EDGE COMPUTING IN THE IOT

FORECASTS, KEY BENEFITS, AND TOP INDUSTRIES ADOPTING AN ANALYTICS MODEL THAT IMPROVES PROCESSING AND CUTS COSTS

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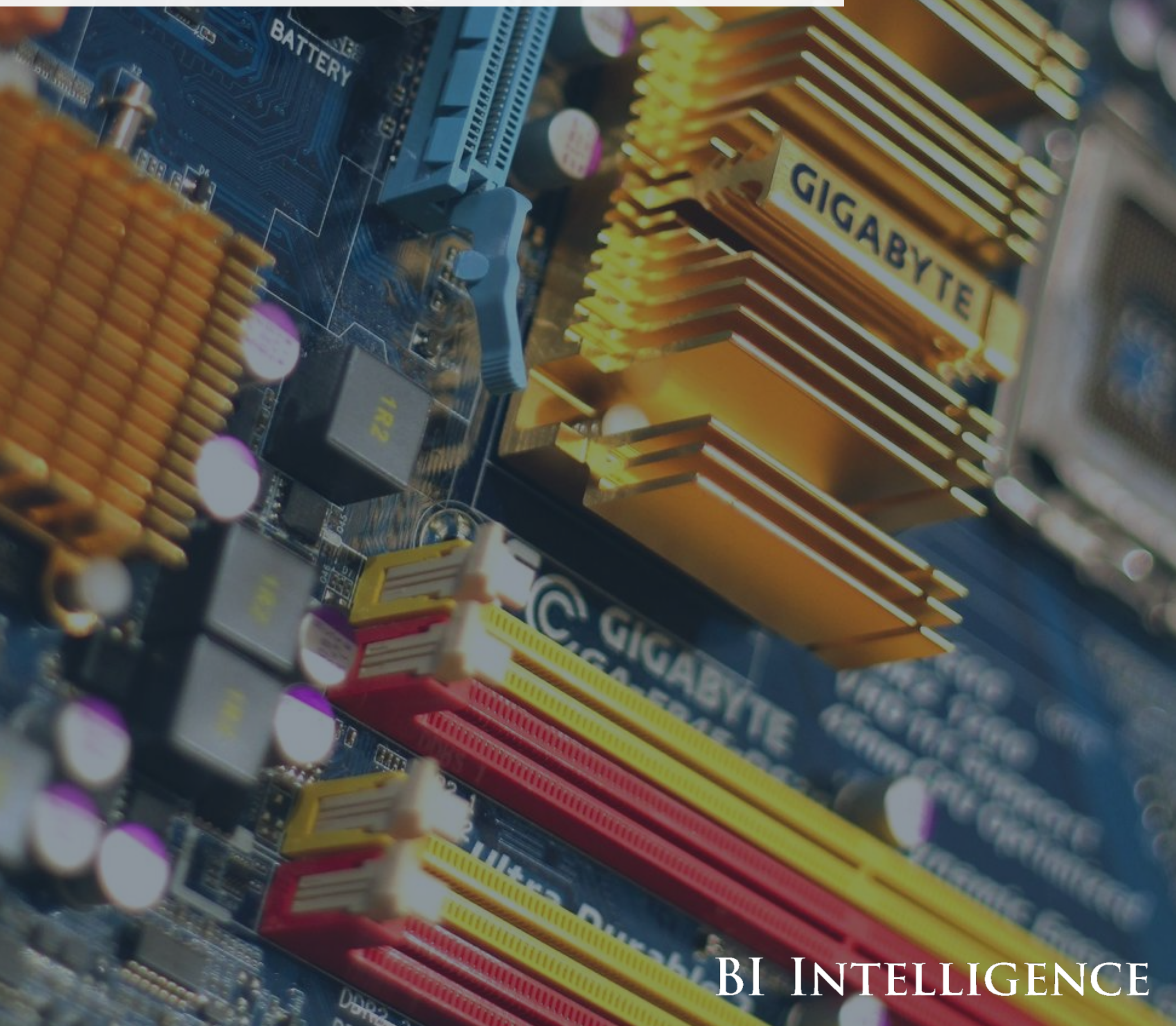
Jonathan Camhi | Research Analyst



BI INTELLIGENCE

KEY POINTS

- **Edge computing is becoming an important new technology within the IoT.** It provides a means to collect and process data at local computing devices rather than in the cloud or a remote data center.

- **We estimate that 5.6 billion IoT devices owned by enterprises and governments will utilize edge computing for data collection and processing in 2020**, up from 570 million devices last year.

- **Many IoT devices don’t have their own computing power, and edge computing is often better suited for collecting and processing data from these devices than the cloud.** Edge computing can be accomplished using gateway networking devices, industrial PCs, or micro data centers.

- **The edge computing model is uniquely well suited to IoT applications because of several key benefits.**

    - For large IoT implementations, sending large volumes of data back to the cloud is much slower than processing at the edge, which allows for near real-time analysis of data.

    - Edge computing reduces costs related to operations and data management compared to cloud computing, although it is more expensive to implement initially.

    - The technology also reduces the amount of data sent back to the cloud; this helps keep data from choking up networks.

    - Edge computing can ensure that other IT assets stay operational even when one device malfunctions because processing is distributed across multiple devices.

- **Because of edge computing's benefits across large-scale IoT implementations, we expect that the manufacturing, utilities, energy, and transportation industries will be the fastest to adopt the technology.** These industries will be followed by smart cities, agriculture, healthcare and retail.

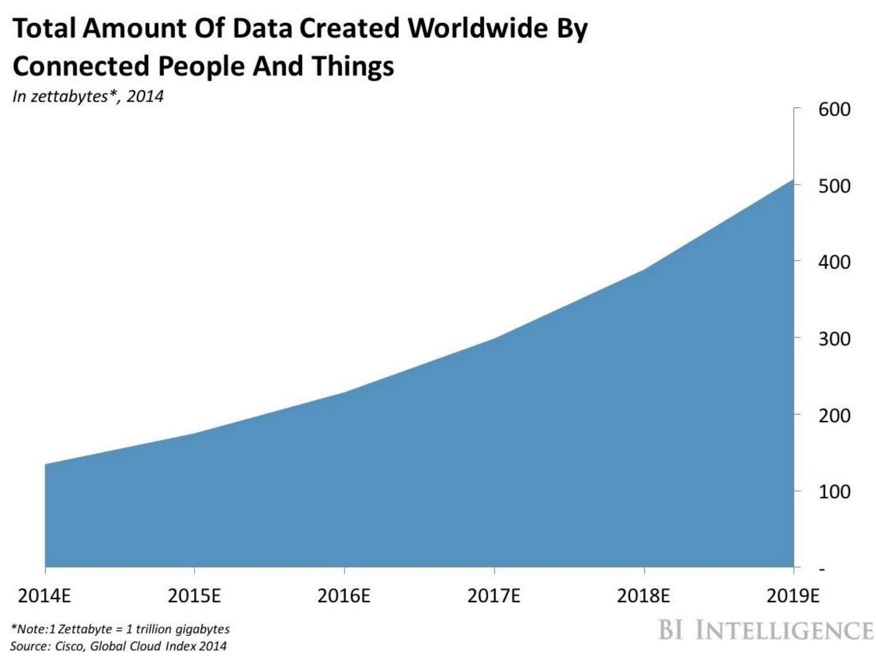
- **There are some key challenges, though, that will need to be overcome for edge computing to take off.** Deploying edge computing for IoT devices can be a complicated task, but emerging standards could help simplify deployments.

Download the charts and data in Excel »

WHY EDGE COMPUTING IS SET TO TAKE OFF

For businesses, the most important benefit of the IoT will be the data generated by billions of new smart sensors and devices. The “Internet of Everything” — all of the people and things connected to the internet — will generate 507.5 zettabytes (1 zettabyte = 1 trillion gigabytes) of data by 2019, according to [Cisco](). Managing, sifting through, and analyzing so much data will be a massive challenge for organizations. But that data analysis will be essential if IoT initiatives are going to provide the insights to drive greater productivity and revenues.

Right now, most of this data management and analysis is performed in the cloud or enterprise data centers. However, several IoT technology providers are promoting a different model called edge computing, or “fog computing,” for the IoT. In an edge computing model, sensors and connected devices transmit data to a nearby edge computing device, such as a gateway device (a networking device like a switch or router) that processes or analyzes the data, instead of sending it back to the cloud or a remote data center.



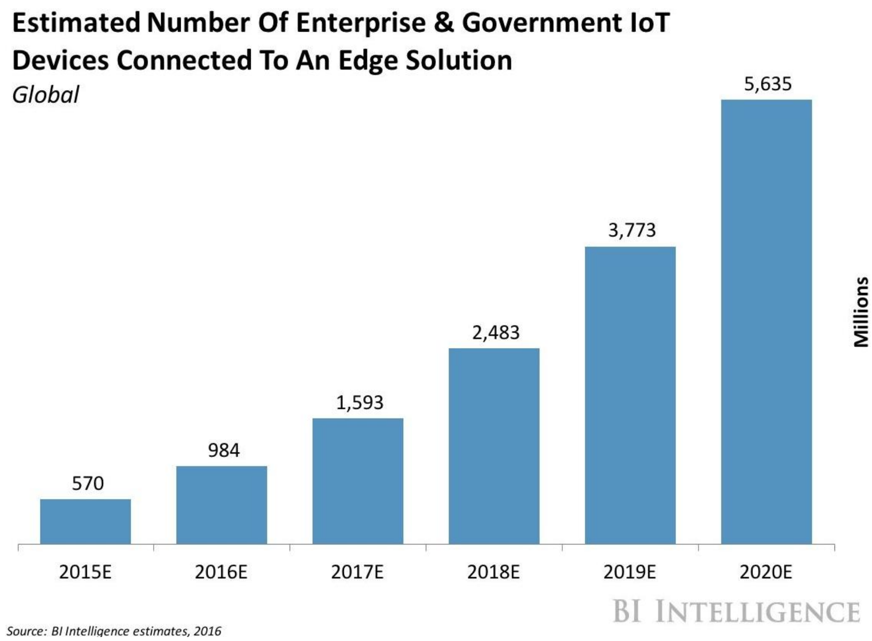
Edge computing provides several benefits for IoT deployments over a cloud computing model, including faster data analysis, lower costs related to data transmission, storage, and management, as well as improved network and application reliability.

The number of IoT devices that are connected to edge computing solutions will grow rapidly in the next few years.

- BI Intelligence expects that more than **5.6 billion enterprise and government IoT devices worldwide will utilize edge computing solutions in 2020 to collect and process at least some of the data they produce, up from 570 million devices in 2015.**

For this estimate, we examined future installation plans among the industries likeliest to adopt edge computing, including manufacturing, agriculture, mining, and oil and gas, among others, alongside reported adoption levels for edge computing solutions within these industries so far. We also looked at company reports from some of the top edge solutions providers including Cisco, Schneider, and IBM, and their projections for the future potential of the edge computing market. We then calculated edge computing penetration as a share of our IoT device adoption forecast.

As edge computing takes off, many data and analytics processes will shift from the cloud to the edge. IDC predicted last year that **45% of the data created by IoT devices worldwide will be stored, processed, analyzed, and acted on at the edge (instead of in the cloud or a remote data center) by 2019.**



In this report, BI Intelligence forecasts the market for edge computing solutions tied to the IoT and explains the specific benefits and challenges around using edge computing for enterprise IoT data storage and processing. Lastly, we look at which industries we expect to lead in adopting edge computing and how the technology could increase productivity and efficiency in these particular sectors.

DATA ANALYTICS AND THE IOT

To understand edge computing in the context of the IoT, it's important to understand the **three places where data can be collected, processed, and analyzed in a typical IoT deployment.** Each of these locations has specific advantages and disadvantages that will determine how a company decides to handle where data is processed.

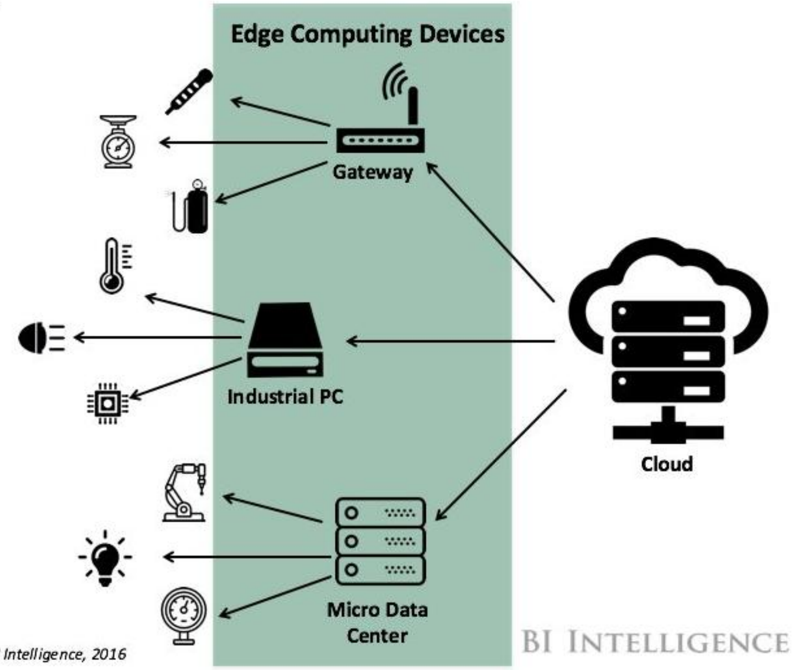
In the cloud: The cloud or a remote data center is currently the most common location for storing, processing, and analyzing data from IoT devices. Many IoT device manufacturers connect their devices back to their own cloud-based applications to process and analyze data. There are many cloud-based IoT software platforms that can ingest, aggregate, and analyze data from a variety of IoT devices, including platforms from cloud services providers like Amazon Web Services and Microsoft Azure, connectivity platforms like Cisco's Jasper, application enablement platforms, analytics platforms, and vertical-specific platforms like IBM's platform for smart cities. And some chipmakers and device manufacturers are even equipping IoT devices with pre-configured connections to these cloud platforms.

At the endpoint: The endpoint is the device that is generating the data — like a self-driving car that's equipped with dozens of sensors and cameras. Self-driving cars come with powerful computers that can collect and analyze all of the data from those cameras and sensors in real time, allowing the car to immediately react to potential obstacles in its surroundings. While it often makes sense to process data at the endpoint, many IoT devices, including the billions of sensors that will be deployed as IoT adoption grows, don't have their own memory or computing power to process the data generated.

At an edge computing device: An edge computing device is particularly useful for enterprise IoT applications. Many types of small, low-power IoT devices used by businesses, including sensors, smart meters, and smart lights, don't have any computing power to process and analyze the data they're generating — that makes analyzing the data at the endpoint impossible. Edge computing is a model in which a central device that has computing power, such as a network gateway device, or industrial PC, collects data from other nearby devices for processing and analysis. A common example of edge computing in the IoT would be a number of sensors deployed around a factory or oil field that are connected back to a network gateway (such as a switch or router) that collects data from the sensors and runs applications to process and analyze it.

Edge Computing Model

2016



Source: BI Intelligence, 2016

These three locations are not mutually exclusive. Many IoT deployments make use of data storage, processing, and analysis at multiple locations. For example, a connected industrial machine in a factory might have most of its data processed at an edge computing device to monitor its performance, while some data is sent to the cloud where it can be aggregated and analyzed together with other operational data.

To address multiple-location use, many software companies that provide applications and analytics tools designed for data generated from IoT devices are tailoring their solutions for deployment, both in the cloud and on edge computing devices.

- IBM recently partnered with Cisco to implement its cloud-based IBM Watson artificial intelligence tools for the IoT on Cisco's edge computing devices.
- Last year, Cisco bought Parstream, a Germany-based startup that offers a software database solution for processing data at the edge in real time.
- In addition, SAP and PTC recently released versions of their respective HANA and ThingWorx software platforms tailored specifically for processing and analyzing IoT data at the edge.

There are three main types of edge computing devices for the IoT:

1. **Gateways:** Gateways have traditionally been networking devices like switches and routers that connect other devices. As such, these networking devices are critical for the IoT, as they'll connect the billions of smart sensors and devices that are projected to go online over the next few years. **But with some additional components, gateways can do more than just connect sensors and IoT devices.** More providers are starting to build “intelligent” gateways that include memory and computing power to store and process the data generated by the devices these gateways connect. Such gateways can also run applications that analyze the data and automate alerts and other functions. Intel, Dell, HP, and Cisco are some of the major companies building intelligent gateways.

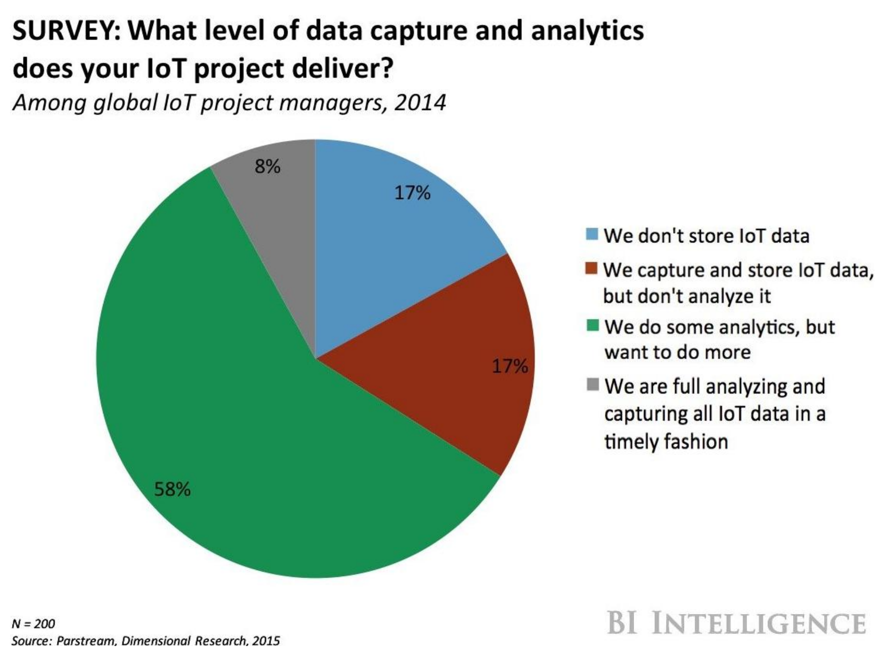
2. **Industrial PCs:** Industrial PCs are computer systems built with rugged components to withstand the conditions of industrial environments like high heat and inclement weather. These durable systems can be housed in stand-alone appliances or embedded in different types of industrial machines. Most run Windows or Linux to process data and run applications for industrial automation. For example, an industrial PC embedded into a power grid’s control system can automate commands to scale the grid’s power output up or down based on current demand. Industrial PCs have been used in manufacturing, transportation, energy, and healthcare for a long time, but the growth of edge computing, in conjunction with the IoT, is expected to boost the market for industrial PCs in the coming years. Some of the largest industrial PC providers include industrial systems providers Schneider Electric, GE, Siemens, and Emerson Electric.

3. **Micro data centers:** Local mini data centers of one to 10 server racks can be placed at a location like a factory to collect and analyze all of the data generated by the factory’s connected sensors and machines. This setup saves money by eliminating the cost of constructing a dedicated data center, and the micro data center can take advantage of the factory’s electricity and cooling, which reduces operational costs. These micro data centers can be configured-to-order and then assembled onsite. In addition, micro data centers can be prefabricated with industrial enclosures to protect them from heat, weather conditions, and corrosion. Schneider Electric, Dell, and Huawei are among the largest players in the market for micro data centers.

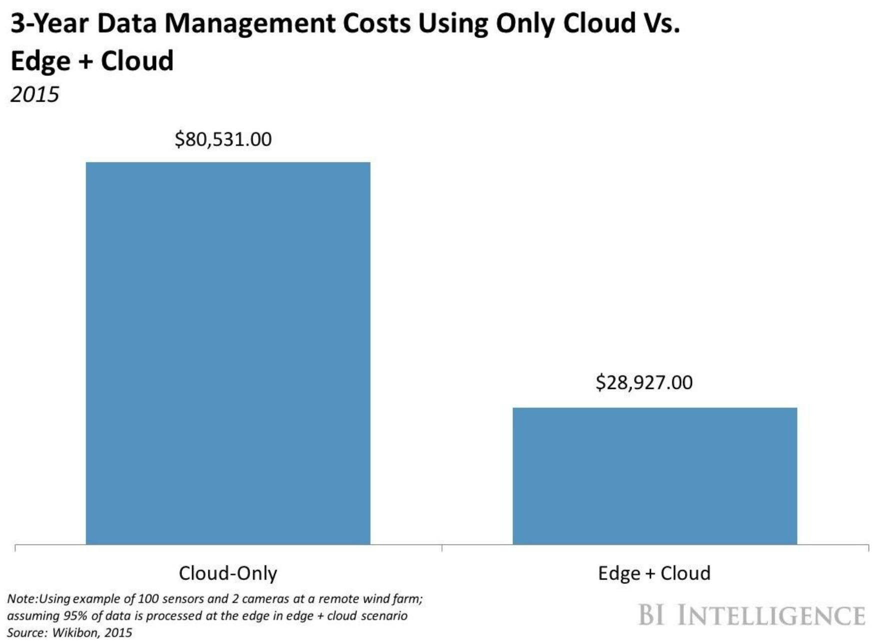
KEY BENEFITS OF EDGE COMPUTING

The edge computing model is uniquely well suited for IoT applications across a number of different industries because of several key benefits.

Lower latency: Sending large volumes of data from connected sensors and devices back to the cloud for analysis takes much more time than analyzing the data at the edge. Edge computing allows for near real-time analysis of data, which is necessary for many IoT devices and applications. For instance, if a sensor sends an alert that a machine on an assembly line is about to break down, that information needs to be acted on right away to prevent costly downtime. Unplanned downtime at a factory can cost up to $20,000 per minute, according to industrial robots manufacturer FANUC. So processing and analyzing the sensor's alert in real time at the edge — rather than in the cloud — could save the assembly line's operator a good deal of money. Only 8% of 200 managers responsible for IoT projects at their companies surveyed by Parstream last year said their company is capturing and analyzing all of the data from their IoT projects in a timely fashion.



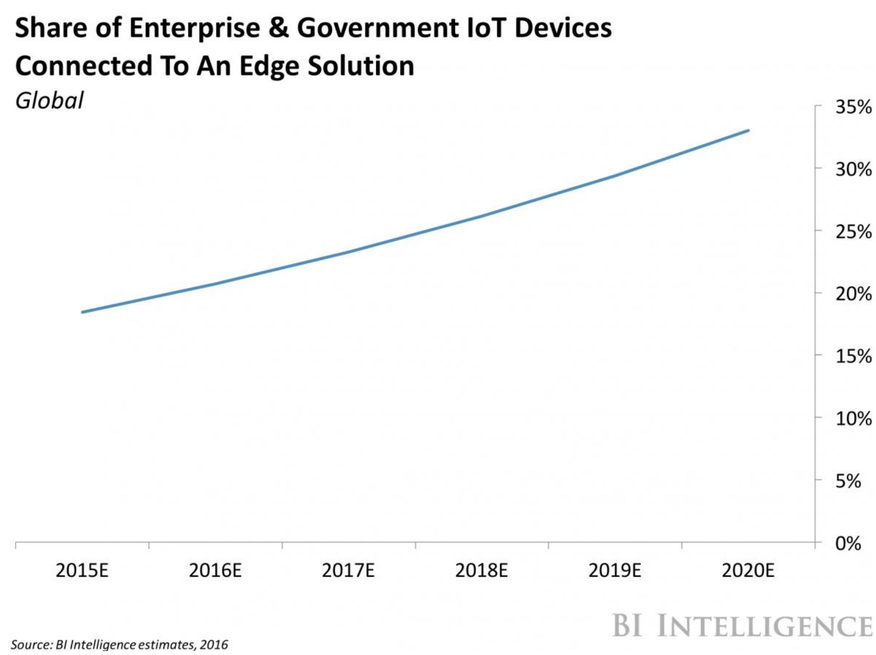
Reduced operational costs: Edge computing reduces costs on operations and data management compared to cloud computing. For example, a small, remote wind farm equipped with sensors and security cameras, processing 95% of the data from those devices on edge computing devices and sending the other 5% to the cloud would cost only $28,900 over a three-year period, according to a study by Wikibon. In contrast, sending all of the wind farm's data back to Amazon Web Services for storage and processing would cost $80,500 over a three-year period, the study found. That's because the wind farm would have to pay per gigabyte for transmitting and storing the data in the cloud. By processing 95% of the data at the edge, it reduces the data transmission and storage costs by nearly 65%. Purchase and installation of edge computing devices are more expensive than implementing cloud services, but Wikibon found that edge computing is worth the investment when it reduces the total volume of data sent to the cloud by 30% or more.



Conserves network bandwidth: Large deployments of connected sensors and devices can generate so much data that it chokes up the networks that transport the data back to the cloud, negatively impacting network performance. Cisco estimated last year that an offshore oil field equipped with connected sensors and machines can generate up to 750 gigabytes of data per week, and connected commercial airplanes can produce 10 terabytes (1 terabyte = 1,000 gigabytes) every 30 minutes. Sending all of that data back to the cloud slows down networks and could cause them to fail. Reducing the amount of data sent back to the cloud by processing it on local edge computing devices eliminates that issue.

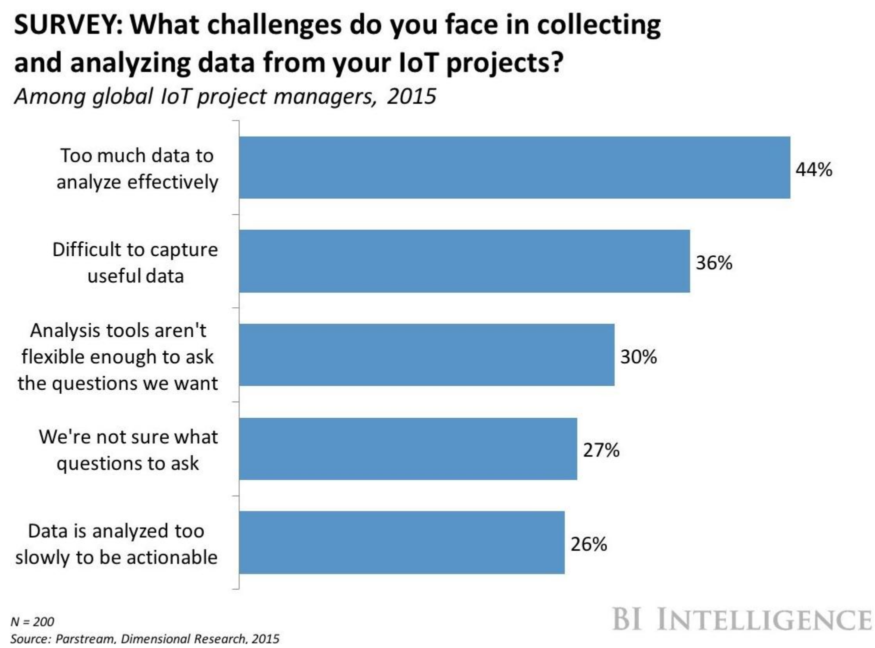
Improved availability of IT assets: In addition to improving network reliability, edge computing can also help ensure that other IT assets are operating reliably, as there is no single point of failure in an edge computing model. In a cloud computing model, a disruption to the cloud caused by some malfunction or a cyberattack could cause the enterprise to temporarily lose access to all data and applications running in the cloud at the time. In contrast, enterprises typically deploy multiple edge computing devices to handle data collection and process workload. Since the data and applications are distributed across multiple devices, if one device fails, the others can continue to operate.

Together, these benefits will drive more organizations to use edge computing for collecting and processing their IoT data. **We estimate that the share of IoT devices owned by governments and organizations connected to an edge computing solution will grow from 18% last year to 33% in 2020.**



TOP INDUSTRIES LIKELY TO DEPLOY EDGE COMPUTING

Advantages related to cost, latency, and network bandwidth make edge computing best suited either for IoT implementations in which companies generate huge piles of data that require connecting devices in remote locations, or that involve distributing devices over large geographical areas. For this reason, we believe the industries that will adopt edge computing for the IoT most rapidly are the industrial sectors including manufacturing, energy, utilities, and transportation. We see other sectors in the IoT, including smart cities, agriculture, healthcare, and retail, adopting edge computing eventually as well.



Manufacturing: IoT deployments in the manufacturing sector tend to involve large numbers of connected sensors and devices that produce very large amounts data, which can be extremely valuable to manufacturers. For example, GE equipped one of its factories in Schenectady, NY with more than 10,000 sensors that track operations and conditions on the plant floor as part of an IoT initiative. Sending data from so many devices back to the cloud would cost a great deal of money, making this kind of large-scale deployment a perfect fit for edge computing. Being able to quickly analyze many diverse streaming data sources could produce up to $371 billion in savings and new revenue opportunities for the global manufacturing sector, according to Microsoft.

Energy: Energy production involves assets like oil wells, gas pipelines, and wind farms that are typically built in remote locations. Such remote locations often have limited network connectivity, meaning there isn't enough bandwidth to transport large volumes of data. Additionally, using edge computing in these locations for data collection and processing can deliver real-time insights that enhance productivity. For example, Envision Energy, one of the world's largest wind energy producers, implemented a hybrid computing model combining data collection and analysis at the edge, in the cloud, and in its own central data center to analyze data from more than 3 million sensors at the company's geographically dispersed wind farms. This allowed Envision to cut the time it took to analyze data from the sensors from 10 minutes down to a few seconds, leading to a 15% increase in the amount of energy produced by its wind farms.

Utilities: Utility companies have to collect large volumes of data to monitor power distribution networks and water pipelines. The 46 million connected smart meters installed in the US produce 1.1 billion different data points that utility companies must process every day, according to Cisco. In addition, utility companies also have to monitor data from their distribution networks, substations, power plants, and other assets. Some of this data has to be acted on urgently: If an alert indicates that the power grid might go down, the utility has to be able to respond immediately. So utilities will need to make use of edge computing for faster data analysis and response times.

Transportation: Rail companies, in particular, can benefit from the faster data analysis and response times that can be achieved with edge computing. Outfitting trains and railway infrastructure with sensors can provide warnings of any malfunctions or performance issues. And rail companies need to be able to process and analyze data from those sensors as quickly as possible to prevent accidents or delays. Railway companies are already installing gateway devices to provide Wi-Fi connectivity in their trains, so it would be a natural progression for them to upgrade to intelligent gateways that can also collect and process data from sensors installed on the trains.

Later Adopters

Besides the industrial sectors, several other industries should benefit greatly from edge computing within the IoT. However, these sectors will likely adopt IoT solutions more slowly than the industrial sectors, so it will be some time before they're generating the huge volumes of data that make edge computing a worthwhile investment.

Smart cities: The public sector will likely take longer to adopt edge computing for smart cities projects because municipalities typically have tight IT budgets and slow technology procurement processes. However, smart cities will eventually stand to benefit from edge computing because of the massive volumes of data that they'll have to collect from huge sensor networks that monitor traffic, pollution, crime, and energy and water use.

Agriculture: Similar to smart cities, the agricultural sector will gradually install large sensor networks that will produce piles of data about weather, soil, and crop conditions. Processing that data at the edge will be cheaper and provide faster alerts about potential problems that could cause crop failure.

Healthcare: Hospitals and other healthcare service providers will need to process data in real time from connected medical devices used to monitor ill patients. Sending such data back to the cloud for analysis could take extra time and possibly prevent healthcare providers from delivering the proper care when needed.

Retail: Retail stores are implementing cameras to monitor security and operations. These cameras will create large volumes of streaming data that will need to be analyzed rapidly for security alerts and instant insights into customer traffic and inventory. A single retail store with $20 million in annual sales with 100 connected cameras on the premises would save more than $33,000 annually by processing the cameras' data at the edge instead of in the cloud, according to Cisco.

CHALLENGES TO EDGE COMPUTING ADOPTION

The biggest challenge right now around implementing an edge computing solution is that it tends to be much more complex to implement than simply sending all of the data back to an existing data center or to a cloud service provider. For each individual IoT deployment that utilizes edge computing, an enterprise has to account for a number of factors, including:

- Enterprises may have to program their software applications to work on different types of edge devices, ones possibly running different operating systems and connecting to IoT devices over different networking standards such as Bluetooth, Wi-Fi, or Zigbee. This can be a very difficult task.
- Enterprises need to set parameters for how applications at the edge will sift through all of the data collected and prioritize different data points, alerts, or notifications. For instance, an application running on an edge device in a factory might collect data from a variety of different sensors measuring conditions in the factory and performance across different machines. The application will need to know which information from which sensor is important to process first. Such parameters will have to be tailored for each and every IoT deployment.
- Almost all edge computing deployments will be connected back to a data center or cloud server, as well — some data will be processed and stored at the edge, and some at a data center or in the cloud. For each IoT deployment that uses such a “hybrid” or “converged” computing model, the enterprise will need to figure out how to distribute data storage and processing between the edge devices and the cloud or data center. A number of different factors could influence that distribution including cost, latency, bandwidth, and security. Additionally, enterprises may have to account for data privacy regulations that might require certain data be stored and processed in a centralized data center.
- Each edge computing device could connect to a multitude of different sensors and devices, and run multiple applications. Identifying, tracking, and managing many IT assets is a cumbersome task for an IT department. At the same time, failure to properly identify and manage all of these assets could lead to application and service outages, decreased productivity, and potential vulnerabilities that hackers could exploit.

Developing open standards for edge computing around software architecture, security, and management would help solve some of these complex issues, and there are groups and individual companies working on such standards. For example, Cisco, ARM, Dell, Intel, and Microsoft forged the OpenFog Consortium late last year to develop standards to alleviate the pain points around deploying edge computing for the IoT.

Until these issues are resolved, it will remain easier for companies to handle their data storage and processing for IoT deployments in the cloud. And cloud software platform providers are likely to resist the shift toward edge computing because it will decrease revenue from storing and handling data for their enterprise clients. AWS, for instance, launched its own IoT platform last year built around storing, processing, and managing data in its cloud services.

Despite these challenges, companies in the industrial sectors are already shifting more of their IoT data storage and computing to the edge because of the long-term costs of sending high volumes of data to the cloud. As adoption increases in these sectors, it will provide lessons around edge computing deployments and strategies that other companies can copy. Over time, we expect that such lessons, combined with open standards, will remove a great deal of the complexity related to edge computing, leading to increased adoption across a wide range of industries utilizing IoT technologies.

THE BOTTOM LINE

- Edge computing provides a means to collect and process data at local computing devices rather than in the cloud or a remote data center.
- We estimate that 5.6 billion IoT devices owned by enterprises and governments will utilize edge computing for data collection and processing in 2020.
- Edge computing is often better suited for collecting and processing data from IoT devices than the cloud. Edge computing can be accomplished using gateway networking devices, industrial PCs, or micro data centers.
- The edge computing model is uniquely well suited to IoT applications because of several key benefits, including near real-time analysis of data, lower costs related to operations and data management, reduced data sent back to the cloud (and, therefore, less constricted networks), and the assurance that other IT assets remain operational even when one device malfunctions.
- We expect that the manufacturing, utilities, energy, and transportation industries will be the fastest to adopt the technology. These industries will be followed by smart cities, agriculture, healthcare and retail.
- Deploying edge computing for IoT devices can be a complicated task, but emerging standards could help simplify deployments.

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