Research Insights

The edge computing advantage

Industrial companies unlock efficiencies and data-rich insights

IBM

How IBM can help

Clients need to harness the game changing potential of real time actionable insights. They need to apply predictive and learning analytics to workflows and assets. And they must enable their digital transformations by investing in core infrastructure that powers AI. They can go a long way toward achieving all of that with edge computing. Edge has 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 Jason Jackson, Spencer Lin, and Marcelo Sávio

Key takeaways

The power of edge

Edge computing brings computation, data storage, and power closer to the source of data generation, allowing for more immediate insights from connected devices and systems. Edge can help organizations drive faster operational responsiveness, improve energy efficiency, and support new data-driven business models that can capture massive untapped value.

A valuable investment

Almost two-thirds of organizations say they will invest in AI in the next 3 years to create new business models at the edge, combining intelligent workflows, automation, and edge device interconnectivity. They expect investments in edge computing to produce a positive ROI of 6.3% within 3 years.

Making the most of edge

Leading companies are leveraging edge today. These Edge Disruptors are embracing complementary technologies and focusing on select applications for edge computing. As the technology matures, adoption is expected to broaden quickly.

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The vast potential of edge

Edge, a distributed computing model, brings computation, data storage, and power closer to the source of data generation. Processing data where it is created—at the edge—allows for the more immediate application of analytics and AI capabilities, eliminating round-trip cloud issues and enabling real-time actions. Edge computing can help energy, natural resources, and manufacturing companies take advantage of Industry 4.0 and drive productivity gains.

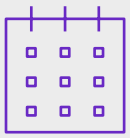
Smart manufacturing uses intelligence systems to make autonomous decisions that optimize machinery performance and equipment maintenance. The combination of edge computing and Industrial Internet of Things (IIoT) devices leads to smarter supply chains, better equipping them to handle disruption. 5G/private cellular network speed permits factory and remote sensors to provide real-time updates about the operating environment, but it also adds to today's ever-increasing volume of data with even more connected devices.

As devices proliferate, so will data. By 2025, an estimated 38.6 billion connected IoT devices are expected to generate over 90 zettabytes—or 90 trillion gigabytes—of data.[1] Sending this device-generated data to a centralized data center or to the cloud can result in bandwidth, energy, and latency issues.

Edge computing is a more efficient alternative. With edge, much of the data does not travel a network to the cloud or a data center to be processed, significantly reducing latency—the delay in the transfer of data following a transfer instruction. Data can be analyzed at its source, allowing organizations to make decisions and take actions based on the most current data at any point in time. For example, an edge-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.

81%

of executives involved in their organizations' edge computing strategies expect edge applications to improve operational responsiveness in the next 5 years



94%

say their organizations will implement edge computing in the next 5 years

23%

average ROI is expected by Edge Disruptors within 3 years of their edge computing investments, compared with 3% for their peers

Edge computing is on the cusp of explosive growth. With the continued expansion of the IoT, Gartner predicts that 75% of enterprise-generated data will be created and processed outside the traditional data center or cloud by 2025.[2] The number of apps at the edge will increase 800% by 2024, IDC predicts.[3] The edge computing market is expected to grow at a compound annual growth rate of 34% between 2020 to 2025, with the manufacturing vertical as the largest segment.[4]

To understand organizations' current and future edge computing strategies, the IBM Institute for Business Value, in conjunction with Oxford Economics, surveyed 1,500 executives across 22 industries and 21 countries (see "Study approach and methodology"). This report focuses on the 140 chemicals, petroleum, and industrial products respondents who are aware of and involved in their organizations' edge computing strategies.[5]

69% of chemicals, petroleum, and industrial products companies use edge for energy management.

Edge computing's power here and now

Organizations can capitalize on edge computing's capabilities to enable insights from connected devices and systems, equipment monitoring, and inventory management—all in real time. For example, Yara, one of the world's leading fertilizer companies and a provider of environmental solutions, has built a digital farming platform that connects and empowers independent farmers.[6] This platform helps farmers manage their crops with capabilities such as damage prediction and weather forecasting, using IoT sensors and AI to improve agricultural outcomes.[7]

In mining, the use of intelligent, autonomous machinery can help human workers avoid high-risk conditions. This machinery is equipped with sensors, AI, and machine learning capabilities to detect and avert hazards in real time. Edge computing helps run and analyze data right on the machinery itself, so the information needed to make decisions is consistently available.[8]

For industrial machinery companies, edge computing can operate on the factory floor to intelligently monitor the performance of machinery in real time and optimize costs. Predictive analytics can provide real-time insights into the condition of factory equipment to detect potential failures, significantly reduce loss and downtime, and help maintain quality.[9] In addition, industrial machinery's field services representatives can use edge-enabled devices to access secure corporate data—even in disconnected environments.

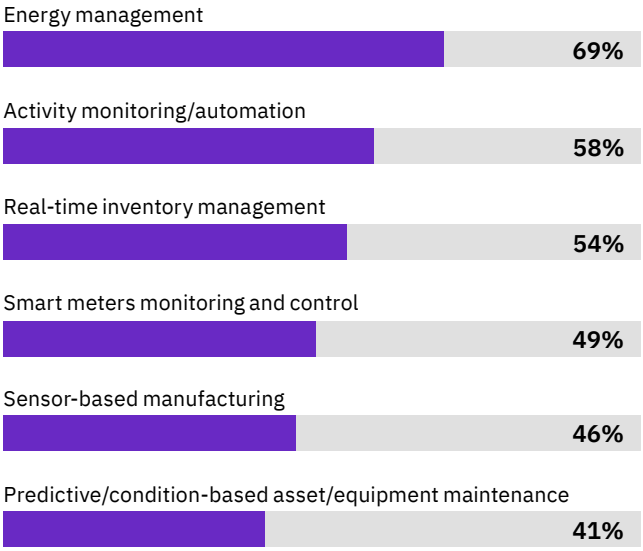
Among the most prevalent use cases for edge among chemicals, petroleum, and industrial products companies, the top 3 are energy management, activity monitoring, and real-time inventory management (see Figure 1).

Edge computing can help improve energy usage. It reduces network loads, optimizes energy used for compute and storage, and enables solutions that help enterprises better monitor and manage their energy consumption.[10]

Figure 1

Right on the edge

How chemicals, petroleum, and industrial products companies use edge computing



Q. Which of the following edge computing use cases apply to your organization? n=140

Activity-monitoring applications range from back-office processes to predicting future responses and altering work tasks. For example, the proper monitoring of furnaces and gas-fired heaters can deliver stable, reliable heat and reduce fuel consumption, waste, emissions, and maintenance costs.[11] Using machine learning and AI capabilities, activity-monitoring solutions can recognize patterns in unstructured data, make decisions, and even solicit services from other devices or systems.

Real-time inventory insights can be combined with weather condition data to help companies proactively respond to supply-chain disturbances.

Edge Disruptors expect 23% ROI from their edge investments within the next 3 years, compared with just 3% for their cohorts.

The majority of chemicals, petroleum, and industrial products organizations are in the early stages of edge computing, with over two-thirds in the planning stage. Nearly 3 in 10 are further along in their journey, implementing use cases. In 5 years, emerging technologies will mature, and adoption should advance rapidly, as 94% tell us their organizations will have implemented edge computing by then.

Executives anticipate an average ROI of 6.3% from their edge investments in only 3 years. Organizations expect to achieve benefits from 3 key areas through edge computing solutions: 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. 81% of respondents say edge computing applications will have a positive impact on their organizations' operational responsiveness in 5 years. Respondents told us that edge-induced responsiveness can lead to significant business benefits: reduced operating costs (64%), automated workflows (58%), and increased operational efficiency or productivity (51%) in the next 5 years.

Improved energy efficiency

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

46% of organizations are using edge computing applications for energy-efficiency management today. That number will jump to nearly 3 in 5 within 3 years. And within 5 years, organizations expect edge computing to decrease their annual power consumption by 8.9%.

Business model innovation

Edge computing can power new data-driven business models. Close to two-thirds of respondents are planning AI investments in the next 3 years to further support edge-inspired business models. Organizations are also changing their processes and workflows to accommodate intelligent machines and interconnected devices. 7 in 10 are innovating business models and workflows for automation. Executives tell us their organizations are training their employees about intelligent machines (64%) and how to work collaboratively with them (58%).

Meet the Edge Disruptors

To help organizations identify strategies to improve their edge computing capabilities, we identified a subset of respondents we call 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% ROI in the next 3 years. On average, Edge Disruptors expect 23% ROI from their edge investments within the next 3 years, compared with just 3% for their cohorts.

Representing 17% of the chemicals, petroleum, and industrial products respondents, these Edge Disruptors evidence competitive differentiation in agility—92% versus 72% of their peers. In addition, they outperformed their peers in revenue growth and profitability over the last 3 years.

Edge Disruptors emphasize 3 key actions to drive success:

1. Leverage edge computing today
2. Embrace complementary technologies
3. Focus on select applications.

Leverage edge computing today

Edge Disruptors today invest more than twice as much as their peers in edge computing as a percentage of their technology budget (6.3% compared with 2.7%). As a result, they are further along on their edge computing journey (see Figure 2).

While they are currently implementing use cases, they plan to shift to implementing edge solutions that align with their business objectives in 3 years. In 5 years, many more Edge Disruptors say they will leverage edge computing in a manner fully aligned to their business objectives and effectively integrated with existing enterprise systems and processes.

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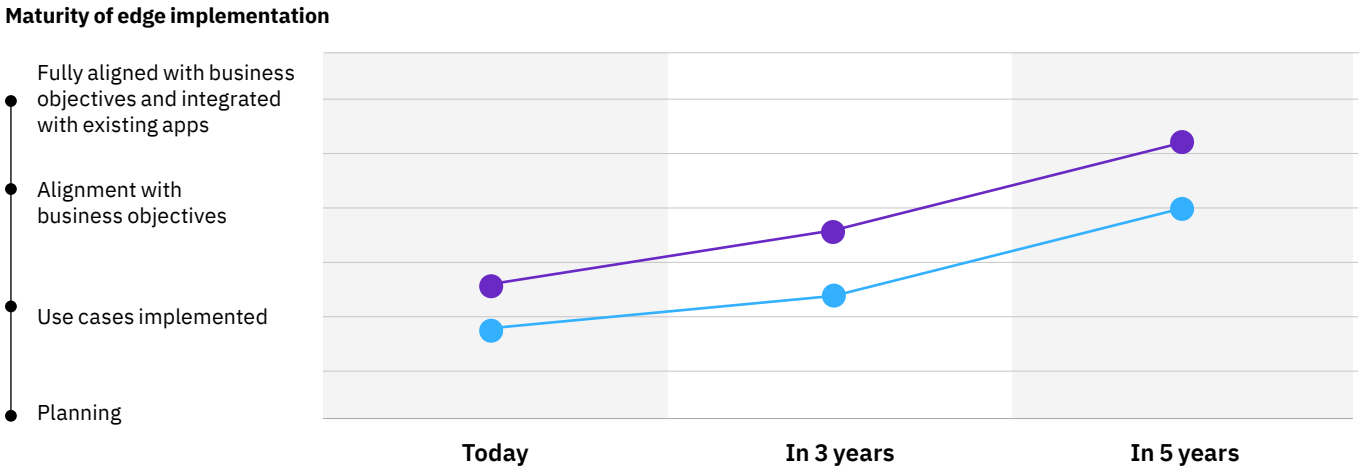
Figure 2

Reaching maturity

Edge Disruptors look to go beyond use cases and align with business objectives.



Q. Degree to which your organization has implemented edge computing today, in 3 years, in 5 years. n=140

Edge Disruptors say their investments in edge today contribute to 1.6% of their profitability versus 0.7% for their cohorts.

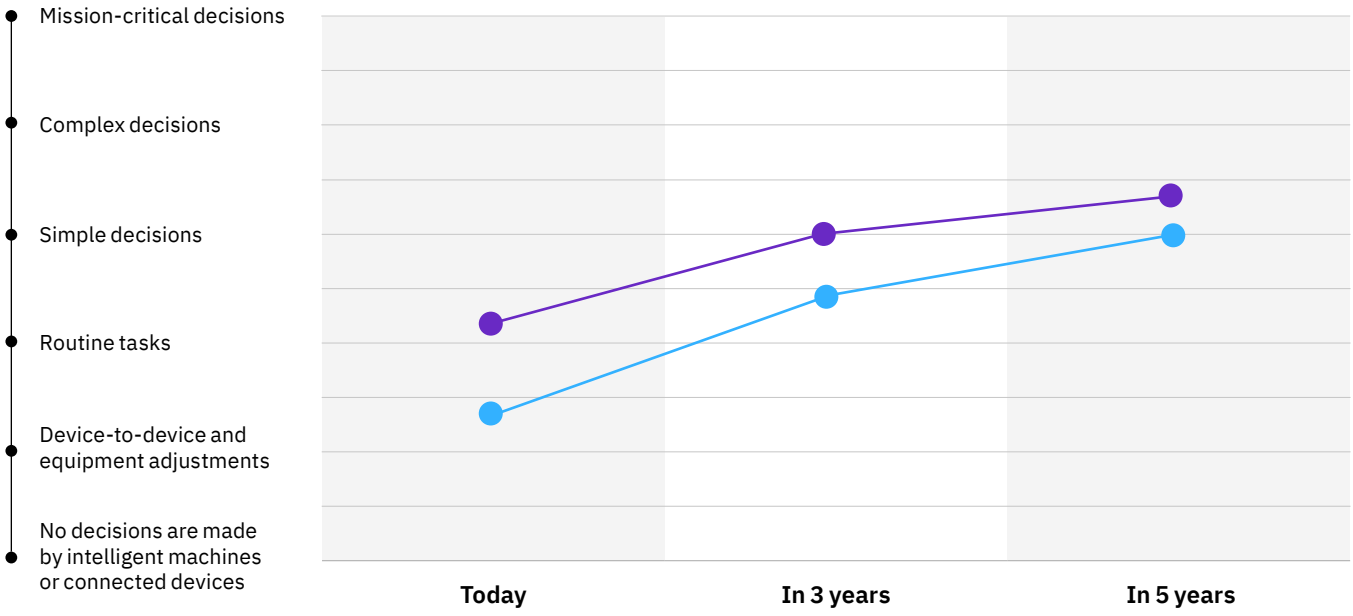
Their investments have paid off. Edge Disruptors say their organizations' investments in edge computing today contribute to 1.6% of their profitability versus 0.7% for their cohorts.

In addition, Edge Disruptors are leaders in deploying intelligent machines to make decisions (see Figure 3). Today, they allow intelligent machines and connected devices to make simple decisions, compared with their peers who use them for routine tasks. Over the next 5 years, Edge Disruptors expect intelligent machines to make complex decisions.

Figure 3

A smarter way

Edge Disruptors expect to use intelligent machines to make harder decisions.



Q. Highest level of decision making that your organization allows intelligent machines and connected devices to perform today, in 3 years, in 5 years. n=140

Embrace complementary technologies

Edge Disruptors recognize they need to evolve from a centralized cloud approach to edge computing. Two-thirds confirmed this, compared with just 44% of their peers. As more data is processed on the edge, less data needs to traverse the cloud, thus decreasing data latency and energy consumption and increasing levels of automation and responsiveness.

Edge computing enables faster, less restrictive data analysis, allowing for deeper insights, faster response times, and improved customer experiences. Powered by edge and AI, devices and machines can interpret data patterns and make decisions instantaneously; they can quickly act and even learn. Edge Disruptors lead the charge in embracing complementary technologies (see Figure 4).

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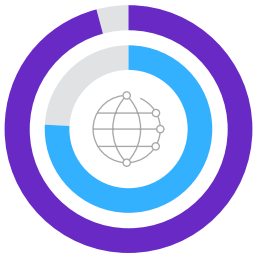
Figure 4

Joining forces

More Edge Disruptors today invest in technologies that complement edge—and get more in return.

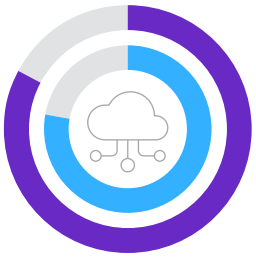


96% | 76%

Internet of Things

ROI

30% 18%

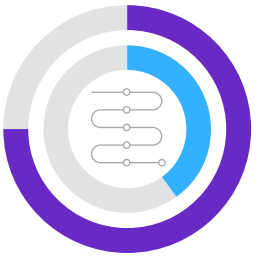


83% | 78%

Cloud computing

ROI

43% 26%



75%* | 40%

Robotic process automation

ROI

69%* 43%

Edge Disruptors | **All others**

* Results using low counts are statistically unreliable but can be considered directional.

Q. Which of the following new and emerging technologies is your organization investing in today?; Q. What return on investment do you expect to achieve for each of the technologies in which your organization is investing? n=140

A chemicals company: Improving productivity and safety with site-traffic visibility[12]

A major North American chemicals company faced a threefold increase of people on a construction site, plus an aggressive construction timeline. It wanted to build a traffic management system to help improve construction productivity and reduce the overall risk of project delays.

Using edge computing, the traffic management solution provides construction workers with visibility into congestion and shuttle bus arrival times on the site, empowering workers to make better decisions. It also provides a range of traffic insights to enable better traffic planning and traffic safety reports for health, safety, security, and environment (HSSE) management.

Taking just 3 months to implement, the solution provides $6 million in productivity savings. It will also help reduce costs due to non-productive overtime and mitigate delays to deliveries, ultimately benefiting the overall construction schedule.

Edge can combine effectively with numerous complementary technologies. Edge computing plus IoT helps reduce costs with AI monitoring machinery conditions and adjusting to optimize usage. Motion, temperature, and climate sensors can change environmental controls to more efficiently use energy in manufacturing operations. Edge and cloud computing work together to address an organization's needs for computing options. Big data can be operated on the cloud, while localized, instant data is computed and operated on at the edge.

Finally, edge and robotics or robotic process automation can drive automation in equipment, devices, and processes that support production operations. Robots that gather and transmit data through an edge network using IIoT devices can identify irregularities and eliminate inefficiencies.[13] Edge also can automate IoT device predictive maintenance and reduce downtime.

Focus on select applications

Edge Disruptors share some commonalities with their peers in how they use edge computing today (see Figure 5). Edge has permeated their production processes, enabling productivity and agility improvements through sensor-based manufacturing. Not surprisingly, Edge Disruptors and their peers are also taking advantage of energy-efficiency management and its benefits.

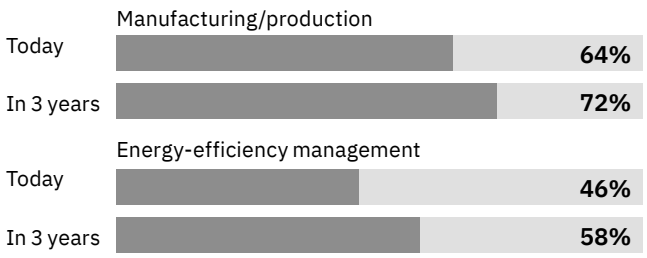
But Edge Disruptors have taken it a step further. They're starting to look at faster responsiveness through inventory management and the ability to adjust their operations based on real-time information. In 3 years, Edge Disruptors will focus on edge's impact on asset utilization through predictive, condition-based asset and equipment maintenance systems.

Figure 5

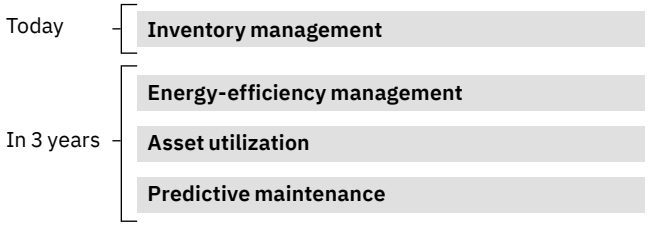
Ahead of the pack

Edge Disruptors plan to do even more with edge computing applications.

Common applications for both Edge Disruptors and all others



Significant differences between Edge Disruptors and all others



Q. For which of the following applications is your organization using edge computing today, in 3 years, in 5 years? Select all that apply. n=140

A specialty chemical provider in the oil and gas industry: Creating an edge-enabled intelligent workflow to differentiate the customer experience[14]

Facing stiff competition, a specialty chemical provider wanted to differentiate its customer experience by using Industry 4.0 digital capabilities. But the company encountered a number of challenges, including a lack of visibility into remote field equipment, a supply chain with manual processes and without proper demand, replenishment and route planning capabilities, and reactive field service.

The company tapped a combination of technologies—edge computing, IoT, mobile, and ERP—to build a supply chain optimization solution and an asset and service management solution. Hardened IoT technology transmits operational data via satellite/cellular to an IoT platform, which then passes data to the two solutions.

The supply chain optimization solution uses consumption data to automate replenishment planning, set inventory levels, and plan routes. The asset and service management solution uses asset operational data to predict failures and schedule preventive maintenance. Engineers use equipment performance metrics to engineer higher-performing and reliable equipment.

The combination of customer forecasts and historical usage creates a multi-week view of deliveries visible in the customer portal. The ERP system integrates with other systems to provide bill of materials, customer data, deliveries, and invoices. With mobile access, the customer portal aggregates deliveries, invoices, maintenance schedules, and modeling requests and makes them all visible to the customer and client.

In the future, the company will be able to combine asset operational data with customer operational data to determine true product performance and track deliveries in near real time. It also will be able to integrate the plant to improve performance and closely align with short- and long-term demands.

Action guide

The edge computing advantage

Edge computing is transforming how organizations manage, process, and leverage data. Chemicals, petroleum, and industrial products organizations need to position themselves today to embrace edge computing's promise for tomorrow.

1. Power and enhance data transfer.

- Explore and scale new technologies to power devices on the edge.
- Monitor evolving use cases for applicability to your organization's requirements. Use cases can include machine-to-machine security validation, blockchain for enhanced ledger-based communication between edge devices, and the use of 5G/private cellular to enhance advanced edge computing capabilities.
- 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 simply collecting data from every interaction —human, IoT, machine, and integrated—to using it to generate insights. Assess and prioritize the insights that deliver the most value.
- Identify underserved users and determine 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.
- Run advanced asset optimization in real time. Core cloud-based analytics are now being streamlined 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.

- Use edge capabilities for more immediate 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 a competitive advantage 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, nodes, on-premise servers, and hybrid cloud platforms.

6. Win big: Differentiate with speed.

- Investigate potential use cases where the combined power of 5G/private cellular and edge computing can drive innovations, 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 round-trip cloud issues and enabling real-time actions.

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Study approach and 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. This report focuses on the 140 chemicals, petroleum, and industrial products respondents.

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 the successful and accelerated implementation of edge computing. Edge Disruptors (17% of the chemicals, petroleum, and industrial products respondents) 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% ROI.

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