse&pdf-overlay=//www.delltechnologies.com/asset/en-us/solutions/infrastructure-solutions/customer-stories-case-studies/dell-technologies-linde-china-customer-profile.pdf

References

xvi Bringing data insights to life: How Disneyland® Resort is using edge technology to help power next-gen attractions, HPE, 2023, https://www.hpe.com/psnow/doc/a50007831enw

xvii HRH The Duke of Cambridge visits Microsoft's UK headquarters to learn about Project SEEKER as part of his work with The Royal Foundation, Microsoft, November 2021, https://news.microsoft.com/en-gb/2021/11/18/first-of-its-kind-multispecies-ai-model-to-detect-illegal-wildlife-trafficking-is-ready-to-roll-out-to-airports/

xviii Delta and Misapplied Sciences launch a personalized flight information board in Detroit, Tech Crunch, June 2022, https://techcrunch.com/2022/06/29/delta-and-misapplied-sciences-launch-a-personalized-flight-information-board-in-detroit/

xix How Edge Computing Is Driving Advancements in Healthcare Analytics, Intel, https://www.intel.com/content/www/us/en/healthcare-it/edge-analytics.html

xx AR in Healthcare Can Revolutionize Patient Outcomes Right Now. Here's How, Magic Leap, January 2022, https://www.magicleap.com/news/how-ar-is-revolutionizing-healthcare-today-magic-leap

xxi LF Edge's State of the Edge 2021 Report Predicts Global Edge Computing Infrastructure Market to be Worth Up to $800 Billion by 2028, the Linux Foundation, March 2021, https://www.linuxfoundation.org/press/press-release/lf-edges-state-of-the-edge-2021-report-predicts-global-edge-computing-infrastructure-market-to-be-worth-up-to-800-billion-by-2028

About Accenture

Accenture is a leading global professional services company that helps the world's leading businesses, governments and other organizations build their digital core, optimize their operations, accelerate revenue growth and enhance citizen services— creating tangible value at speed and scale. We are a talent and innovation-led company with 738,000 people serving clients in more than 120 countries. Technology is at the core of change today, and we are one of the world's leaders in helping drive that change, with strong ecosystem relationships. We combine our strength in technology with unmatched industry experience, functional expertise and global delivery capability. We are uniquely able to deliver tangible outcomes because of our broad range of services, solutions and assets across Strategy & Consulting, Technology, Operations, Industry X and Accenture Song. These capabilities, together with our culture of shared success and commitment to creating 360° value, enable us to help our clients succeed and build trusted, lasting relationships. We measure our success by the 360° value we create for our clients, each other, our shareholders, partners and communities.

Visit us at www.accenture.com.

About Accenture Research

Accenture Research creates thought leadership about the most pressing business issues organizations face. Combining innovative research techniques, such as data science led analysis, with a deep understanding of industry and technology, our team of 300 researchers in 20 countries publish hundreds of reports, articles, and points of view every year. Our thought-provoking research developed with world leading organizations helps our clients embrace change, create value, and deliver on the power of technology and human ingenuity. For more information, visit www.accenture.com/research