Emerging Tech: Empower Outcome-Centric IoT With AI

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By Analyst(s): Milly Xiang

Initiatives: Emerging Technologies and Trends Impact on Products and Services

> Enterprises are defining new IoT strategies to be outcome-centric. Product leaders of IoT solutions should exploit the potential of various AI techniques such as edge AI and GenAI to build industry-specific value out of IoT use cases and to create new value propositions and revenue streams.

Overview

Key Findings

- The combination of enhanced edge device capabilities and the enabling AI/ML software allow IoT product leaders to deliver targeted and required business outcomes based on local contextualized data.

- Various GenAI techniques impact a wide range of IoT information and applications, potentially renovating smart-connected products, operations and experience, particularly LLM and synthetic data bringing short-term opportunities.

- A hybrid approach of cloud-out and edge-in is required to exploit edge AI and GenAI-enabled IoT opportunities to balance horizontal scalability and vertical specialization to efficiently deliver targeted outcomes.

Recommendations

Product leaders of IoT software and applications should:

- Implement phases to exploit edge AI by adding edge AI capabilities to your existing IoT offerings, then advancing the use cases based on the evaluation of edge AI evolution and impact on IoT applications.

- Create a convincing application by applying GenAI to existing IoT activities where new benefits can be derived.

- Adopt a hybrid edge-cloud approach and partnership to exploit AI in IoT settings to help clients achieve balance between horizontal scalability and simple operations versus vertical specialization and cost.

Strategic Planning Assumptions

- By 2025, more than 95% of new industrial Internet of Things (IoT) deployments will include analytics and AI-edge inference capabilities, up from less than 30% in 2022.

- By 2025, 80% of the product development life cycle will make use of generative AI (GenAI) code generation, with engineers acting as architects, validators and orchestrators, up from less than 20% today.

- By 2026, more than 80% of independent software vendors (ISVs) will have embedded GenAI capabilities in their enterprise applications, up from less than 5% today.

Analysis

Technology Description

AI impacts IoT solutions in multiple ways, representing a broad range of applications. Various AI techniques can be used at all levels in the IoT architecture — from edge to cloud — and applied to a wide range of IoT information, including video, still images, speech, network traffic activity and sensor data. Adding various AI techniques greatly expands the potential of IoT solutions to deliver business outcomes by enhancing:

- Sensing, capturing and interpreting capabilities (such as cameras and natural language inputs)

- Human-machine interactions (recognizing users' behaviors and preferences and better addressing their needs and even predicting what they want)

- Data management and analytics capabilities (meeting the requirements for localized and centralized intelligence, personalization with security, confidentiality, and privacy)

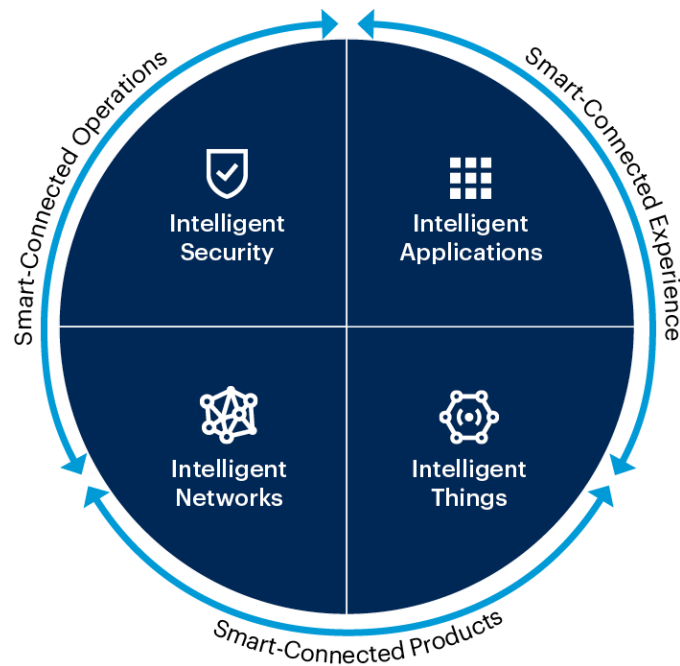- Process improvement (automating or augmenting a task or application)

In the past three years, IoT buyers have moved beyond early implementations concentrated on consolidating the management of data from diverse types of connected assets and equipment, to become more demanding of required business outcomes, including but not limited to:

- Improved workforce productivity

- Process optimization

- Improved customer experience and loyalty

- Enhanced employee and customer safety and health

- Resource conservation

As IoT becomes more widespread and more business-critical, delivering purpose-built, targeted outcomes using various AI techniques becomes a defining characteristic of new IoT strategies across industries. IoT product leaders have multiple opportunities to build competitive differentiation by exploiting AI technologies' impact and respond accordingly. By applying intelligence across various layers and tiers of IoT solutions, they can develop outcome-oriented IoT solutions through enabling smart-connected products, smart-connected operations and smart-connected experience, as shown in Figure 1.

Figure 1. AI Empowers Outcome-Oriented IoT Solutions
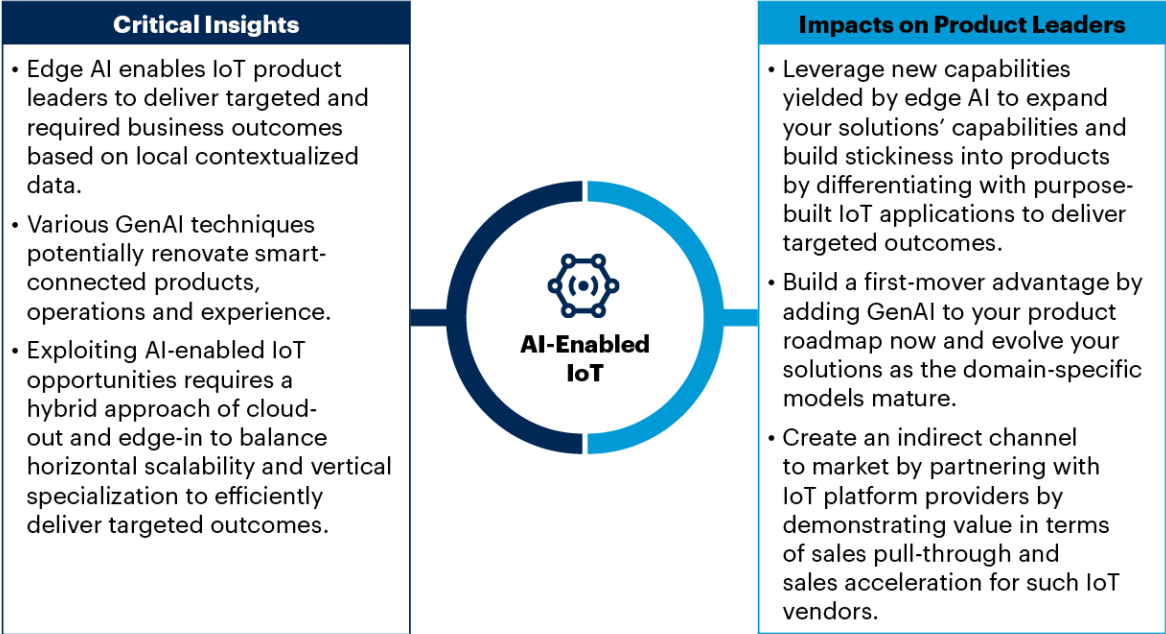
AI Empowers Outcome-Oriented IoT Solutions

Source: Gartner
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This document offers three critical insights related to using AI to empower outcome-oriented IoT and the impact on product leaders (see Figure 2).

Figure 2. Critical Insights for Using AI to Empower Outcome-Oriented IoT

Critical Insights for Using AI to Empower Outcome-Oriented IoT

Critical Insights
- Edge AI enables IoT product leaders to deliver targeted and required business outcomes based on local contextualized data.
- Various GenAI techniques potentially renovate smart-connected products, operations and experience.
- Exploiting AI-enabled IoT opportunities requires a hybrid approach of cloud-out and edge-in to balance horizontal scalability and vertical specialization to efficiently deliver targeted outcomes.

AI-Enabled IoT

Impacts on Product Leaders
- Leverage new capabilities yielded by edge AI to expand your solutions' capabilities and build stickiness into products by differentiating with purpose-built IoT applications to deliver targeted outcomes.
- Build a first-mover advantage by adding GenAI to your product roadmap now and evolve your solutions as the domain-specific models mature.
- Create an indirect channel to market by partnering with IoT platform providers by demonstrating value in terms of sales pull-through and sales acceleration for such IoT vendors.

Source: Gartner
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Gartner

The Shift Toward Edge Intelligence Leads to More Business-Responsive IoT Systems

Edges — the physical locations where things and people connect with the networked digital world — are closest to problems and events, supply chain incidents, and customers, and are the source of the information processed in an IoT solution. The combination of enhanced edge device capabilities and enabling AI/machine learning (ML) software is accelerating development cycles of more flexible, intelligent and responsive IoT systems. It enables IoT product leaders to deliver targeted and required outcomes through creating new value, new products and new business models based on local context and efficient AI techniques.

AI-empowered assets and infrastructure are the foundation of the value of edge AI. Currently, among the existing IoT-installed assets, many already have some form of embedded computing, and many of these assets are being retrofitted for edge AI capabilities. What's more, IoT endpoints and device manufacturers are producing more assets with embedded computing environments for AI-enabled software, as application processors' capability to deliver AI keeps increasing and the cost of compute continues to decline.

In addition, AI technologies and trends becoming increasingly optimized for resource-constrained devices will rapidly expand the use of various AI techniques on the edge in the future. For example, TinyML is the enabler of "AI Everywhere." Model compression reduces the size of a trained neural network for deployment on small devices to enable inferencing on relatively inexpensive processors. Federated learning allows training to be done closer to the edge.

Sample vendors: Advantech; ADLINK Technology; Agora; ARM; Axiomtek; Intel; NVIDIA; Qualcomm

Near-Term Implications for Product Leaders

Market demand for business value enabled by edge intelligence signals significant opportunity for IoT product leaders to agitate legacy hardware and software markets by providing a platform for disruptive innovation. Various AI techniques yield new capabilities that allow IoT product leaders to expand their solutions' capabilities and build stickiness into products. This creates a competitive advantage by differentiating with purpose-built IoT applications to deliver targeted outcomes in a fast-changing market through real-time data processing and decision making to:

- Increase efficiency

- Reduce bandwidth needs

- Improve privacy and security

- Enhance operational resilience

In the short term, however, the diverse maturity levels of various AI techniques and resource- and energy-constrained edge devices will remain challenges. For example, model compression and TinyML are about three to six years from early majority adoption (see Emerging Tech Impact Radar: Edge AI). Also, AI technologies are closely tied to silicon technology development, which will advance swiftly over the next five years and create new capabilities and cost points for inferencing. IoT product leaders need to build an understanding of how AI technologies and trends are evolving and impacting IoT applications and use cases. They can use this knowledge to determine when it makes sense to advance their products and services by investing in or partnering with related AI capabilities to exploit more IoT use case possibilities.

Recommended Actions for the Next Six to 18 Months

- Establish an edge AI enablement strategy that aligns to your broader IoT product strategy by determining which elements of edge AI applications you can deliver directly, and which require technology partners.

- Guide your customers to develop edge AI business cases to fill a specific need of IoT use cases, balancing technical elements, such as the need for real-time intelligence, security and scalability, against the overall business requirements and integration complexity.

- Work aggressively with new and innovative edge AI software providers to differentiate the depth and breadth of capabilities across edge environments to drive emerging IoT use cases.

GenAI Accelerates IoT Solution Creation and Business Outcome Delivery

With the advent of generative AI based on foundation models, the approach to AI as applied to IoT opens new lines of exploration and innovation. Unlike traditional machine learning, which focuses on mapping input to output, generative models leverage different learning approaches to produce novel and realistic outputs based on the patterns and information present in the training data. Applied to a wide range of IoT information including video, still images, speech, network traffic activity, and sensor data, GenAI accelerates delivery of new, real and in-context value out of IoT data, discovering innovative products and applications. Thus, it expands the potential of IoT solutions to solve more business challenges in a timely and cost-efficient manner.

GenAI's impacts to IoT expand from industrial into broader commercial and consumer IoT. Some early use cases surfacing include:

- **User experience:** GenAI can create personalized and interactive user experience by analyzing user data collected by IoT devices, and creating personalized recommendations, alerts and notifications. This will elevate consumer, commercial and industrial IoT systems' contextual awareness and facilitate more natural interaction. For example, Samsung has announced the plan to upgrade Bixby with advanced GenAI capabilities featured in all future smart home appliances.[1] Thundercomm announced the integration of the Rubik large language model with the Qualcomm RB5 AMR Reference Design to develop a robotics solution enabling a more natural language interaction and a better understanding of human aims.[2] Sensibo integrates ChatGPT into its smart HVAC products to automated AC schedules "based on custom behavior of the user and Climate React personal recommendations."[3]

- **New IoT data:** GenAI can generate synthetic data that can be used to train machine learning models and enhance data analytic capability to unlock hidden insights within IoT data. For example, ABB integrates generative AI into the Genix platform and application, enabling functionality such as code, image and text generation to help industrial customers unlock insights hidden in operational data.[4]

- **IoT security:** GenAI enhances the ability to recognize patterns and to identify security potential risks more quickly. For example, Cynerio uses GenAI to supercharge its capabilities in data analytics, threat detection and attack response to secure IoT, Internet of Medical Things (IoMT), operational technology (OT) and IT devices in healthcare environments.[5]

- **IoT connectivity:** GenAI can heighten network efficiency through intelligence or self-management. For example, Soracom adds GenAI capability to IoT connectivity, announcing three new services that can work together or separately "to analyze IoT device data on the fly or connect devices to AI/ML capability now available through the hyperscale platform."[6]

Sample vendors: ABB; Amazon Web Services (AWS); Cadence; MediaTek; Meta; Microsoft; Qualcomm; Sensibo; SDMC; Tachyum; WISeKey

Near-Term Implications for Product Leaders

Most GenAI models today mainly focus on text and images, or sound, and only a limited number of models are focused on sensor data as an input. IoT-related use cases are currently not in focus, and the IoT vendor community is yet to produce a compelling combination of GenAI and IoT. Major developments observed were in the form of product upgrades. Other developments include partnerships and collaborations to co-develop solutions that include large language models (LLMs) and GenAI capabilities into IoT platforms and applications.

While GenAI offers great opportunities for IoT product leaders to evolve their existing offerings in multiple ways, it opens a wide area of opportunity to potentially create new products, use cases, capabilities and business models. This will not only impact IoT device and smart-connected-product manufacturers, but also broader software and service product leaders that can leverage GenAI to develop industry-specific solutions that offer differentiated value, thus creating a competitive edge. In the meantime, IoT product leaders can leverage GenAI to transform their product management practices. For example, they can use GenAI to create virtual prototypes to test and optimize their designs before producing physical prototypes, or to support the whole product customer journey (from exploring, buying, using, engaging and supporting).

However, IoT product leaders should be mindful that applying GenAI in IoT to deliver industry-specific outcomes remains challenging in general due to the immaturity and the lack of accuracy from domain-specific GenAI models. And in certain IoT settings, it is particularly far away from being rolled out on a large scale — for example, where GenAI accuracy and response latency requirements are high, such as, in the case of connected cars.

Recommended Actions for the Next Six to 18 Months

- Build a first-mover advantage by adding GenAI to your product roadmap now, and create a convincing application where GenAI can derive new benefits out of existing IoT activities.

- Develop use-case-oriented IoT solutions by leveraging existing application frameworks to accelerate development and deployment of models, and fine-tuning models and applications over time.

- Prioritize IoT use cases where GenAI can:

    - Transform scene "understanding" (for example, using GenAI to empower computer vision models to generate meaningful insights from novel or unknown situations)

    - Enhance customer experience (for example, using GenAI-powered conversational AI in IoT systems to bring more natural human-machine interaction)

- Reduce the cost and risk by partnering with best-of-breed vendors to add GenAI capabilities to either enhance your existing offerings, such as security, connectivity and user interface, or to develop new applications around smart-connected products, operation and experience.

Hybrid Approaches to Scale AI's Full Potential in Delivering Targeted Outcomes in a Cost-Efficient Manner

The exploitation of AI and IoT value highlights a progression of sophisticated capabilities across various components of an IoT architecture, such as sensors, edge devices, networks and IoT platform components. It requires an ensemble of hardware and software working in concert. The shift toward edge-compute IoT architecture doesn't necessarily signal the end for more common cloud-based IoT networks. AI processing must be distributed between the cloud and edge devices for AI to scale and reach its full potential.

Based on observed investment, development and marketing of new solutions by technology and service providers, Gartner believes the AI-enabled IoT market is entering a period of highly competitive offerings and accelerated delivery. Technology vendors targeting to embed intelligence to IoT solutions are trying to address the opportunities from either:

- A cloud-out approach (extending cloud capabilities and services closer to the edge), primarily driven by cloud service providers (for example, AWS IoT Greengrass and Alibaba Cloud Link IoT Edge) to garner a higher proportion of the total IoT spending. They use edge-computing products to extend their cloud-based IoT platforms and are integrating AI capabilities across the entire IoT stack to add concrete and measurable business outcomes from AI/ML services and applications.

- An edge-in approach (focusing on rich edge ecosystems and integrating to cloud services), rising to seize the edge and far-edge opportunity in IoT by software and application vendors, endpoint and edge device manufacturers, and systems integrators, to provide cloud-independent IoT solutions. This approach allows them to avoid cloud and platform lock-in, enable on-premises deployments, and meet the diverse requirements of IoT use cases across verticals. IoT software and application vendors are increasing the use of edge-in architecture to strengthen positioning in the market through delivering targeted outcomes with a clear focus on highly verticalized requirements.

Because of these factors, product leaders of IoT solutions need to understand the vendor landscape and evolve their product portfolio and partnership strategies to take advantage of it and deliver differentiated products.

Sample vendors: Alibaba Cloud; AWS; Axelera AI; BeeBryte; Feelit; Google; Microsoft; NoTraffic; Omniflow; Tuya Smart

Near-Term Implications for Product Leaders

Product leaders of IoT solutions should be mindful that "cloud-out" and "edge-in" are not mutually exclusive strategies. End users would technically need cloud-out and edge-in based on different IoT use cases to achieve balance between horizontal scalability and simple operations versus vertical specialization and cost. Therefore, they may work with multiple software, service or communications vendors on their AI-enabled IoT projects, requiring product leaders to adopt a broad partnership strategy.

IoT product leaders looking to accelerate time to market cost-effectively can leverage enabling infrastructure provided by large IoT platform vendors through cloud-out design architecture to develop their own AI-enabled IoT solutions and applications. This hybrid edge-cloud model helps deliver scalability and ease of operations while addressing the diversity of use cases and requirements among verticals. It also allows IoT product leaders to evolve and diversify their pricing model to subscription-based. And from a go-to-market perspective, the partnership with hyperscalers and large IoT platform vendors will make them realistic contenders for some larger IoT projects.

Recommended Actions for the Next Six to 18 Months

- Create an indirect channel to market by partnering with IoT platform providers and by demonstrating value in terms of sales pull-through and sales acceleration for such IoT vendors.

- Enhance your attractiveness to hyperscalers and large IoT platform providers by innovating around new edge AI and GenAI-enabled IoT use cases that involve rich interactions between multiple edge entities that are loosely tied to core cloud capabilities to bolster competitiveness.

- Deliver scalability and ease of operation while addressing the diversity of use cases and requirements by partnering with hyperscalers and large IoT platform providers that support open standards at the cloud-out-based cloud infrastructure and platform services (CIPS) layers.

- Minimize the cost of implementation by working with the client to manage data sent to the cloud to train models.

Evidence

[1] Samsung to Elevate Smart Homes With GenAI-Powered Bixby, IoT Tech News, part of the TechForge Media portfolio

[2] Thundercomm Demonstrated GenAI Integrated Robotics Solution to Accelerate a New Wave of Robotics Innovation, Thundercomm.

[3] Sensibo Integrates OpenAI's ChatGPT Into Smart HVAC, techAU.

[4] ABB and Microsoft Collaborate to Bring Generative AI to Industrial Applications, ABB.

[5] Cynerio Harnesses the Power of Generative AI to Revolutionize Healthcare Cybersecurity, Cynerio.

[6] Soracom Adds Generative AI Capability to IoT Connectivity, Soracom.

Document Revision History

Emerging Technologies: AI-Enabled IoT - 21 March 2022

Recommended by the Author

Some documents may not be available as part of your current Gartner subscription.

Emerging Tech Impact Radar: Edge AI

Innovation Insight for Edge AI

How TSPs Can Accelerate the Generative AI Readiness of Their Enterprise Customers

Pragmatic Guide to Scoping and Delivering Generative AI Capabilities in Tech Product Offerings

The Next Major Opportunity for Data and Analytics Services — Enabling Enterprise Generative AI