Why organizations are betting on edge computing

Insights from the edge

IBM **Institute for Business Value**

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How IBM can help

Clients need strategies and operating plans to harness the game-changing potential of real-time actionable insights, apply predictive and learning analytics to workflows and assets, and enable their digital transformations. Edge computing with AI is creating the potential to enable new markets and grow new revenue streams. We see this rapidly evolving competence pushing the boundaries of what is possible for in-the-moment human and machine collaboration—a new workflow partnership. IBM's Intelligent Connected Operations offer integrated services, software, and edge computing solutions. Connect with us to navigate this dynamic, rapidly changing landscape and apply the computing power of AI on the edge to integrate end-to-end processes. For more information visit ibm.com/services/process/iot-consulting

By Skip Snyder,
Rob High, Karen Butner,
and Anthony Marshall

Key takeaways

Power of edge

Edge computing brings computation, data storage, and power closer to the point of action or event, reducing response time and saving bandwidth. Its revolutionary capabilities coupled with artificial intelligence (AI) enable interpretation of data patterns, learning, and decisions in real time.

Ready to respond

Real-time data processing at the edge allows for more immediate insights from connected devices and systems. The vast majority of executives surveyed tell us edge computing applications will help their organizations improve operational responsiveness—with the number-one impact being reduced operating costs.

Valuable investment

Almost three-quarters of organizations say they will invest in AI in the next three years to create new business models at the edge, combining intelligent workflows, automation, and edge device interconnectivity. They also expect investments in edge computing to produce positive ROI within three years.

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Living on the edge

While edge computing has been on the IT and operations radar for some time, it has now moved into the corporate mainstream. According to *Network World*, edge will be part of almost every industry.[1] Rollout of 5G will only increase demand and need. In the different normal of a COVID-19 world, edge computing's significance and potential are more important than ever.

A combination of edge computing and industrial Internet of Things (IoT) devices enables smarter supply chains, better equipping them to handle disruption of all kinds. Edge computing can also enhance and expand the performance of drones used for a myriad of reasons from disinfection and diagnosis to crowd management and deliveries.[2] And edge computing with 5G can help address bandwidth, speed, and security issues for networks experiencing sudden—and ongoing—traffic surges. In fact, adoption of 5G opens the door to a situation where edge is not just an option, but a necessity.[3] Edge computing already has a host of applications and the potential to transform processes and entire industries.

Edge computing helps address issues stemming from today's ever-increasing amounts of data. Customers' expectations for compelling, immersive real-time interactions continue to grow, and boundaries between the physical and the digital continue to erode. The resulting explosive growth in the number—and computing power—of IoT devices is generating unprecedented amounts of data.

Data volumes will increase even faster as 5G networks enable lightening speeds and even more connected devices. IDC predicts that by 2025, every connected person in the world will have at least one digital data interaction every 18 seconds—likely from one of the billions of IoT devices, which are expected to generate over 90 ZB of data in 2025.[4] Sending all that device-generated data to a centralized data center or to the cloud will most certainly result in bandwidth, energy, and latency issues.

84%

of executives involved in their organization's edge computing strategies expect edge applications to positively impact operational responsiveness

91%

tell us their organization will implement edge computing

Leading organizations expect to realize an average ROI of

24%

within three years from edge computing investments

What exactly is edge computing?

Edge is a distributed computing model that brings computation, data storage, and power closer to the point of action or occurrence of an event. Processing data where it is created—at the edge—allows for more immediate application of analytics and AI capabilities.

Edge computing is a more efficient alternative. Because much of the data does not traverse over a network to a cloud or data center to be processed, latency—the delay between transfer of data following a transfer instruction—is significantly reduced. Edge computing enables faster, less restrictive data analysis, creating the opportunity for deeper insights, faster response times, and improved customer experiences. Powered by edge and AI, devices and machines can interpret, learn, and make decisions instantaneously.

While some edge computing is being applied today, it is poised for explosive growth in the future. With the continued growth of the IoT, Gartner predicts that 75 percent of enterprise-generated data will be created and processed outside the traditional data center or cloud by 2025.[5] The global edge computing market, valued at USD 3.5 billion in 2019, could reach USD 43.4 billion by 2027.[6]

To learn about organizations' current and future edge computing strategies, the IBM Institute for Business Value joined forces with Oxford Economics to survey 1,500 executives across 22 industries and 21 countries. Executives reveal their plans for the technology and how it can drive responsiveness, energy efficiency, and business model innovation. In addition, we explore ROI expectations, as well as identify a small group of leaders who are diving into edge with bigger investments—and expectations. (For further details on our survey and data analysis, see the *Research methodology* section at the end of the report.)

> "The player that best harnesses connected IoT and 5G is going to win big on so many levels. It will be able to modernize its network and transform decision responsiveness."

COO, Telecommunications, Canada

A more edgy experience

Edge computing can benefit virtually any application in a distributed system. The ability to analyze data at its source allows businesses to make decisions and take actions based on the most current data at any point in time. Adding the speed and low latency of 5G to edge-based applications opens the door to innovation at a whole new level (see *Insight: Linking 5G and edge computing for industry innovation*).

Processing data at the edge in real time reduces the amount of data sent to the cloud. Although it may interact with a centralized cloud, edge computing doesn't need contact with one, allowing for offline reliability. For example, an edge computing-enabled IoT device can create, process, store, and act on data even when the device is not connected to the internet. When a connection is available, relevant data is then shared within a continuous operating environment.

Organizations are already capitalizing on edge computing's capabilities to enable real-time insights from connected devices and systems, real-time equipment monitoring, and real-time inventory management. For example, sustainable agriculture companies are equipping plants with IoT-enabled sensors and using edge computing to monitor the growth needs and ideal harvest time for individual plants.[7]

Automotive companies are essentially making cars into edge devices, equipping them with internal and external sensors that generate data. Edge computing can power decisions and actions in real time for individual vehicles—from braking to steering and lane changes.[8] Edge computing's capability to reduce latency is also useful in the mobile gaming space. In real-time online games, milliseconds can make the difference between winning and losing—and edge computing meets users' demands for fast, low-latency connections that improve the multiplayer experience.[9]

Insight: Linking 5G and edge computing for industry innovation

Paired together, 5G networking and edge distributed computing capabilities enhance one another, creating incredible opportunities for new products, platforms, and experiences across industries. The blazing speed and low latency offered through 5G networks, combined with the real-time insights available when processing data at the edge, have the potential to drive major innovations across industries:

– Manufacturing: With Industry 4.0, intelligent automation is nearing the next levels of advancement with interconnected plant floors and expanding communications to ecosystems.

– Supply chain: Real-time insights enable just-in-time supply chains, allowing suppliers to respond quickly to demand volatility.

– Healthcare: Mobile applications and monitoring devices directly connect patients with their care teams through automated AI services and real-time data processing.

– Field workforce: Sales or field services personnel can access secure corporate data—even in disconnected environments—using edge-enabled devices.

– Transportation: Edge-enabled fleet management (trucks and drones) allows load, mode, and routing optimization for workload balancing and last-mile logistics.

– Autonomous vehicles: AI processing localizes immediate data digestion and autonomous reaction not just in automobiles, but also in mining, oil and gas exploration, and other industrial product applications.

Executives say edge computing can improve operational responsiveness, increase energy efficiency, and drive business model innovation.

Groundbreaking capabilities

We focused our research on executives who are aware of and involved in their organization's edge computing strategies.[10] The majority of these organizations are in the early stages of edge computing, implementing proof-of-concept use cases. And just over a quarter are further along in their journey, having implemented edge solutions that align with their business objectives.

However, in five years, the tables should turn, as 91 percent tell us their organizations will have implemented edge computing by then. Forty-three percent anticipate use cases for specific functions, while 36 percent say they will have widely implemented edge solutions that align with their business objectives. And a select few organizations (12 percent) will be leveraging edge computing in a manner fully aligned to their business objectives and effectively integrated with existing enterprise systems and processes.

What are these organizations expecting to achieve through edge computing solutions? While executives cite numerous benefits from edge capabilities, three key areas stand out: responsiveness, energy efficiency, and business model innovation.
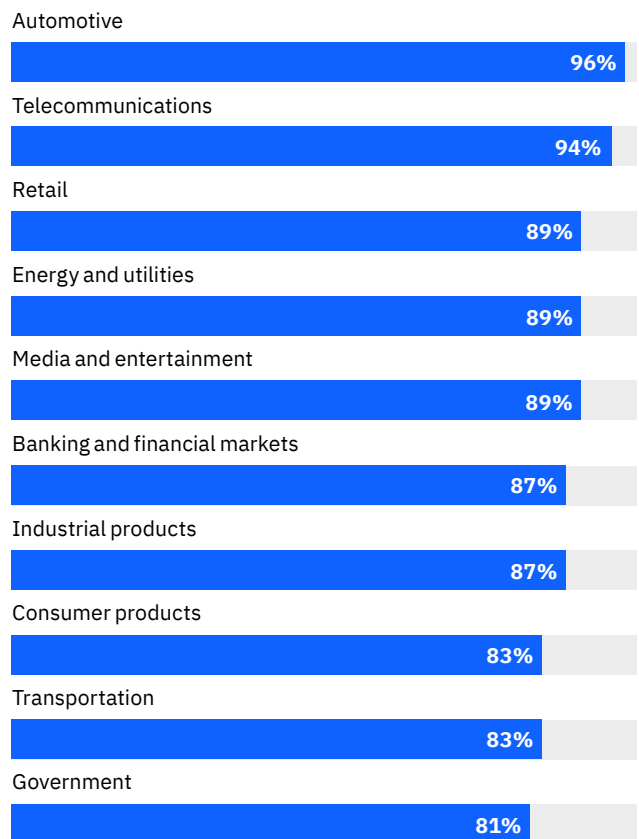
Responsiveness

Organizations are counting on edge computing to help them be more responsive to changing conditions and customer interactions. Eighty-four percent of executives say edge computing applications will have a positive impact on their organization's operational responsiveness in five years. Executives from the automotive and telecommunications industries are particularly confident in edge computing's capabilities in this area (see Figure 1).

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Figure 1

Executives expect edge computing to increase their organization's ability to respond to change

Top industries projecting increased operational responsiveness from edge computing in five years

Automotive
96%

Telecommunications
94%

Retail
89%

Energy and utilities
89%

Media and entertainment
89%

Banking and financial markets
87%

Industrial products
87%

Consumer products
83%
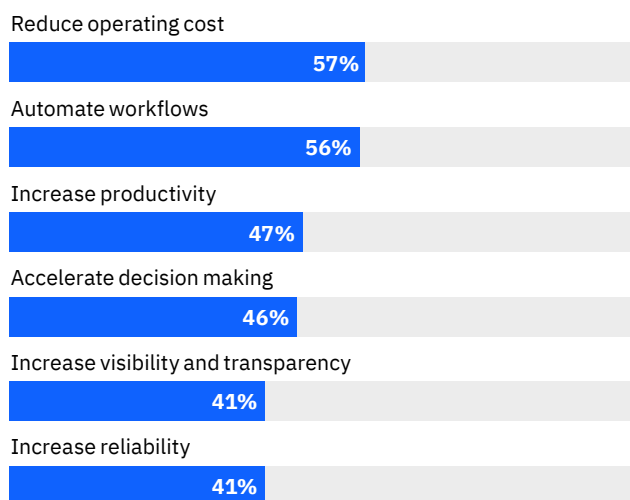
Transportation
83%

Government
81%

Source: IBM Institute for Business Value 2019 Edge Computing Study.

Edge-induced responsiveness can lead to significant business benefits. A majority of respondents tell us edge computing will help them reduce operating costs (57 percent) and automate workflows (56 percent) in the next five years (see Figure 2). Close to half expect edge capabilities to increase productivity (47 percent) and accelerate decision making (46 percent).

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Figure 2
Increased responsiveness yields significant business benefits

Greatest impact from edge computing responsiveness in five years

Reduce operating cost
57%

Automate workflows
56%

Increase productivity
47%

Accelerate decision making
46%

Increase visibility and transparency
41%

Increase reliability
41%

Source: IBM Institute for Business Value 2019 Edge Computing Study.

GreenCom Networks: Empowering the energy market of the future[11]

GreenCom, a leading energy IoT company, helps energy companies design innovative services to optimize decentralized production and consumption. The company developed an IoT platform to help its customers manage energy demand, supply, and storage capacity. This highly scalable energy IoT platform processes data flows from millions of connected devices in real time.

GreenCom has developed an edge software stack that runs on small, low-cost gateway devices. Not only does the gateway software monitor each device's production and consumption, it also can control the devices themselves. Rather than selling kilowatt hours, power companies can use these analytical models to create a whole new class of managed energy services, with predicted customer savings of up to 30 percent.

> "To remain competitive, organizations in our industry will need to evolve from a centralized cloud approach to one that includes edge computing."

Chief Operations Officer, Industrial Products, Germany

Improved energy efficiency

Edge computing can help organizations manage energy efficiency and reduce power consumption. As more data is processed on the edge, less moves to and from the cloud, thus decreasing data latency and energy consumption.

Over half (54 percent) of organizations will use edge computing applications for energy efficiency management within three years. And within five years, organizations across industries expect edge computing to decrease their annual power consumption up to 11.5 percent, with those from telecommunications and electronics expecting the greatest decrease (see Figure 3).
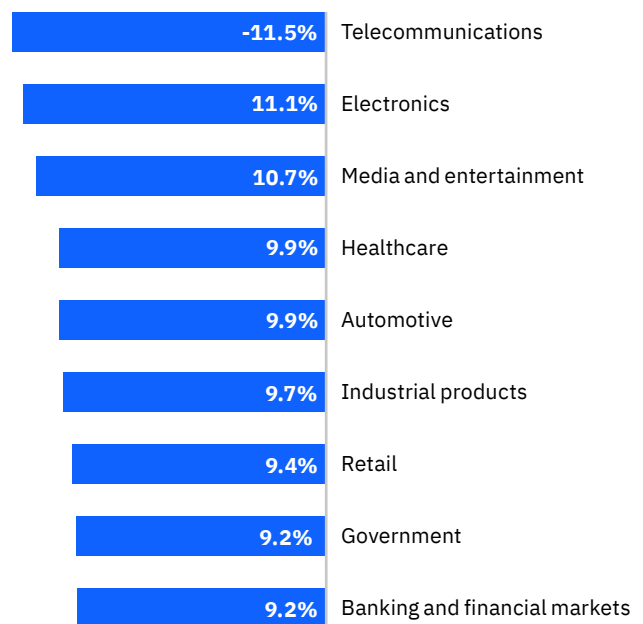
Business model innovation

Executives tell us that edge computing can power new data-driven business models. Close to three-fourths are planning AI investments in the next three years to further support edge-inspired business models.

Organizations are also changing their processes and workflows—essentially how they do work—to accommodate intelligent machines and interconnected devices. A majority are innovating business models and workflows for automation (64 percent), as well as optimizing operations for situational awareness (52 percent). Executives tell us their organizations are also educating employees about intelligent machines (48 percent) and how to work collaboratively with them (50 percent).

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Figure 3
Executives plan to leverage edge computing for more efficient energy management

Average expected reduction in annual power consumption from edge computing in five years

-11.5%	Telecommunications
11.1%	Electronics
10.7%	Media and entertainment
9.9%	Healthcare
9.9%	Automotive
9.7%	Industrial products
9.4%	Retail
9.2%	Government
9.2%	Banking and financial markets

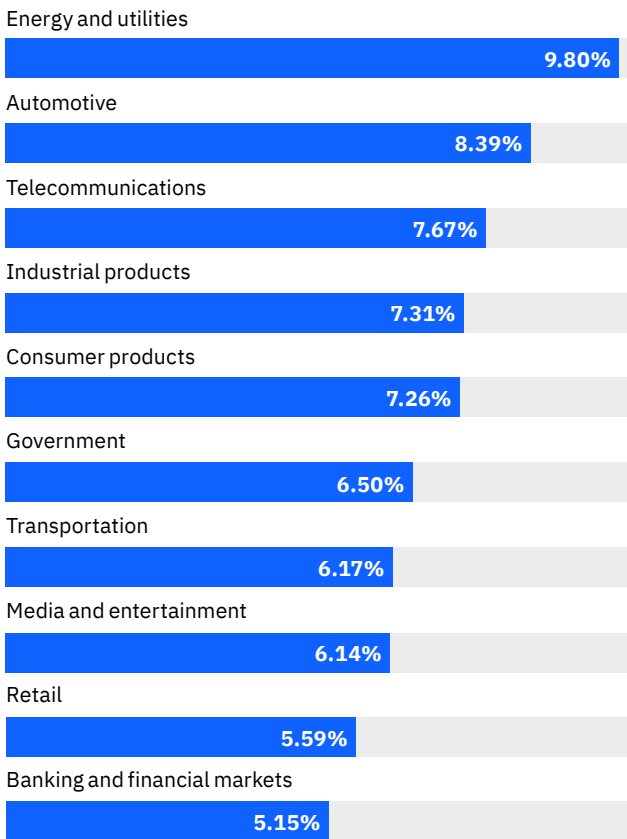*Source: IBM Institute for Business Value 2019 Edge Computing Study.*

Investing in edge pays off

Executives anticipate an average ROI of almost 6 percent from their edge investments in only three years (see Figure 4). Energy and utilities executives are particularly bullish on edge, expecting an average ROI of almost 10 percent; automotive executives are not far behind with 8 percent.

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Figure 4

Executives predict that edge investments will produce positive ROI within three years

Average ROI expected by industry from investment in edge in three years

Energy and utilities
9.80%

Automotive
8.39%

Telecommunications
7.67%

Industrial products
7.31%

Consumer products
7.26%

Government
6.50%

Transportation
6.17%

Media and entertainment
6.14%

Retail
5.59%

Banking and financial markets
5.15%

Overall average 5.7%

Source: IBM Institute for Business Value 2019 Edge Computing Study.

Insight: Transforming asset management

Mining and other construction-related companies strive to optimize production, which requires functional equipment. A key to keeping equipment up and running is to avoid unplanned maintenance by optimizing scheduled maintenance.

Many companies are deploying predictive maintenance solutions based on IoT and smart sensor analysis. These solutions use AI machine learning algorithms to analyze the equipment sensor data at a component level, enabling organizations to better predict and prevent equipment breakdowns.

With component predictions in hand, these companies have the critical elements needed to optimize scheduled maintenance practices across their operations for all equipment. These solutions can drive productivity improvements up to 30 percent in some areas.

ProMare: Leveraging AI and edge technology to unlock ocean secrets[12]

ProMare is a nonprofit corporation that promotes marine research and exploration throughout the world. It is creating the first full-sized unmanned solar-powered ship, with the endurance and reliability to operate remotely in every corner of the globe.

Onboard sensors for radar, sonar, video, radio, global positioning system (GPS), depth, and automatic identification will collect data from the environment continuously. Using accelerated servers with deep learning toolsets and frameworks, the company is creating models to recognize navigation hazards. The company is also creating machine learning models to control the vehicle, perform route planning and optimization, analyze results from its automatic identification system, and avoid adverse weather.

Meet the edge disruptors

To determine whether organizations with big plans and high hopes for edge computing stand out from their competitors, we created a subset of respondents: the edge disruptors. We selected them based on their expectations that 1) edge computing will have a positive impact on their organizational responsiveness and 2) their edge investments will yield between 15 and 70 percent ROI in the next three years.

Representing 9 percent of the total respondent population, these edge disruptors understand how edge computing capabilities can help uncover new business opportunities, increase operational efficiency, and provide enhanced experiences for customers. In addition, they are leaders in their industries, having outperformed peers in revenue growth and profitability over the last three years.

Distinctive disruptors

The disruptors also differentiate themselves through productivity, agility, and innovation. Compared to other respondents, 8 percent more disruptors say they surpass competitors in productivity measures, while 14 percent more outshine competitors in terms of agility. We found the biggest disparity in the area of innovation: Compared to other respondents, 58 percent more disruptors outperform their competitive peers in innovation.

Edge disruptors are also leaders in deploying intelligent machines to make decisions. Today, 10 percent allow intelligent machines and connected devices to make complex and mission-critical decisions—more than double the percentage of other respondents. In just five years, 60 percent of disruptors expect machines to make such decisions, compared to just 33 percent of other respondents.

Edge disruptors also anticipate edge computing benefits in activity monitoring/automation, smart meter monitoring/control, and predictive condition-based asset management. And for energy management, 62 percent are using edge computing today, and more than three-quarters will in the next three years.

> "Edge computing enables new business models that will capture as yet untapped value from machine data."

Chief Strategy Officer, Pharmaceuticals, United States

Disruptors: An industry view

Executives across industries are building strategies to personalize customer experiences, generate faster insights and actions, and maintain continuous operations. Edge computing can play a key role in these strategies, albeit in different ways for different industries.

We were interested in where and how edge disruptors from various industries expect to achieve the 15 to 70 percent ROI they anticipate from edge implementations. We analyzed disruptor survey data, exploring three timeframes—today, in three years, and in five years— and four industry groups: industrial and manufacturing, infrastructure, consumer, and services. (For more on our analysis and a breakdown of the industry groups, please see the *Research methodology* section at the end of the report.)

Most edge disruptors are currently in the initial investment phase, with the possible exception of industrial and manufacturing companies, which report gains today (most likely because they started their edge journeys before others). More important, we found that disruptors across industry groups expect significant positive ROI in the next three years—more than 20 percent. And infrastructure industries expect to fare even better, predicting almost 30 percent ROI in the next three years.

We also looked at industry group ROI expectations based on use case/application area—in other words, the ways each industry disruptor group is using or plans to use edge computing. Larger trends seen globally and across all industries tend to hold true when looking at ROI impact by industry group (see *Insight: Industry view of disruptor expectations for edge computing ROI)*. Energy efficiency management scores very high in ROI impact in early investment implementations. Predictive maintenance scores high returns in the next three years with anticipation for sustained high returns. Asset utilization scores medium to high ROI.

Generally, across industries, the edge computing impact shifts from improved energy efficiency today to faster responsiveness and innovation in the future. Executives expect sustained impacts (for example, on operational responsiveness, energy efficiency, and workflow optimization) from early investments. They anticipate additional benefits as new edge applications and capabilities are developed and deployed across their enterprise and ecosystems.

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Figure 5

Edge disruptors across industries are investing in edge computing for the future

Expected ROI across edge disruptors in each of the industry groups
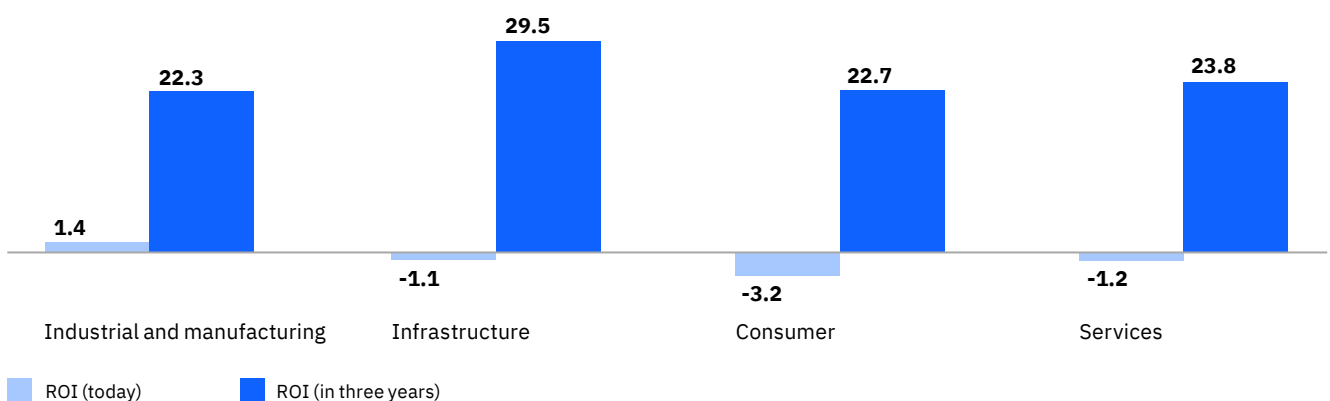
Source: IBM Institute for Business Value 2019 Edge Computing Study.

Insight: Industry view of disruptor expectations for edge computing ROI

Industrial and manufacturing

Companies in this industry group experience very high ROI impact today for edge computing investments in energy management. In three years, they expect high-impact ROI in autonomous vehicles and new or improved products and services. In five years, edge will permeate their production processes and fleets, enabling productivity and agility improvements for sensor-based manufacturing and fleet management processes. This group also expects an impact on asset utilization, likely through predictive, condition-based asset and equipment maintenance systems.

Infrastructure

Here, companies achieve high ROI from current edge computing investments in predictive maintenance and new product/service offerings, primarily in asset/equipment tracking and activity monitoring, as well as automation. In three years, they expect very high returns in manufacturing as they boost operations for projected high returns in new products/services. In five years, travel and transportation companies expect very high impact on fleet management with continued transportation optimization. Many of these organizations also anticipate high returns on predictive sales at point-of-sale, telecommunications organizations in particular.

Consumer

Today, consumer-touching organizations experience high ROI from edge computing in energy efficiency. Also, edge computing for real-time inventory tracking and management yields high returns, which is unsurprising given the industries. Predictive maintenance tops their use of edge, as they move from medium impact today to very high in the next three years—and the next five. Many companies in this group also anticipate an impact on productivity, likely through activity monitoring and automation.

Services

The services sector currently achieves very high ROI from investments in energy efficiency management. Asset utilization yields medium impact today, with expected high impact in three years. For this group, the most prominent use case is activity monitoring and automation, particularly for banking/financial markets and insurance industries. Predictive maintenance is expected to yield very high sustained ROI impact in the next three to five years as these industries sharpen operations.

Edge computing capabilities will push industry innovation to a whole new level.

On the edge of the future

With the continued infusion of intelligent devices into business and everyday life, the potential for real-time insights—created from data processed closer to its source—will only grow. In fact, IDC predicts the number of apps at the edge will increase 800 percent by 2024.[13]

It is likely that, ultimately, edge computing will touch virtually every industry. Looking at our overall survey population by industry, we found that the most edge-engaged industries—those scoring highest in usage and expectations—plan to substantially increase their level of edge computing implementation, moving from use cases to business alignment and integration (see Figure 6).

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Figure 6
Scaling and impact skyrocket in the next five years
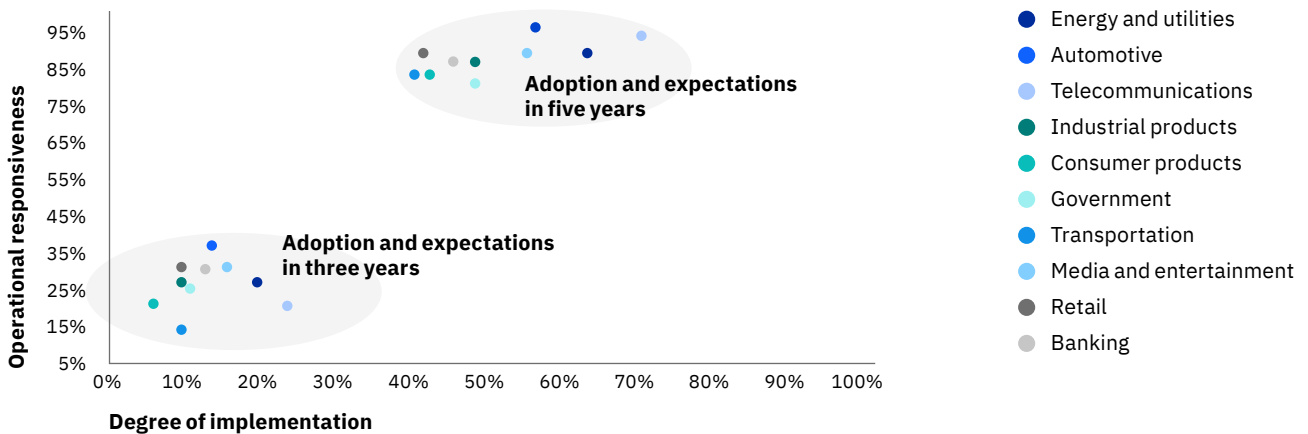
Degree of implementation – Organizations that are implementing use cases of edge aligned with business objectives. (3, 4, or 5 on a 5-point scale)

Operational responsiveness – Organizations that expect positive and significant impact on operational responsiveness (4 or 5 on a 5-point scale)

Source: IBM Institute for Business Value 2019 Edge Computing Study.

Most organizations in these edge-engaged industries also expect moderate impact on operational responsiveness in early stages. However, when they hit the pinnacle of implementation across their organizations, these companies expect operational responsiveness to also increase. While the levels of impact on operational responsiveness and expected ROI vary by industry, the general trend holds true.

Telecommunications organizations have a keen eye on edge computing, with more than 70 percent expecting edge to align with business objectives and 94 percent anticipating significant impact on responsiveness in the next five years. Close behind in implementation are energy and utilities respondents, with 64 percent expecting aligned use cases, while 89 percent anticipate increased responsiveness in five years. Automotive executives have the highest expectations for responsiveness at 96 percent, while 57 percent anticipate edge implementations aligned with business objectives in five years.

Preparing for tomorrow

Edge computing is transforming how organizations manage, process, and leverage data. Some organizations are already realizing benefits from edge computing, setting themselves apart in areas like growth, productivity, agility, and innovation. Others are still discovering how to leverage the power of edge to drive responsiveness, energy efficiency, and business model innovation. Our action guide can help organizations—regardless of where they are in their journey—position themselves today to embrace edge computing's promise for tomorrow.

Action guide

How to gain an edge through edge computing

1. Power and enhance data transfer.

– Explore and scale new technologies for powering devices on the edge.

– Monitor evolving use cases, including machine-to-machine security validation, blockchain for enhanced ledger-based communication between edge devices, and the use of 5G to enhance advanced edge computing capabilities, for applicability to your organization's requirements.

– Build a platform that serves as an edge enabler. Bring analytics and machine learning to the on-premises edge environment, enabling machine performance optimization, proactive maintenance, and operational intelligence.

2. Curate data to drive impact.

– Move from collecting data from every interaction—human, IoT, machine, integrated—to using it to generate insights. Assess and prioritize where insights deliver the most value—and to whom.

– Identify underserved users and assess how to meet customer needs with data and services, not features and functions.

– Choose your platform carefully to ensure it has measurable, scalable automation components. You should be able to measure business impact, gain visibility, and apply governance to end-to-end workflows—hybrid cloud to edge.

3. Bring the apps to the edge.

– Uncover ways to apply intelligence to operational functions and activities to power real-time insights that are decisive and actionable. A new market has emerged for edge software apps.

– Run advanced asset optimization in real time. Core cloud-based analytics are now being reduced in size to run efficiently on the edge—ingesting and handling edge data, assisting with data flow, using digital twin solutions to listen to and create digital duplicates of assets, and enabling real-time predictive maintenance and machine learning.

4. Act in real time.

– Utilize edge capabilities for immediacy in response and action.

– Enable a new class of intelligent products and processes that can reason and learn with the support of AI in real time.

– Use AI technologies to reveal patterns that people might otherwise not see or predict for fast action.

5. Edge ahead of the competition.

– Achieve competitive advantage by creating differentiation with agile workflows and in-the-moment processing. Differentiate by providing customer, employee, and partner insights for responsive action.

– Balance workflow and compute needs requiring unique configurations with your hybrid cloud and edge strategy:

  • Use hybrid and centralized cloud networks for the "heavy lifting" data processing with a distributed real-time device processing capability

  • Deploy specific apps on the edge device, on nodes, on premise servers, and on hybrid cloud platforms.

6. Win big: Differentiate with speed.

– Investigate potential use cases where the combined power of 5G and edge computing can drive innovations in your industry, such as those requiring ultra-low latency and massive machine-to-machine data exchanges.

– Examine workflows that require complex event data processing. With edge computing architecture, complex event processing happens in the device or a system close to the device, eliminating cloud round-trip issues and enabling real-time actions.

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Methodology

In collaboration with Oxford Economics, the IBM Institute for Business Value surveyed 1,500 executives with direct knowledge of their organizations' strategies, investments, and operations concerning edge computing. This group encompassed 22 industries with corporate headquarters spanning 21 countries around the world.

Respondent roles included CEO/head of strategy, CFO/head of finance, CMO/head of marketing, COO/CSCO/head of operations, CIO/head of IT/head of technology, chief technology officer, and executive responsible for strategic alliances or partnerships. We explored their organizations' planned investments, expected benefits and impacts, and applicability of edge computing across their enterprise and ecosystem. We also sought input regarding their adoption and investments in various emerging technologies and the impact on their workforce.

We used classification analysis to segment the survey population, identifying a distinct group representing successful and accelerated implementation of edge computing. Edge disruptors (9 percent of the population) were selected based on their expectation that edge computing will have a positive impact on their organizational responsiveness and that their edge investments will yield between 15 and 70 percent ROI.

We also employed an econometric model and performed regression analysis, scrutinizing this group of disruptors on the independent variables of the applications in which their organizations are using and/or plan to use edge computing against the dependent variable of ROI. We regressed three timeframes: today, the next three years, and the next five years. Further we analyzed these results by various industry sectors: industrial and manufacturing (automotive, chemicals and petroleum, consumer products, electronics, and industrial products), infrastructure (energy and utilities, telecommunications, and travel and transportation), consumer (retail, media and entertainment, life sciences, and healthcare), and services (banking/financial management and insurance, government, education, and IT).

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