GUIDE

IoT at the edge: Enabling Equipment-as-a-Service business models

New opportunities for manufacturing leaders

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Introduction/Executive Summary

IoT at the edge represents a step change in IoT. IoT has moved away from the old model of processing all IoT data in the cloud, which limited its role to monitoring and reporting. Processing data at the edge enables local control and automation. With the growth of 5G offering broadband-like connectivity to IoT devices, enterprises will be able to process data close to more connected "things" than ever, with higher bandwidth and lower latency. As a result, IoT at the edge will transform IoT in enterprise operations.

The aim of this report is to explore the wide range of opportunities that IoT at the edge opens for smart equipment makers. This report is aimed at enterprise users of IoT in the industrial sector, as well as IoT application, product, and solution developers. The content below summarizes market insight from Beecham Research's Report, IoT at the Edge: Enabling the Real Time Enterprise, with a specific focus on the industrial sector. In the first section, we present Beecham's original research and publicly available research from other named sources. In the second section of the report, we present the view from Software AG based on extensive experience with edge deployments and customer success stories.

Read on to see why the industry is so excited about the potential for IoT at the edge, as well as challenges and opportunities for smart equipment manufacturers. Industrial leaders are getting early wins with IoT at the edge and moving up the maturity ladder, starting with remote monitoring and progressing to smart maintenance, performance management, and offering Equipment-as-a-Service (EaaS). Those that can use remote insights and real-time information will be able to develop smart, connected products that work more effectively, find new ways to serve customers, and build a strong moat around their business.

Foreword – Beecham Research

Beecham Research has specialized in the development of the rapidly-growing connected devices market for over 20 years. We see edge computing as a particularly important next step in the evolution of the IoT market and of IoT solutions to meet enterprise needs. As the market statistics in this report show, IoT at the edge is enabling new IoT applications for a range of use cases. There are several applications where it is already a vital part of enterprise strategy, and this will grow as industrial firms need to adopt more real-time methods of operation.

The four key advantages of edge computing

For equipment makers, the IoT represents a disruptive market opportunity to add new value for users of their products. Why is IoT at the edge a key enabler for new solutions and services? Compared to traditional IoT where data is processed in a data center or in the cloud, edge computing for IoT has several characteristics that help manufacturers offer new services and transform their relationship with customers:

1. **Latency:** Edge computing moves application workloads to edge servers (also called nodes) to process the data close to where it is collected—and close to where action needs to be taken—instead of processing data in the cloud or at a distant data center. Processing data close to the source enables faster analytics results and the ability to trigger an immediate response.
2. **Performance:** Running decision-making and control algorithms closer to the edge sensors can improve control and enable manufacturing customers to gain greater insights and finer control over industrial assets. And edge computing opens new possibilities for IoT applications in areas with limited network connectivity.
3. **Security:** Perhaps counterintuitively, edge computing can enhance security compliance even though the devices are distributed across a wide area. By processing data close to the source, edge computing reduces the sharing of sensitive information and can help maintain high levels of data security, as well as compliance with data sovereignty regulations.
4. **Cost:** By reducing the volume of data sent to the cloud, companies can reduce their spending on bandwidth and cloud computing.

How to define edge computing

Edge computing is a distributed IT architecture that moves computing resources as close as possible to the source of the data, as opposed to processing data in the cloud or in data centers.

The increasingly important role that the edge plays in the IoT environment is reflected in the number of terms that are employed. They include *far edge* and *near edge*; *thin edge*, *thick edge* plus the *network edge*; and then there is *fog computing*, which acts as a mediator between the edge and the cloud. The term *edge continuum* is used to articulate how the requisite compute resources can be distributed for optimal processing; from cloud and private data centers to edge systems and devices.

- The far edge is the infrastructure deployed in a location farthest from the cloud data centers and closest to the users: devices and sensors but also cell towers. The near edge is the infrastructure deployed between the far edge and the cloud data centers, nearer to the central offices of telecoms.
- In thin edge computing (also called constrained edge), less processing occurs at the point of sensor data collection. Thin edge often involves battery powered sensor or devices used for applications producing limited quantities of data, such as tracking.
- Thick edge refers to applications and devices using large quantities of data and/or requiring significant computing capabilities. The IoT sensors and devices are connected to network nodes running edge applications close to where the data is collected, i.e. the network edge.
- Fog computing and edge computing are both about processing data closer to the source—a significant difference concerns the place where processing occurs. Fog computing is an extension to cloud computing typically deployed in local cloud hubs, such as regional hubs or radio access networks. It acts as a mediator between the edge and the cloud.
- Edge computing brings performance, latency, cost, and security advantages to industrial IoT solutions. For manufacturing customers, this real-time data processing is a key enabler for advancing more sophisticated business models.

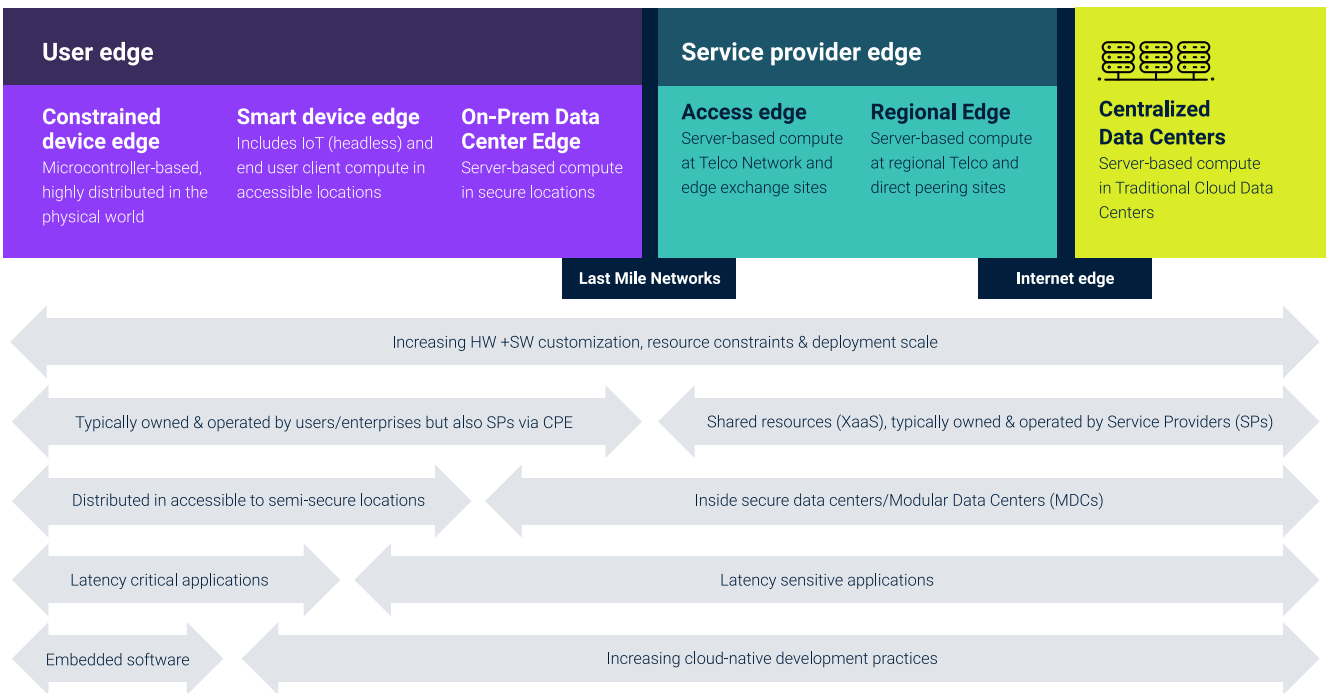


Figure 1: Definitions of edge computing, as provided by the Linux Foundation. Note that different sources segment the edge in different ways and may use alternative terms.

Value drivers for edge

How can IoT at the edge unlock value for both equipment manufacturers and end users? Consider traditional non-networked products: profit to the manufacturer comes from the one-time sale of the product, and the equipment maker has a limited relationship with the customer. The only two times the manufacturer and customer might interact are when the product is sold, and when it breaks. The customer has limited insights into, and control over, equipment performance.

Now contrast this with a networked product, which offers an opportunity for insights and control throughout the life of the product. Manufacturers can offer many services with the product based on the customer's priorities and their own experience offering connected devices. The starting point for almost all IoT projects is remote monitoring. The second level is analyzing that data, for example to predict potential failure, apply predictive maintenance, and minimize downtime. The third level is real-time decision support, where data is provided in near real time for operational decision-making.

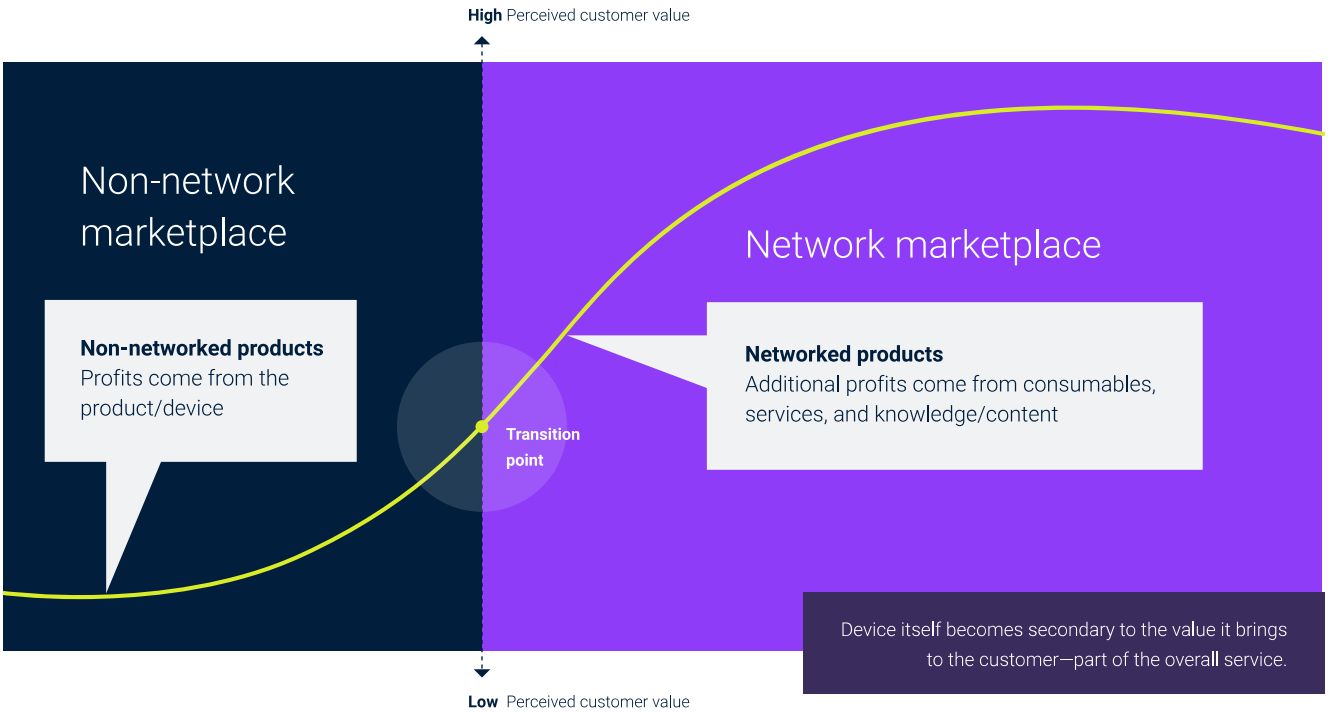


Figure 2: Connectivity drives new value to customers. Source: Beecham Research

The ultimate opportunity for manufacturers is to offer their product and services in a combined package—Equipment-as-a-Service (EaaS). All maintenance and running costs are incorporated into the EaaS charge, turning CapEx into OpEx and helping the customer reduce up-front costs and get more value from equipment. For the equipment maker, EaaS represents an opportunity to compete in terms of both product and a range of services surrounding the product, as well as an opportunity to develop closer, ongoing relationships with customers throughout the product life cycle. As a result, an equipment maker offering products and services together as a package has major commercial advantage.

Edge is necessary for these new capabilities and business models because it solves the challenges of processing IoT data in the cloud or a far-off data center. With edge computing, IoT data can be processed faster, which unlocks new opportunities for performance optimization. It improves security with local control. And it reduces networking costs by sending only the necessary data to other business applications.

> Is the market ready for IoT at the edge? Not particularly. Does the market need it? Definitely. Does this represent a potential competitive advantage in their own markets for first-mover enterprises? Very likely.
>
> - Robin Duke-Woolley, CEO, Beecham Research

IoT at the edge: The user view

Beecham Research reviewed findings from several user surveys on the use of edge computing. Highlights of these surveys, below, demonstrate how customers are currently thinking about this market.

86% of companies surveyed are utilizing edge computing technologies today or plan to deploy in the next 24 months (Eclipse Foundation)

Findings from recent user surveys highlight the growth of edge computing and the strategic importance to industry leaders. The benefits cited are commensurate with the properties of edge computing, which include increased processing bandwidth, immediate access to data through latency improvements, reduced costs associated with connectivity and storage infrastructure, and improved security.

IoT edge is growing in importance and adoption

Published in 2021, the Eclipse Foundation's IoT and Edge Commercial Adoption Survey includes responses from 300 businesses from multiple sectors. The results show that IoT and edge are both growing in importance, as well as adoption.

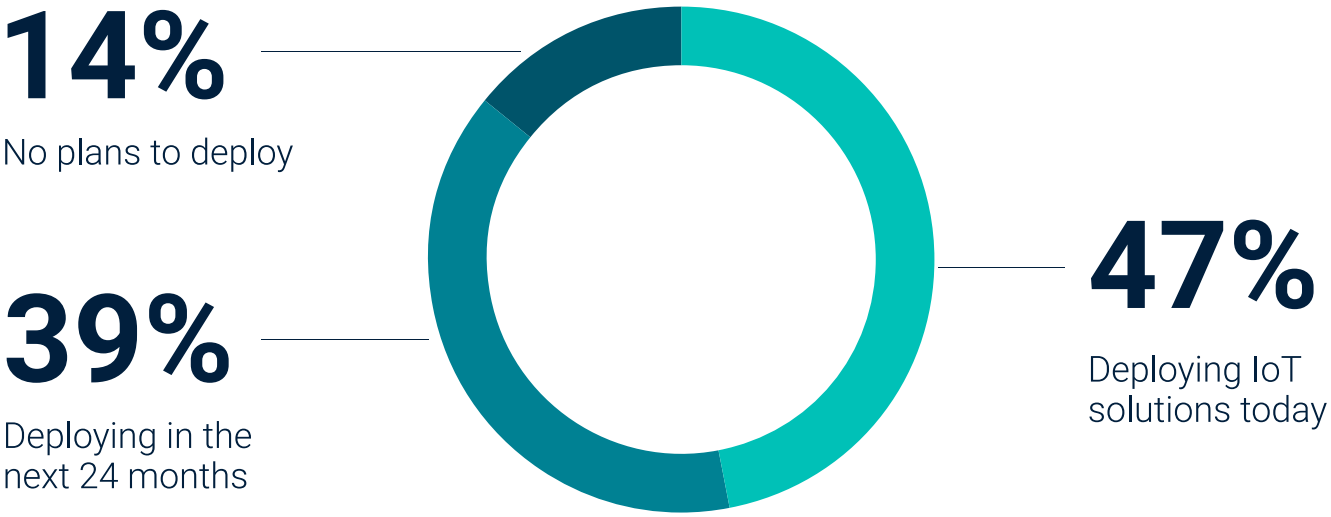


Figure 3: 86% of surveyed companies are already deploying IoT solutions today, or plan to in the next 24 months

Of the companies surveyed, 30% indicated project spending between $100k and $1 million in 2020—a twofold increase over 2019. The size of these investments is all the more significant because over half of companies surveyed employ fewer than 100 people.

In addition, these edge investments are increasingly led by the business, not IT. The survey revealed that 35% of organizations indicated that decisions were being driven by staff at the Senior Executive level, roughly double the rate from the previous year, and major decisions taken by IT personnel were reduced from 26% in 2019 to 21% in 2021.

5G and edge computing advance IoT value

Forrester Research's 2020 report, How 5G And Edge Computing Advance IoT Value, surveyed over 200 global mobility decision makers whose firms, all 1,000+ employees, are implementing edge computing.

Those surveyed say that 5G powers IoT, automation, and edge computing use cases. It enables processing next to the connected device, using ultra-low latency and ultra-high bandwidth, and extends the breadth and variety of supported edge computing use cases.

Biggest benefits of edge computing	
Data doesn't need to be transferred	31%
No Remote Location Connectivity	31%
Faster Response – Avoids Network Latency	27%
Regulations Require Local Control	27%

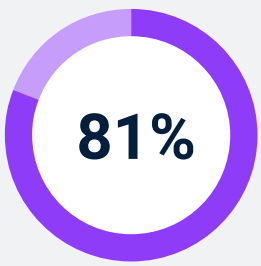
Edge computing is helping these companies solve previously intractable problems by employing solutions such as real-time AI across the physical/digital divide. And for manufacturers, this capability drives increased production and revenue through smart factory applications and value delivery.

Edge disrupters are embracing complementary technologies

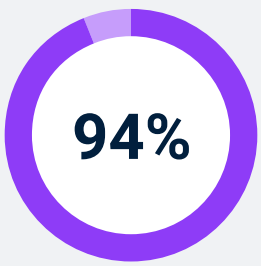
30% of IoT edge distruptors expect an ROI from IoT investments

In 2021, the IBM Institute for Business Value, in conjunction with Oxford Economics, published The Edge Computing Advantage, a survey of 1,500 executives across 22 industries and 21 countries. This report focuses on the 140 chemicals, petroleum, and industrial products respondents.

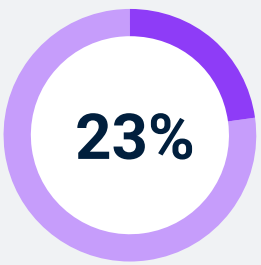
The survey found that leading companies are leveraging edge today. These edge disruptors are embracing complementary technologies including IoT, cloud computing, and robotic process automation. As the technology matures, adoption is expected to broaden quickly: nearly all respondents say their organizations will implement edge computing in the next five years.



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



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



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

Figure 4: IBM's survey shows the growing adoption and value of edge computing

The survey identified a subset of respondents called “edge disruptors,” with a shared characteristic that:

- They expect edge computing will have a positive impact on their organizational responsiveness
- Their edge investments will yield between 15% and 70% ROI in the next three years; and
- 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.

These edge disruptors look to go beyond use cases and align with business objectives. They also expect to use intelligent machines to make harder decisions. And because they invest in technologies that complement edge, they get more in return.

IoT at the edge: The vendor perspective

For its in-depth market survey, Beecham Research interviewed solution providers who are familiar with all components of edge solutions, serving customers spread widely across industry sectors. Interviewees held a wide range of positions, from senior business leaders to niche technical specialists. Here’s a sample of what they said.

1. Latency and privacy are key drivers for edge

Latency and bandwidth are very important in real time applications and IoT devices are growing very fast, generating large volumes of data. We are seeing a big demand in simplifying the deployment and delivery of low-latency applications and the ability to connect edge networks between different regions and providers.

Another driver is security, data sovereignty, and compliance with privacy regulations such as GDPR. Sometimes you need to have data processed and stored in a certain country or region and the edge is great for that.

There is a strong technical case for embedded and edge abilities complementing connectivity, especially as networks become more complex and decentralized solutions are modernizing infrastructure.

> The most prevalent trend is in reducing latencies. You reduce your latency just by having computing and data physically closer to users.
>
> - Computing Service Director of Developer Product and Relations, Startup specializing in global Data Network and Edge

2. Manufacturing has valuable IoT edge computing use cases

Edge has advantages in many verticals, industrial automation, building automation, and retail automation. For manufacturing, asset health monitoring, predictive maintenance, and planning maintenance actions on machines are especially valuable use cases.

> Traditional use cases are isolated on-site solutions, but the arrays of distributed processing solutions are mushrooming.
>
> - System Validation Engineer, ST microelectronics

3. The edge to cloud continuum is key for digital transformation

Edge computing offers several key benefits. Because the data generated locally is processed close to the source, customers no longer need to upload data to the cloud and then download insights later. This reduces the load on the centralized system, lowers connectivity requirements, and potentially improves cost. Whatever subset of data you need to save for long-term storage, or to integrate with other business applications, is readily available.

Edge enables new functions for IoT solutions to deliver value: edge computing can clean data in real time, extract valuable processed insights, reduce reaction times, adhere to local data stipulations, and cut energy and data costs overall.

But it's not entirely either/or: for many firms with connected devices, cloud and edge will co-exist in a hybrid cloud/IoT environment. In addition, edge allows IT and OT communities to work together with new solutions that are geared toward business users, not an IT audience.

> Ease of deployment, in many cases the cloud is very useful and very helpful because you can send anywhere in the world, but the edge provides more flexibility/reactivity in your operations. Edge is where the IT and OT are merging. For example, in the network virtualization, you still need IT and OT to come together so it can work.
>
> - Chief Operating Officer, Edge Computing Virtualization and Orchestration company

4. AI and ML at the edge can drive automation

Automation is currently the number one driver created or enabled by AI. AI and ML are valuable for detecting anomalies: data can be collected from machines that are on the shop floor, looking at patterns and training the machine learning model for patterns that would indicate that a machine is performing in an abnormal way.

> We are seeing AI and ML taking a lot of data, in machinery with temperature sensors and vibration sensors. Running in an AI/ML system allows you to determine if the machine is more likely to breakdown.
>
> - Chief Technology Officer, Edge software solutions company

5. Private networks and 5G will both drive connectivity

Companies looking at IoT at the Edge are mostly working on private networks currently, but 5G will have a big impact in terms of bandwidth to improve the spectrum and bandwidth that is available to enterprises. In this respect, 5G is going to be more like broadband.

5G stand-alone data infrastructure is a software-defined network that significantly raises the performance and capacity bar. There are three generic services that matter most to edge computing applications. With narrowband internet access through massive Machine Type Communication (mMTC) services, 5G can support up to one million devices per square kilometer. With high bandwidth internet access through enhanced mobile broadband (eMBB), it can transmit data at 10 gigabits per second. And with ultra-reliable low latency communication (URLLC), it offers very low (sub-millisecond) latency with low error rates.

With these enabling technologies, 5G operators will be able to provide added services to end-customers, with better ease of use and fewer complexities, to accelerate end-user adoption of both IoT and edge computing solutions.

From a manufacturing and industrial IoT perspective, 5G and edge computing provide a winning combination because it enables low-latency networking of hundreds or thousands of devices in high density environments.

> 4G LTE are often utilized in fleet management use cases. 5G would be particularly suited in more high density environments where you have hundreds of robots working together in factories.
>
> - Director Experience Design, Edge infrastructure

6. Security and enterprise readiness are key challenges

Experts cite two main challenges to adoption of edge computing: physical security of devices and enterprise readiness.

Physical security is the highest challenge because devices are mostly remote, so companies need to take security into account to avoid hacking and malware.

Regarding readiness of companies to adopt edge devices, when companies have grown their IoT and initiated trials, sometimes they encounter difficulties: will devices work together with their numerous compatibility issues? Can operating systems support IoT edge applications?

> Edge is where the IT and OT are merging. For example in the network virtualization, you still need IT and OT to come together so it can work. We see ourselves having to work with the stakeholders in organizations' IT and OT and making sure they are aligned and they agree before we deploy projects.
>
> - Chief Operating Officer, Edge Computing Virtualization and Orchestration company

IoT at the edge: Enabling the real-time enterprise

Research and market surveys have shown that end-users see the value of low-latency data collection and processing at the edge. Today's economy is predicated on the ability to provide customers with what they want, when and where they want it—in other words, real-time insights and action. By radically reducing the elapsed time in business processes, an enterprise can sense and respond faster to events that affect its business.

The ever-growing volume of data is truly a challenge: IDC has estimated that in 2020, 59ZB (Zettabytes) of data was created, which is equal to 59 trillion gigabytes. Firms are looking for ways to capture, process, and act on this data efficiently.

Edge helps firms turn their data into actionable information, at scale, faster than ever. With faster processing of IoT data, firms can see how equipment, fleets, and other "things" are performing in real-time. Even more importantly, they can enhance system performance with targeted interventions.

As a result, edge is shifting IoT's core functionality from monitoring and reporting—a role that was traditionally performed in the cloud—to local control and automation. With IoT data processed at the edge, enterprises can now employ outcome-driven solutions that operate in real-time environments comprised of intelligent devices, intelligent systems, and intelligent networks.

IoT and the intelligent edge

The value of IoT is predicated on the ability to capture parameter and event data and process it into insights. Transforming information into intelligence is increasingly coming from the deployment of machine learning (ML) and artificial intelligence (AI) technologies at the edge as well as in the cloud. Small, power-efficient, and cost-effective AI chipsets can now be embedded in IoT edge hardware. This enables them to function as an intelligent network of small, local data centers, which in turn allows large amounts of data to be processed locally, thereby boosting the amount of information on which operational and management decisions can be based.

Advances in chipset technology have boosted the computing resources of the devices deployed at the edge. This has enabled intelligent edge computing to perform data analysis tasks that were previously undertaken at a central facility such as the cloud. For example, if a security breach is discovered, the ability to turn off a feature in real time becomes a mission-critical requirement. In addition, edge computing enables companies to carry out authentication tasks closer to end users, which is inherently more secure.

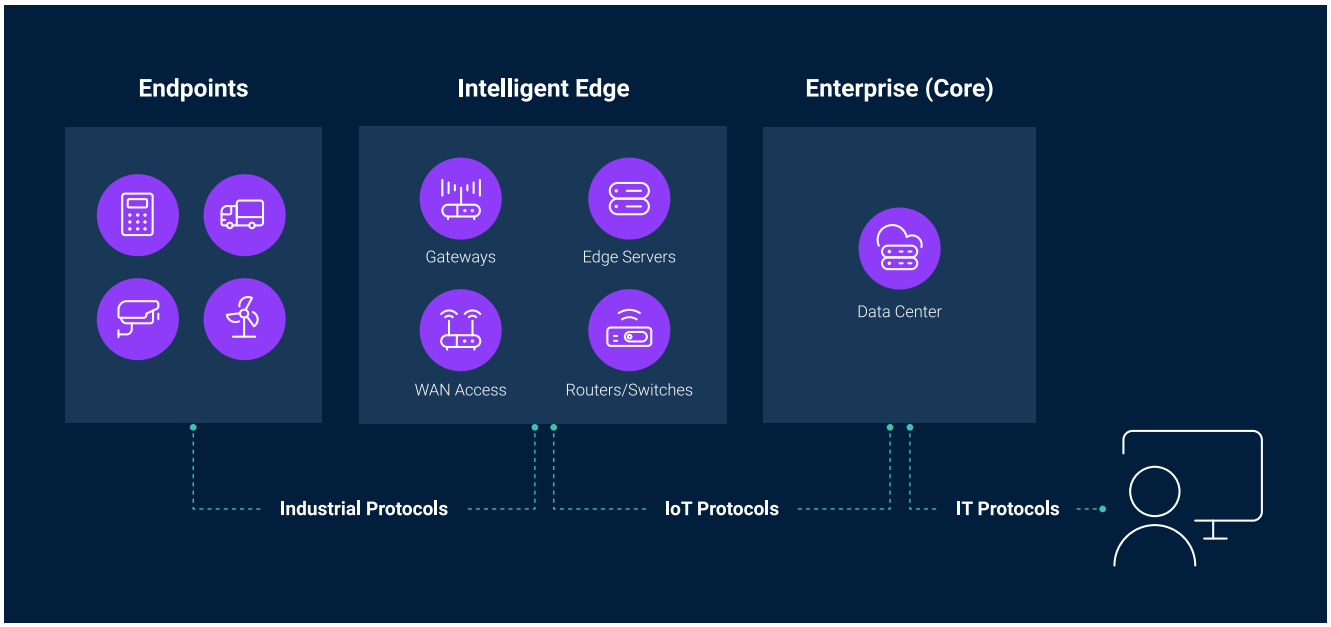


Figure 5: Advances in chipset technology has enabled intelligence, the processing and analysis of raw IoT data, to be provided in near real time at the edge of the network. Source: Beecham Research

The innovations described above are all about the technology. A related development driven by IoT at the edge is the change in the structure of information processing and decision-making in the enterprise. We refer to this as IT-OT convergence: the integration of Information Technology systems (which handle enterprise-wide computing and data processing, usually with batch updates) and Operational Technology systems (which manage and control industrial operations in near-real time). The blending of IT and OT allows organizations to make better use of data generated by IoT devices and edge computing throughout the enterprise. This process is being enabled by deploying a new generation of operational technologies that operate alongside existing enterprise IT systems.

The edge-to-cloud model

The intelligence shift towards the edge of the network enables the centralized cloud to be used for computationally intensive tasks. These tasks can include analyzing bigger data sets from a wider range of sources and employing advanced analytics to gain information on trends. Edge and cloud computing therefore perform complementary, symbiotic roles.

Edge devices only need to provide the results from data that was processed locally, after which it is normally discarded. Only useful, post-processed information is sent to the cloud and stored. The cloud can be used to blend real-time IoT information with up-to-date information from enterprise applications such as CRM and ERP.

Because companies can quickly spin up cloud resources as needed—ranging from infrastructure services, such as compute, storage, and databases, through to IoT, machine learning, data lakes, and analytics—enterprises have greater ability to experiment and test new ideas. In addition, with cloud computing, there is no need to over-provision resources up front to handle peak levels of business activity. Resources can be scaled up or down in line with changing business requirements.

By combining edge and cloud capabilities, companies can use the "edge continuum" to expand their options for collecting, processing, integrating, and acting on IoT information across the enterprise.

How IoT at the edge enables new services and business models

Response by Software AG

Beecham has presented the trends and technology enablers that are helping companies move toward edge computing and its benefits. No longer limited to monitoring and reporting, IoT solutions now enable local control and automation. The research points to exciting ways IoT at the edge will transform IoT in enterprise operations.

In our experience, equipment makers are eager to apply these advances in IoT to accelerate product development cycles, help their customers operate more effectively, and offer services that diversify their revenue. In short, with IoT they're able to make smarter products and generate value faster. For these manufacturers, edge overcomes six typical challenges in industrial IoT:

1. Real-time performance

Real-time actions based on machine data is essential to avoid machine downtime, higher repair costs, or poor product quality, and the roundtrip to the cloud can take longer than the time window for a successful outcome. Edge computing can deliver low network latency and fast response times, a critical advantage when dealing with high value assets where the cost of every minute of downtime rapidly decays value.

2. Unreliable connectivity

Predictable, continuous monitoring is required to ensure that the actions to remotely manage critical industrial equipment is based on a reliable stream of measurements, regardless of the bandwidth or performance of the connection. IoT at the edge can ensure a sequential stream of measurements are received by the remote hub regardless of connectivity bandwidth constraints or intermittent dropouts.

3. Security and confidentiality

Equipment used to manage critical infrastructure, industrial facilities, and emergency services cannot be reliant on cloud infrastructure or public networks alone. With a self-contained edge computing environment, organizations can count on comprehensive computing capabilities embedded in secure environments.

4. Costly connectivity

Some geographic locations have extremely limited connectivity options, which can make the cost of remotely monitoring deployed machines prohibitive, especially if the transferred data volumes are high. Edge can significantly reduce the transferred data through pre-processing the data prior to transmission, sending the processed metrics, and only sending the raw data when essential.

5. Local autonomy

Highly reliable processes require the control of local machines to be based on local measurements and the operation of local actuators, with no dependency on the availability of external compute resources. With the right approach to edge, manufacturers can deploy on-site execution of sophisticated condition monitoring or predictive analytics.

6. Anomaly detection

Trends that indicate the potential for a future problem are often hidden by the massive number of high-frequency measurements generated by modern industrial equipment that is uneconomic to transfer for data analysis offline. Edge solutions can now integrate machine learning models to continuously analyze the data for previously identified failure fingerprints, assess trends, and capture operational outliers.

Beyond tactical edge: EaaS as a strategic differentiator

Those looking at IoT as a strategic enabler are also seeing the potential for edge computing to enable a transition from unit sales of equipment to Equipment-as-a-Service (EaaS). In the EaaS model, equipment and services are bundled to customers in an OpEx model, reducing up-front costs to customers while generating more sustained, recurring value for both equipment users and manufacturers.

Software AG's role in IoT is unique: one of our core goals is to deliver a platform that helps smart equipment makers deliver higher value products to their customers. As a result, we have considerable experience with the needs of both equipment makers and their customers. EaaS is truly a value-adding capability: it has the potential to enhance the business of equipment providers while also aligning equipment with users' needs.

Consider the benefits to customers. With a pay-as-you-use business model, equipment users gain a risk-free method to try new equipment. By accessing equipment through subscription instead of ownership, buyers gain cost transparency, and can eliminate large up-front capital expenses so they have greater financial flexibility to invest in their business. By paying for use instead of ownership, they can also scale operating expenses to match their need for the equipment over any given time period. By shifting responsibility for maintenance to the equipment provider, customers can reduce risk and increase focus on their own operations. All these factors enable customers to reduce total cost of ownership.

Equipment makers also see benefits. EaaS reduces barriers to adoption by making the up-front costs to their customers far lower. Subscriptions can help make accounts "stickier" through long-term relationships. Equipment makers can improve margins by expanding profitable after-sale services and parts, rather than relying on ever-shrinking margins of equipment sales. The increase in after-sales services can more than offset the costs of high asset utilization. With greater control over equipment function and maintenance, equipment makers can also improve the service life of their machines—an important factor in improving environmental sustainability.

EaaS is only possible if the equipment manufacturer stays connected to its smart products. Edge computing is the key enabler that brings data processing, storage, and power closer to IoT devices. With low-latency, reliable, secure data collection, processing and connectivity, manufacturers can offer their equipment as part of a service package that generates insights, enables rapid responses, and unlocks new use cases for their equipment. As such, edge is a critical enabler for manufacturers to deliver value and efficiency through data analytics and real-time controls.

67%

of suppliers are evaluating, planning, or offering EaaS

6.7%

of all equipment in the Service Addressable Market is predicted to be sold as EaaS by 2025

IoT Analytics, Equipment as a Service Market Report 2020-2025. February 2020.

As a partner to manufacturers deploying IoT solutions and moving toward EaaS business models, we have seen both the potential of IoT at the edge and the roadblocks some firms encounter. Anticipating these challenges means you can prepare your organization for the path ahead.

First, consider the business challenges. Pricing an EaaS agreement can be difficult. This is especially true for equipment suppliers who want to move to a unit-based payment model because they must find a new way to define and measure value to the end-user. Embracing EaaS also requires transition to a new business model that has implications for distributor relationships. Manufacturers accustomed to receiving payment up-front for unit sales of equipment must be ready to delay revenue to later in the process, as customers use the equipment and services. Finally, financing is an inherent part of EaaS offerings; equipment providers need to create new relationships with finance institutions to offer a range of agreements for customers to choose from.

Then, consider the technical challenges to moving to an EaaS model. Cost-efficient operation requires sophisticated analytics, integrated with field service and spare parts management. Equipment suppliers need to create additional business metrics to generate trusted equipment usage statistics for accurate billing, and automated billing software to enable more frequent, lower cost payments. In terms of risk management, EaaS suppliers need to assume operational risks that the customer formerly absorbed—so understanding and modeling these risks is necessary. This includes modeling environmental factors such as temperature, vibration, dust level, humidity, and more.

Fortunately, IoT at the edge can help overcome many of these challenges. But every equipment supplier needs to understand the risks, and methods to mitigate those risks, as they pursue the potential of IoT at the edge—especially if they seek to build a successful EaaS business model.

Delivering EaaS: Three phrases of the maturity curve and the role of edge

Because of the challenges laid out above, we have not seen any manufacturer embrace IoT and go straight to an EaaS model. Instead, an enterprise's transformational journey as a smart equipment maker, from initial steps to a fundamental shift in business strategy (i.e. transitioning to an EaaS model), is typically structured in phases of IoT maturity. Edge plays a critical role in each IoT maturity phase of the smart equipment maker.

For smart equipment makers, the advance in technical capability goes hand in hand with the business strategy to offer new value-added services. Read on to see where your organization stands now and learn how to advance your capabilities, whether you're just getting started or have the experience to plan an evolution to an EaaS business model.

Keep in mind that each phase requires significant changes in technology, organization, and processes for the business to successfully exploit the benefits. It's generally not feasible to leapfrog a phase without consequence. Also keep in mind that customers may need time to become familiar with new IoT-enabled services as their manufacturers add capabilities—familiarizing customers with the benefits of IoT at the edge is generally necessary before they will be on board with a manufacturer offering an integrated equipment-and-services package.

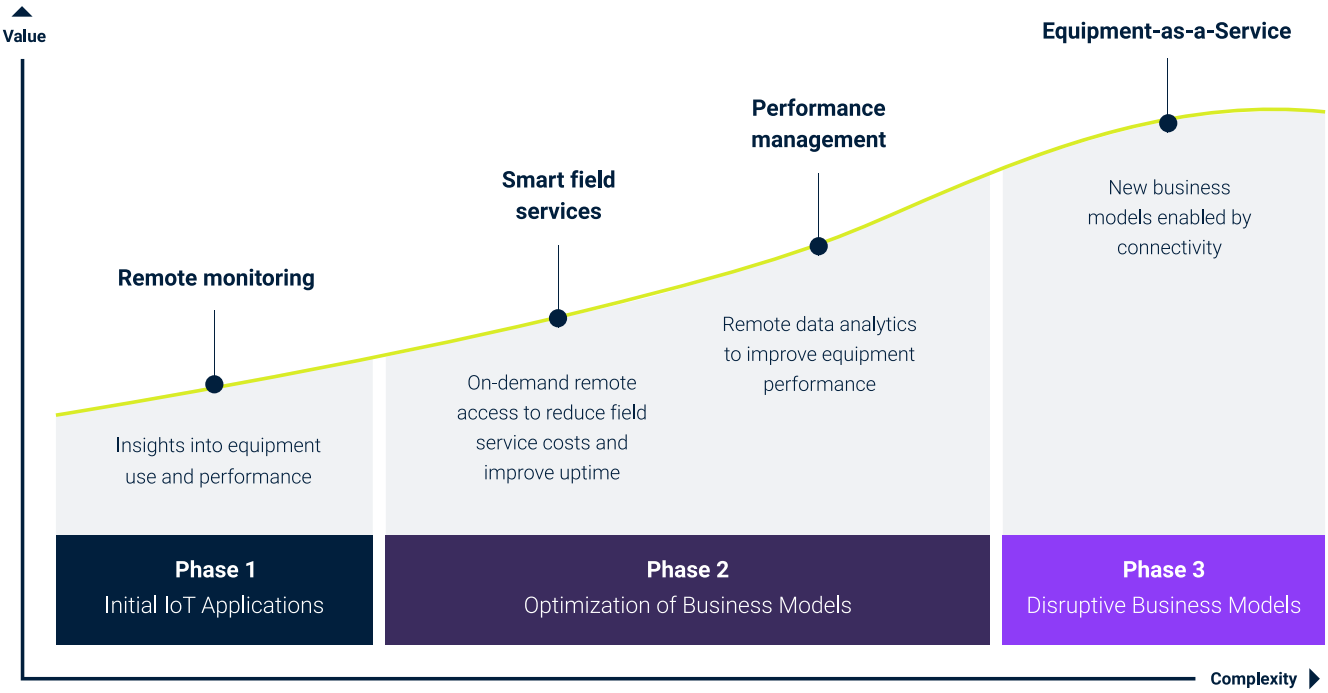


Figure 6: Organizations making smart connected products can take steps up the IoT maturity curve, creating value at each phase.

Phase 1 is about connecting and monitoring equipment. Historically, equipment makers have had little information about how their products are being used in the field. Instead, they had to rely on users to inform them of failures. Manual processes to manage equipment were inefficient. IoT at the edge enables efficient, reliable, secure remote monitoring, capturing data from many sensors and devices and reporting only the processed information to enterprise systems in the cloud or data center. Internal field service and product development teams can incorporate both live data and historical trends into their service management and product evolution processes.

What's needed to offer connected equipment with remote monitoring? The IT and OT steps include:

- **Making edge devices as machine gateways**
  - OT protocol adapters, fieldbus comms, industry protocol integration of heterogenous OT/asset landscape
  - OT integration to any level of the automation pyramid (field, control, supervisory, or management layer)
- **Making edge gateways into connectivity & device management controllers**
  - Implementing robust, efficient, and secure "northbound" connectivity of equipment to IoT platforms
  - Avoidance of vendor lock-in to maintain strategic flexibility and allow integration with the customer's choice of IoT platform in the field
- **Centralized device management and operation of equipment**
  - Embracing a remote-first paradigm to avoid costly site visits
  - Monitoring equipment health and operations
- **Using edge devices as configuration and management interface for subordinate devices including:**
  - Enabling remote / local UI for asset configuration and management
  - Implementing software and firmware for management of subordinate connected systems

Phase 2 extends and refines the data-driven insights using analytics and context to improve operational performance and create new digital services for customers and third-party maintenance partners. With competition increasingly based on outcome rather than product quality, smart equipment makers need to continuously strive to offer the highest equipment operation to remain competitive, e.g., improved machine uptime, lower energy consumption, and better output quality. Because edge computing brings data analysis and control close to smart equipment, manufacturers can optimize machine performance with fast, precise control.

While the focus in this phase is mainly on new external digital services, the underlying business model remains the same as in Phase 1: up-front equipment sales with digital services bolted-on. This means the smart equipment maker continues to sell a combination of equipment and services to the end customer as an "investment and purchase", rather than a subscription model. Typically, smart maintenance and performance management packages are suitable for this level of maturity.

What's needed to offer connected equipment with smart maintenance capabilities? The IT and OT steps include:

- **Deploying edge devices as local semi-fully autonomous deployment option for analytics**
  - Data filtering, pre-aggregation, normalization, and complex condition monitoring
  - ML model execution, AI/ML Ops
- **Using edge devices for usage level services**
  - Monitoring Overall Equipment Effectiveness (OEE)
  - Integrating field services
- **White-labelling of user interfaces to allow smart equipment makers to offer branded services to their customers**

Phase 3 delivers full EaaS with the necessary disruption of the existing business model. Increase the number of customers who only want to pay for defined outcomes, rather than inputs. They want to realize both a lower equipment total cost of ownership (TCO) and have the equipment costs flexible to accommodate changes in demand.

The EaaS business model enables end customers to convert CapEx into OpEx and transfer maintenance responsibility to the equipment supplier. To successfully offer this business model, smart equipment makers need to transform their organization. For example, service and maintenance departments turn from an independent revenue center to an important cost center. Re-sell and distribution networks will change. And more sophisticated remote maintenance solutions, as well as more advanced metering and billing capabilities, will be required—which depend on the local autonomy provided by edge computing.

What's needed to shift from separate equipment sales and after-sale services to an integrated service package? The IT and OT steps include:

- **Using edge devices/clusters as local scalable and extensible IoT platform**
  - Making a full IoT platform available on-premises providing user interfaces and interfaces for domain experts and end users
- **Enhancing edge platforms with business integration to ERP systems**
  - Implementing security policies to ensure only the relevant data leaves site
  - Hardening edge devices and platforms for deployment into data-sensitive environments
- **Creating white-labeled solution bundles**
  - Edge and cloud components, which can be re-packaged and sold by re-sellers and equipment makers as end-to-end solutions
- **Building a marketplace for industrial digital services**
  - Enable customers to add smart equipment maker and third-party apps on top of their offering
- **Deeply integrating the IoT estate into the enterprise architecture**
- **Implementing real-time services**
  - Service management, metering and billing to control, monitor and process payment for the usage of the smart equipment

Smart equipment maker success stories

Leading smart equipment makers are working with Software AG's Cumulocity IoT platform to make the most of IoT at the edge, and many are making progress toward an EaaS model.

autosen: Turning edge data into smart sensing

For over a decade, autosen has been a leader in offering sensor and automation solutions. As a driver of digitalization in SMEs and the industrial sector, autosen sought to help its customers by providing a sensor-to-cloud process that is quick, easy, and cost effective so that it could lower the cost of Industrial IoT entry for all industries.

The solution:
autosen developed an all-in-one solution for Industry 4.0 and the Industrial Internet of Things with Cumulocity IoT. The io-key is an easy-to-use, all-in-one solution that consists of an IIoT gateway with integrated Europe-wide flat rate mobile data that sends measurements to the autosen.cloud. As a plug-and-play solution, the io-key automatically recognizes sensors connected via the IO-Link and generates—automatically as well—the corresponding dashboard. autosen can connect 10,000+ sensors from over 200 manufacturers in the cloud in less than 1 minute.

The outcomes:

- Easy connection to the cloud via plug-and-play in under 1 minute
- No intervention in the customer's IT infrastructure
- Automatically generated dashboards
- Numerous monitoring and analytics functions
- Diverse application possibilities with 12,000+ customers
- Tenfold cost savings for end customers

> A universe of possibilities in one box: The io-key combines gateway, connectivity and cloud into a complete solution. No additional expertise required.
>
> - Rainer Schniedergers, Head of products and technology at autosen

SMC: Smart manufacturing with an edge

A global leader in the manufacturing of pneumatic equipment, SMC decided to extend its product lines with smart networking and decentralized intelligence using IoT. However, there was a problem: While sensors in SMC components could detect the data, they had no way of enabling customers to visualize, analyze, and act on it.

The solution:
SMC developed a solution with Cumulocity IoT (installed on Dell's Edge hardware devices) that enables intelligent maintenance, with real-time cloud and edge-based visualization and analytics for machine monitoring & predictive maintenance. Operations are optimized with forecasting that combines with anomaly detection to identify process optimizations and increase overall equipment effectiveness (OEE). SMC increased energy efficiency, with optimized compressed air consumption enabled by real-time analytics of connected pressure and flow sensor data. And it has identical components & tooling from edge to cloud with identical APIs, data modeling, and analytics.

The outcomes:

- Solution rolled out in less than one week
- "Start small, scale fast" starting with just five to 10 sensors
- SMC's new "Smart field analytics" solution available in under 4 months, providing a powerful, simple but easily scalable solution to customers
- With simple dashboards, factory managers are able to employ predictive maintenance across heterogeneous devices on the factory floor
- New use cases deliver customer value with predictive maintenance, leakage detection, and energy efficiency monitoring

> We have a very open partnership with Software AG. We have infinite knowledge in the area of machinery and data detection and they have exceptional knowledge of data capture and analytics through IoT. Ours is the perfect union.
>
> - Oliver Prang, Expert Digital Business Development, SMC Deutschland

Dürr: Building an edge with analytics

Dürr makes and services robotic paint stations used by major vehicle manufacturers. To avoid costly errors during painting, Dürr wanted to monitor, gather, and process real-time data on rotation speed and air supply at the paint stations. A critical requirement was managing the stations autonomously at the edge. In other words, aggregate and analyze data locally without having to send it to the cloud.

The solution:
Dürr developed a software tool (based on the edge technology of ADAMOS) that seamlessly records all data from the automotive painting process. This creates a "digital fingerprint" for each painted body. If a quality problem occurs, the cause can be determined immediately using the recorded data.

The outcomes:

- Reduced errors, thanks to real-time signals every eight milliseconds
- Lower manufacturing costs
- Better, faster decision-making
- Operators design and manage streaming analytics "on the fly"
- Won the German Innovation Award 2020 with EcoPaintJet, a ground-breaking innovation for the highly selective painting of cars

> We have put extremely powerful analytical tools into the hands of those that understand the production process the best, opening a new era of streamlining and improvement.
>
> - Manager Digital Factory, Dürr

DMG MORI launches EaaS to accelerate customer innovation

DMG MORI AG is one of Germany's largest manufacturers of cutting machine tools, as well as technology and automation solutions for Industry 4.0. DMG MORI already has more than 10,000 machines equipped with an Industrial IoT gateway, used as standardized machine data interface (DMG MORI Connectivity), for remote service and connection to DMG MORI Cloud service. It has also deployed a self-service solution for its customers to manage software and security patches. But DMG MORI wanted to reduce the barriers to entry for its customers, and better align its incentives with the manufacturers it serves. To do so, it needed a way to launch an EaaS offering

The solution:
With its products fully connected through IoT at the edge, DMG MORI launched PAYZR, its entry into the world of data-based business models of subscription and pay-per-use. PAYZR stands as an acronym for "PAY with Zero Risk".

The outcomes:

- Enables DMG MORI to offer equipment through subscription instead of ownership, with planning security and cost transparency
- Financial flexibility for its customers, with no investment risk
- Flexible operating expenses for manufacturers, based on actual spindle hours as well as monthly basic fee including all-around carefree package
- Customers can accelerate innovation cycles by avoiding long-term capital expenses
- More efficient, streamlined digital point-of-sales

How to get started

For more than a decade, we've helped businesses overcome the challenges and successfully implement 1,000s of IoT solutions around the world.

We believe that exploiting the potential of IoT should be simple and fast for all. Our Cumulocity IoT platform helps industrial manufacturers transform into service companies offering EaaS options, by enabling their domain experts to deliver strategic business outcomes rapidly using self-service tools.

The platform's capabilities include device management, enterprise integration, and a full range of analytics including condition monitoring, real-time streaming analytics, machine learning, model management, and data lake integration.

We've been named a leader in many analyst reports:

- MachNation's 2022 IoT Edge Scorecard
- Gartner® Magic Quadrant™ for IIoT Platforms, 2022
- The Forrester Wave™: Industrial Internet-of-Things Software Platforms, Q3 2021

With this platform, we're helping companies transform their business by connecting assets and acting on the data they generate. An open and independent platform, Cumulocity IoT works with the things you've got—IT, OT, and protocols—and what you may add in the future.

With Cumulocity IoT, you can:

- Connect any device via any cloud platform and integrate with any application
- Get started in minutes—no coding required, even for analytics
- Use the same APIs, data, and analytics models everywhere—on the edge, in the cloud, and on-premises

Cumulocity IoT is fully distributed, and can be deployed on cloud, core, or at the edge. With our open source thin-edge.io initiative, we are helping extend the management of analytics models, IoT protocol adapters, and IoT apps out to resource-constrained IoT edge devices.

A distributed, open architecture and a common set of IoT capabilities on the edge, on-premises, and in the cloud helps you develop and deploy your solution faster. As a result, Cumulocity IoT customers can "build once, deploy anywhere" across the edge to cloud continuum. Simplify development by using uniform APIs, data, and analytics models across clouds, on-premises, and at the edge. This reduces the management overhead in software and analytics development, accelerates competitive innovation, and builds resilience for IoT solutions.

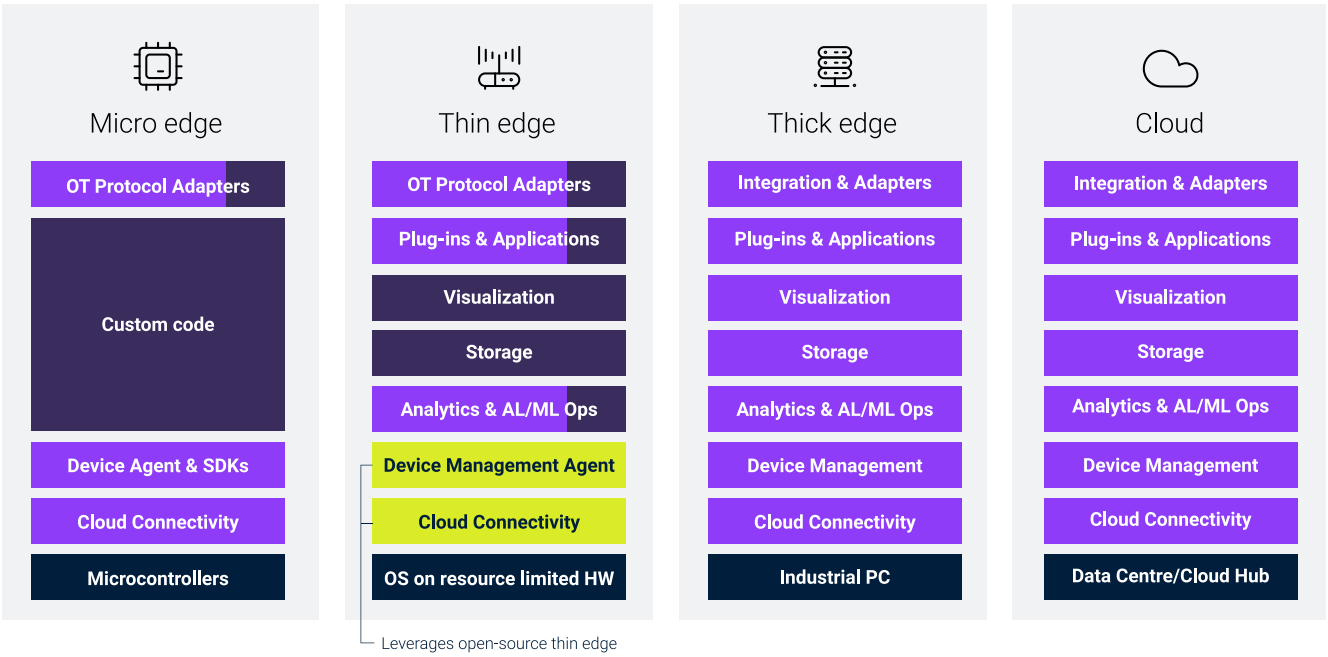


Figure 7: Cumulocity IoT platform enables the edge continuum so you can develop once and deploy anywhere

With Cumulocity IoT, smart equipment makers gain a "buy & build" approach. Our proven platform helps them get started quickly by leveraging out-of-the-box configuration-driven tools. Because the platform is designed in an open and extensible manner, equipment makers can quickly build their own differentiating applications with their own IP and domain specifics. This "buy & build" approach enables equipment makers to focus on their innovation and differentiation, namely their digital services, rather than wasting development time on creating foundational IoT capabilities.

Wherever you are on your IoT journey, Software AG can help you make the most of your investment and achieve the best outcomes for your business. Our enablement services and partnerships can help you develop and deploy your solutions faster while our proven project methodology and reusable processes can accelerate your time to value.

Meet our IoT edge platform

- Discover Cumulocity IoT Edge
- Try Cumulocity IoT for 30 days free
- Talk to one of our experts and see the Cumulocity IoT platform in action
- Join the discussion. See what others are saying—and building

Want to accelerate your IoT initiative?

With Cumulocity IoT, technology isn't the thing holding your innovation back. If it's a lack of resources, expertise, or delivery capability, try Quickstart. Quickstart is a consulting-led, cloud-delivered engagement which provides you a pain-free way to start your IoT pilot in six weeks or less. Accelerate the delivery of your pilot in four phases:

- Start & scope – including a discovery workshop to explore your IoT goals architecture & design—with a deep-dive workshop looking at "as-is" and "to-be" architectures
- Development & test – with continuous support from Software AG consultants
- Review & extend – including measuring outcomes against success criteria

Hands-on guidance from experts can make all the difference. QuickStart offers five days of engagement with Software AG IoT business and technical specialists to facilitate the workshops and develop the solution. Plus, accelerate your solution with access to best-in-class IoT approaches from the 1,000s of deployed solutions on Cumulocity IoT worldwide. We can even help you secure buy-in from senior executives, business leaders, and technology leaders to get your project off the ground successfully.

Related Resources

IoT edge computing

Learn how IoT at the edge brings new opportunities to connect every "thing"—devices, products, machines, and other assets—so you can increase uptime, improve response time, save bandwidth, and reduce costs.

Learn more >

A leading IoT edge platform

MachNation has judged Software AG and its Cumulocity IoT platform a leader for 6 years in a row! See for yourself how the vendors compare—and how we can help you improve the user experience and reduce time to market, while saving time and developer resources.

Learn more >

Free Cumulocity IoT demo

Make Cumulocity IoT your edge: deliver ultra-fast analytics, deploy IoT in new places, and cut infrastructure costs. Talk to an expert and get a free trial to learn what's possible on the #1 low-code, self-service IoT platform.

Learn more >

Take the next step

To learn more, contact your Software AG representative or **visit us at www.softwareag.com**