Google Distributed Cloud for Manufacturing

Powered by Intel, Google Enables Real-time Manufacturing Operations With AI-optimized Intelligent Edge Solutions

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The Next Era of Intelligent Manufacturing

Today's manufacturing organizations have many digital priorities, and to achieve their goals, they need superior technical capabilities and infrastructure on premises. For modern manufacturing organizations, key digital business priorities requiring IT and infrastructure modernization include:

- **Factory and process optimization** to boost efficiency and optimize operations to yield higher quality with greater throughput.
- **Improving quality and inspection efficacy** by leveraging AI-based visual inspection to analyze high-resolution images and video feeds in real time and detect defects with superior speed and accuracy.
- **Enhancing security and asset protection** via AI-based image inspection and recognition to improve physical security as well as material and inventory controls.

- **Workplace safety** by leveraging cameras and wearables that enable real-time alerts or automated corrective measures to protect workers.[1]

- **Reducing scrap and waste** by using AI to enhance quality control to reduce defects and wasted raw materials. A fully managed as-a-service platform with a modern, power-efficient footprint can help meet sustainability goals by reducing overprovisioning and energy consumption more effectively than an aging, self-managed infrastructure can.

To deliver on those priorities, manufacturing organizations are embracing digital transformation initiatives such as AI to modernize operations, improve efficiency, and minimize business risk. According to Google, the most common AI-driven digital business initiatives in progress or under investigation by manufacturing organizations include:

- Using AI at the edge for real-time anomaly detection in OT network traffic and enhancing physical security on the factory floor through AI-powered video surveillance analysis.
- Augmenting quality control and defect detection.
- Improving customization or personalization capabilities.
- Supply chain optimization.
- Process optimization.
- AI-powered analytics for improved product demand forecasting.

Fortunately, manufacturing organizations can propel such initiatives forward more effectively with help from Google Cloud and Intel because Google Distributed Cloud (GDC) can serve as the on-premises extension of Google's AI ecosystem. For example, manufacturers can train models in Vertex AI using Google's powerful cloud infrastructure and then deploy those models consistently to thousands of factory floors using GDC.

Modernizing Infrastructure for the Next Era of Intelligent Manufacturing

Enterprise Strategy Group research highlights that manufacturing organizations face specific IT infrastructure challenges. Consider, for example, that 81% of surveyed IT decision-makers working in manufacturing organizations said that their overall IT infrastructure environment has become more complex in the last two years.[2]

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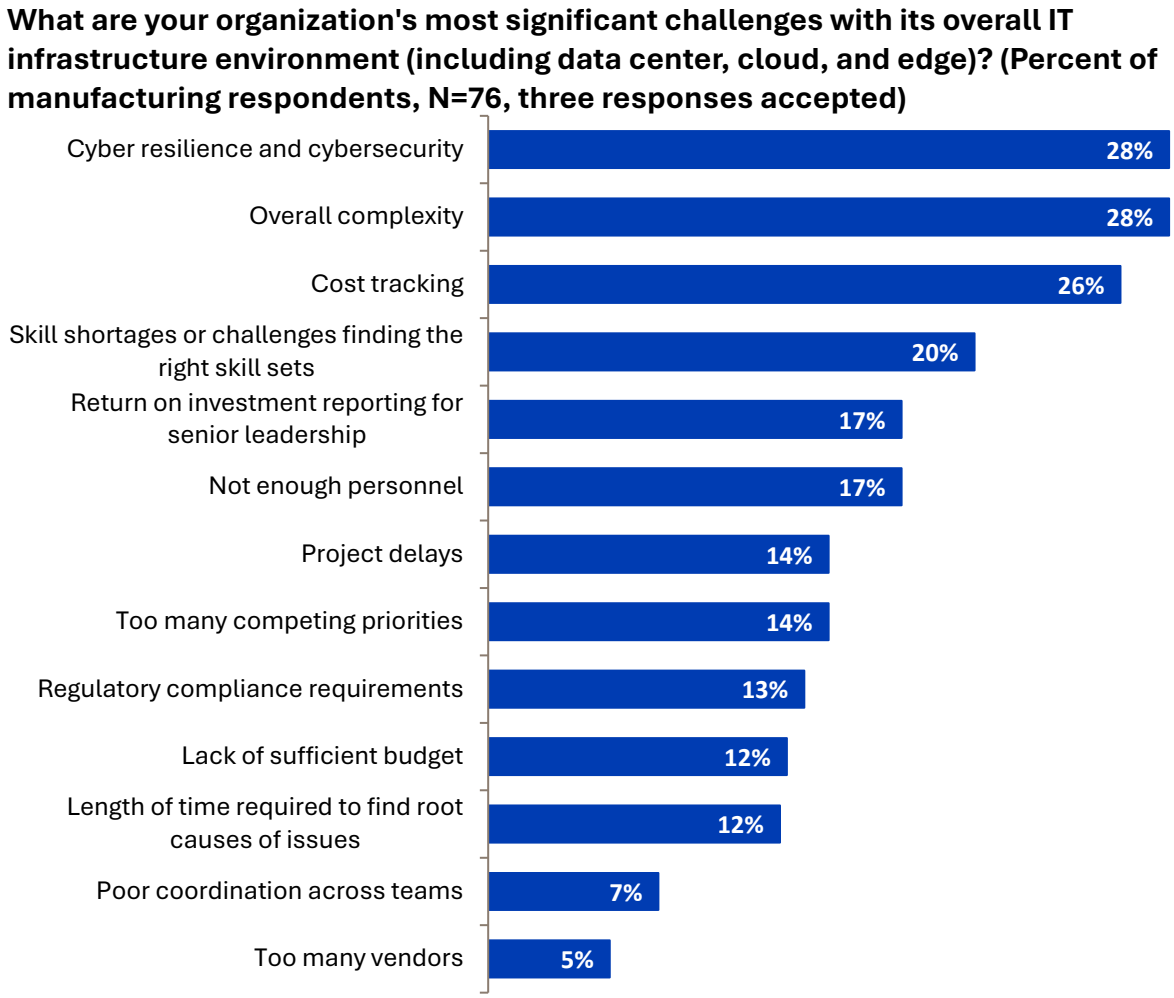
[1] Visit https://www.youtube.com/watch?v=zcLl37rMZuA to see how Google Distributed Cloud is addressing some of the biggest challenges in the manufacturing industry.
[2] Source: Enterprise Strategy Group Research Report, *IT Transformed: Inside the Convergence of Hybrid Cloud and AI*, July 2025.

Those IT leaders frequently cited efforts to ensure cyber resilience and address overall IT complexity as challenges to their IT infrastructure environment (see Figure 1).[3] That finding highlights the need to minimize or eliminate business risks associated with cyberthreats while also reducing the complexity burden for internal personnel. The IT complexity burden is real, and its impact is shown by respondents' concerns about skill shortages and insufficient staffing overall (see Figure 1).[4]

Figure 1: Most Critical IT Challenges for Manufacturing Organizations



Source: Omdia

For manufacturers to achieve their objectives and address their challenges, they must modernize their onsite infrastructures. Centralizing applications in the cloud is a common practice, but limited bandwidth or intermittent connectivity can slow application

[3] Ibid.
[4] Ibid.

responsiveness, leading to outages and lost production. Clearly, manufacturing organizations need local infrastructure composed of solutions not characterized by high levels of cost, complexity, and maintenance needs.

Manufacturing organizations must seek out solutions that deliver the necessary availability, performance, and resilience they need—those that provide flexibility to support evolving digital initiatives such as AI, while minimizing the operational burden.

Approaches to Modernizing an Onsite Operational Technology Infrastructure

Having a modern operational technology infrastructure could help lower total IT infrastructure costs by minimizing cloud spending, specifically, by processing/selecting a vast amount of data locally. Any investment must:

- Deliver the optimal digital experience by providing both service availability and application experience consistency.
- Minimize business risk by providing cyber resilience and data security, along with optimizing data protection and recovery.
- Be able to scale to meet future application and data demands. The environment should be capable of growing to meet the business's future demands while continuing to provide sufficient flexibility to enable the organization to embrace emerging technologies such as AI.

Any new investment must also minimize the burden on internal personnel and resources because throwing more personnel, budget, and infrastructure into new initiatives is an unsustainable approach. Research identifies the many burdens being placed upon internal personnel, which invariably steal valuable time. They include tasks related to:

- **Accurately sizing and forecasting** application and data requirements to properly scope and efficiently size new investments. Seventy-four percent of IT decision-makers in manufacturing organizations said storage and data infrastructure demands and spending are hard to predict.[5] Additionally, given the rampant scale of infrastructure being deployed to support compute-intensive workloads such as AI, power efficiency is

[5] Source: Enterprise Strategy Group Research Report, *Navigating the Cloud and AI Revolution: The State of Enterprise Storage and HCI*, February 2024. All Enterprise Strategy Group research references in this white paper are from this report unless overwise stated.

becoming increasingly important, and that adds to IT's planning burdens. In fact, 79% of IT decision-makers in manufacturing organizations said that sustainability requirements have accelerated their investments in infrastructure modernization. Some are leveraging edge computing to minimize the amount of data sent to the cloud and are taking action to ensure that cloud data runs on sustainable appliances in the data center to help reduce carbon footprints.

- **Deploying, configuring, and integrating** the solution into the existing environment. Sixty-eight percent of IT decision-makers in manufacturing organizations agreed that overall complexity is slowing their IT operations and initiatives.
- **Monitoring, servicing, and maintaining** the entire environment to ensure the optimal application experience while minimizing business risk. Research found that 75% of IT decision-makers in manufacturing organizations reported they have taken on added/new responsibilities to support their organization's digital transformation goals/initiatives or are under pressure to do so. Additionally, 64% of IT decision-makers in manufacturing organizations agreed that managing data at the edge is a significant burden.

Manufacturing organizations should keep several priorities in mind when transforming their onsite infrastructures to support digital initiatives for the near and long term. Of course, the solutions must address these core essentials:

- Ensuring resilience, high availability, and application experience.
- Security, data protection, and data recovery.
- Scalability to meet future application and data demands.

But beyond those essentials, manufacturing organizations also require modern IT infrastructure that can:

- Accelerate time to value and reduce business risk during deployment.
- Offload as many mundane maintenance responsibilities as possible. Reducing the time allocated to necessary but lower-value-added tasks frees up cycles to devote to higher-value initiatives.
- Increase flexibility and options for scaling. The right solution should provide the ability to tune the infrastructure to the organization's needs over the long term, while controlling for costs and adding flexibility.

Edge-specific Transformation Options for Manufacturing

Today, three common paths exist for modernizing edge IT infrastructure: (1) buy it or custom-build it, (2) leverage a turnkey integrated edge infrastructure solution, or (3) opt for an AI-optimized intelligent edge platform. Here's a deeper dive into each of those options.

Option 1: Buy It or Custom-build It

With this approach, the organization's own IT team decides what to buy, how to put it together, and how to test it. The IT team also manages the deployment; provides all operational support before, during, and after that deployment; and performs all recurring maintenance and upgrades.

Advantages

- **Ultimate control.** This approach provides complete control over which technologies are selected, how they are sourced, and how they are integrated, deployed, managed, and monitored.

Disadvantages

- **Ultimate responsibility.** The buy/build option puts the organization on the hook for every aspect of success or failure. That means design, technology evaluation, integration testing, sourcing, staging, timely deployment, and ongoing operational management all fall upon the corporate IT team to effectively plan and execute. They'll also have to manage budget as well as any operational and security risks that crop up along the way. Notably, 19% of manufacturing organizations identified that they prefer to procure, manage, and maintain their infrastructure.[6]
- **High internal resource intensity.** This approach will likely place the greatest demands on the internal resources who support the edge infrastructure throughout its lifecycle. Third-party resources can certainly be employed, but the typical high degree of customization means the organization will still rely heavily on skilled internal resources.
- **Flexibility challenges.** Unless great care is taken during the design process, using great forethought about future expandability, internally designed solutions can introduce limitations. Those limitations increase the potential for technical debt that could limit flexibility in the future.

[6] Source: Enterprise Strategy Group Research Report, *Private AI, Virtualization, and Cloud: Transforming the Future of Infrastructure Modernization*, July 2025.

Option 2. Turnkey Edge Infrastructure Solutions

The turnkey approach typically involves deploying a preconfigured edge compute platform, commonly with specific applications pre-installed, as a means for accomplishing specific solution goals.

Advantages

- **Reduced technology decisions.** Turnkey solutions come with a predetermined, pre-qualified collection of hardware and software components, removing much of the design, selection, testing, and sourcing load from the IT organization.
- **Available deployment and monitoring services.** Many turnkey offerings include optional services to assist with scaling and to speed deployment across storage sites. They also might offer ongoing monitoring of some or all of the edge infrastructure. This can reduce the burden on internal resources, but care must be taken to understand which of these services are priced as one-time costs versus recurring.

Disadvantages

- **Fit for purpose.** Special attention should also be paid to whether or not the turnkey solution can be deployed without requiring expensive, slow infrastructure upgrades to onsite facilities (e.g., power, internal network, or cooling).
- **Flexibility challenges.** Many turnkey solutions are primarily built to deliver one or a few specific applications. The ability to serve as a multi-purpose platform is an afterthought. As a result, they can end up as solution "silos" with limited flexibility to support future demands tied to emerging and rapidly evolving workloads such as AI.

Option 3: AI-optimized Intelligent Edge Platform

AI-optimized intelligent edge infrastructure options leverage architectures used in the public cloud to deliver an extended cloud experience to onsite infrastructure and can be completely consumed as a service. An "intelligent edge platform" such as GDC extends the public cloud operating model to the edge, with consistent APIs, a unified control plane, and a seamless developer experience between the cloud and the edge, which a traditional turnkey appliance (Option 2) typically lacks.

These solutions are differentiated from other turnkey solutions because they provide a platform approach designed for extensibility and flexibility, rather than one tuned to support a few specific applications.

Advantages

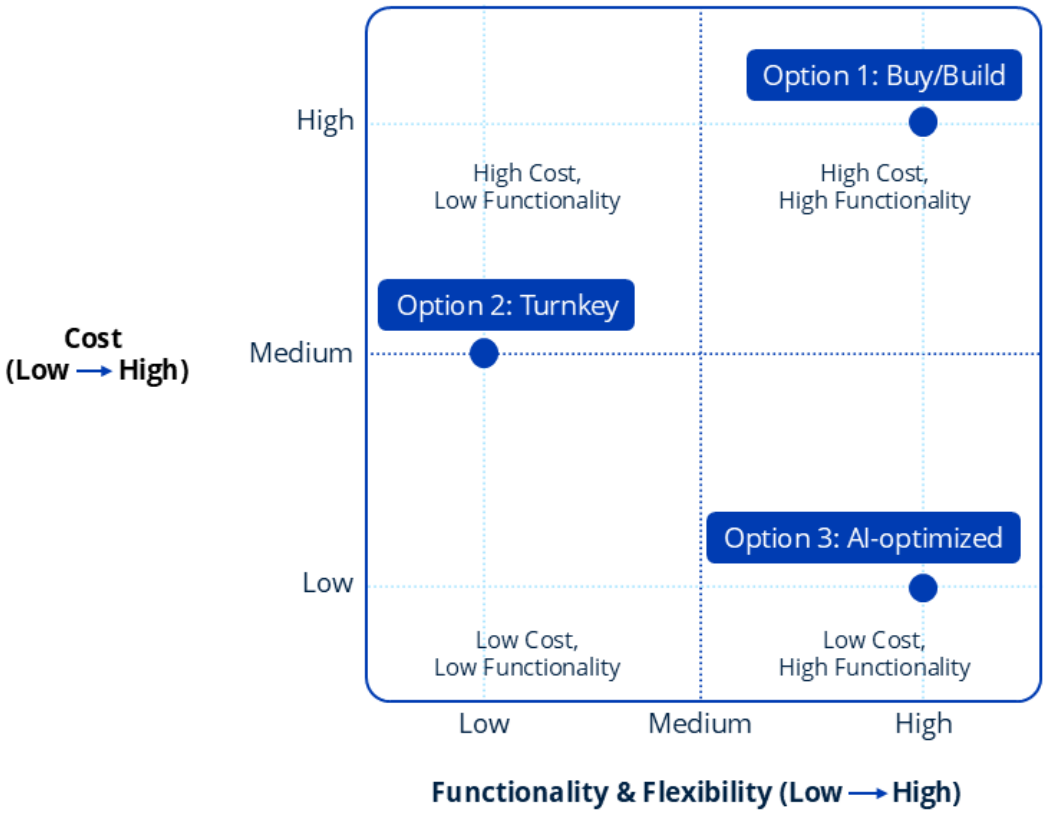
- **Reduced technology decisions.** These solutions provide the same advantages as turnkey solutions in that they come with a predetermined, pre-validated, and pre-integrated set of edge infrastructure hardware and software technologies. That greatly reduces efforts required for design, selection, validation, integration, and sourcing.
- **Integrated deployment and monitoring services.** Intelligent edge solutions will typically include a full lifecycle-as-a-service approach, covering design, testing, staging, deployment, and production monitoring, all included in the core licensing structure. It might also include software and hardware maintenance, further simplifying total cost of ownership and operations.
- **Fully flexible.** Although they are pre-validated and deployed in a similar fashion to turnkey solutions, intelligent edge platforms offer adaptable compute architectures in the public cloud to support flexible application options (including internally developed, open source, or options licensed from an independent software vendor).
- **AI-ready**. Intelligent edge solutions designed to be AI-optimized are specifically meant to support AI technologies, including access to the latest AI and generative AI models.

Disadvantages

- **Requires selection of software applications.** The intelligent edge platform approach does require the selection and validation of specific onsite applications residing on the edge infrastructure, similar to that of the build/buy option.

Overall, while each organization must evaluate these options against its own priorities and capacities (see Figure 2), the AI-optimized intelligent edge platform is the most forward-looking approach, aligning best with modern development practices.

Figure 2: Manufacturing AI Transformation Options Overview



Source: Omdia

Google Distributed Cloud, Powered by Intel, for Intelligent Manufacturing at the Edge

At the core of this solution are Intel Xeon scalable processors featuring Intel Advanced Matrix Extensions (Intel AMX). Intel AMX is a built-in accelerator that speeds up deep learning training and inference workloads—such as natural language processing and computer vision—without relying on additional discrete hardware.

By leveraging Intel AMX, manufacturers can:

- Reduce TCO by eliminating the cost and complexity of specialized discrete accelerators for many AI workloads.
- Boost performance by achieving up to 14x better training and inference performance compared with previous generations.
- Optimize for the edge by running complex BF16 and INT8 matrix operations directly on the CPU, making it ideal for space-constrained factory floors.

GDC is an example of an AI-optimized intelligent edge solution that is pre-built, pre-validated, and composed of compute, storage, and networking hardware. It also includes, by default, Google Kubernetes Engine (GKE)—an open source platform that automates the management, deployment, and scaling of containerized applications and services while supporting legacy VM requirements. For manufacturers, it offers many benefits, including:

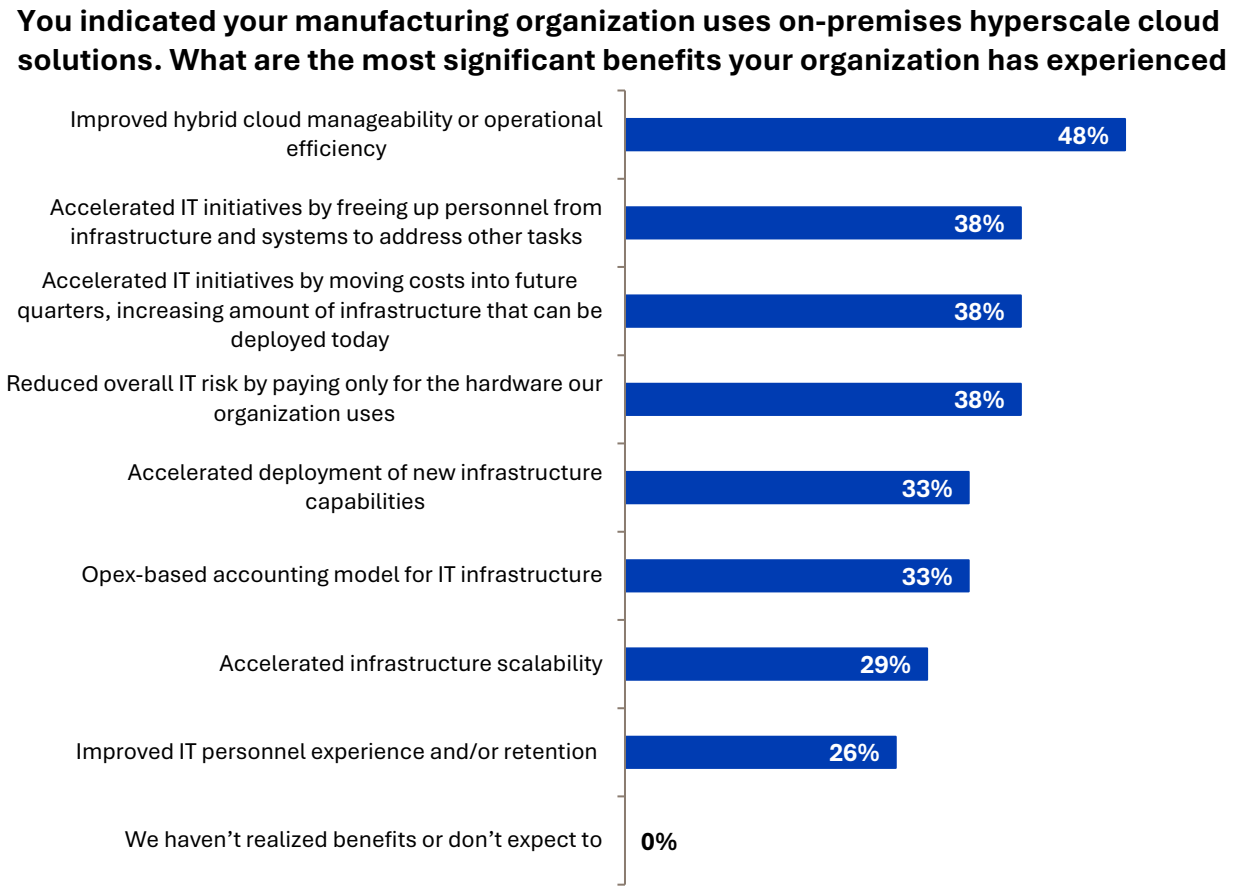
- **A highly available and scalable infrastructure designed for edge deployments.** GDC offers fully managed, highly available GKE clusters and is designed for high availability in environments with limited or intermittent internet access.
- **Multi-application support designed for AI.** It supports both VMs and containers, with optional GPU, enabling consolidation of existing and new AI-based applications on a single platform. The optional GPU support runs visual inspection AI models directly on the factory floor, catching defects in real time. That capability eliminates the need to stream high-resolution video feeds to the cloud, solving the latency and connectivity problem. While optional GPUs are supported, Intel AMX enables the CPU to handle demanding visual inspection AI models directly. This allows for real-time defect detection with a smaller hardware footprint, reducing power consumption and simplifying the thermal management required in harsh manufacturing environments.
- **An optimized footprint for onsite edge facilities.** Servers available in compact, small-form-factor configurations designed for the space and power constraints of edge facilities directly connect to a location's network equipment.
- **Multi-edge location manageability.** GDC provides the ability to centrally manage deployments across tens of thousands of locations. Organizations centralize applications in the cloud while enjoying the latency and connectivity advantages of running applications locally.
- **Integrated automation.** Google's automation and site reliability engineering practices control operational costs while helping to ensure uptime.
- **A platform-based architecture for hybrid cloud operations.** Google's platform technology offers consistency with its public cloud services, simplifying the ability to build applications in the cloud and deploy them to hundreds or even thousands of sites in a consistent, seamless manner. This is an important benefit, as 77% of manufacturing organizations agreed that consistency of experience across data center and cloud environments delivers significant operational benefits.[7]
- **Integrated services for the infrastructure lifecycle.** Inclusive professional services accelerate deployment onsite, reducing demands on internal personnel. Google Cloud support also includes 24/7 operational monitoring and maintenance services.

[7] Ibid.

- **Optimized operational costs.** Google helps reduce IT costs and resource spending with its fully managed hardware and software, eliminating the need for upfront architectural sizing and reducing the burden on internal personnel. Cost is based on usage to reduce the risk of overprovisioning infrastructure relative to business demand.

The data in Figure 3 highlights the benefits manufacturing organizations have realized from leveraging AI-optimized intelligent edge solutions such as GDC, including improved hybrid cloud manageability and the ability to accelerate time to value for digital initiatives.[8]

Figure 3: Benefits to Manufacturing Organizations From AI-optimized Intelligent Edge Solutions



Source: Omdia

[8] Ibid.

Conclusions

The manufacturing sector stands at a critical inflection point. AI-driven transformation is no longer optional; it is now almost essential for competitive survival. With 81% of manufacturing IT leaders reporting increased infrastructure complexity[9] and 75% taking on additional responsibilities to support digital transformation, traditional approaches to edge infrastructure are beginning to prove inadequate to meet the demands of intelligent manufacturing.

GDC, powered by Intel, can address several fundamental challenges facing modern manufacturers. By delivering cloud-native capabilities directly to factory floors and other edge locations, it eliminates the latency and connectivity constraints that can otherwise limit AI deployments in manufacturing environments. The platform's ability to run visual inspection models locally, manage thousands of edge locations centrally, and provide seamless hybrid cloud operations positions manufacturers to capitalize on AI's transformative potential while maintaining operational control.

The evidence so far is compelling. Organizations that embrace AI-optimized intelligent edge platforms could be gaining advantages in quality control, operational efficiency, and cost optimization. GDC's pre-validated architecture, integrated lifecycle services, and usage-based pricing model remove traditional barriers to edge deployments, enabling manufacturing industry IT teams to focus on innovation rather than infrastructure management.

[9] Source: Enterprise Strategy Group Research Report, *IT Transformed: Inside the Convergence of Hybrid Cloud and AI*, July 2025.

For manufacturing leaders evaluating their digital transformation strategy, the time for decisive action is now. The manufacturers that will thrive in the next decade could be those that successfully deploy AI at scale across their operations. GDC provides the foundation to make that vision a reality, delivering the performance, reliability, and operational simplicity required to transform manufacturing operations for the AI era.

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