

# The AI Imperative

Why Industrial Architectures Must Evolve



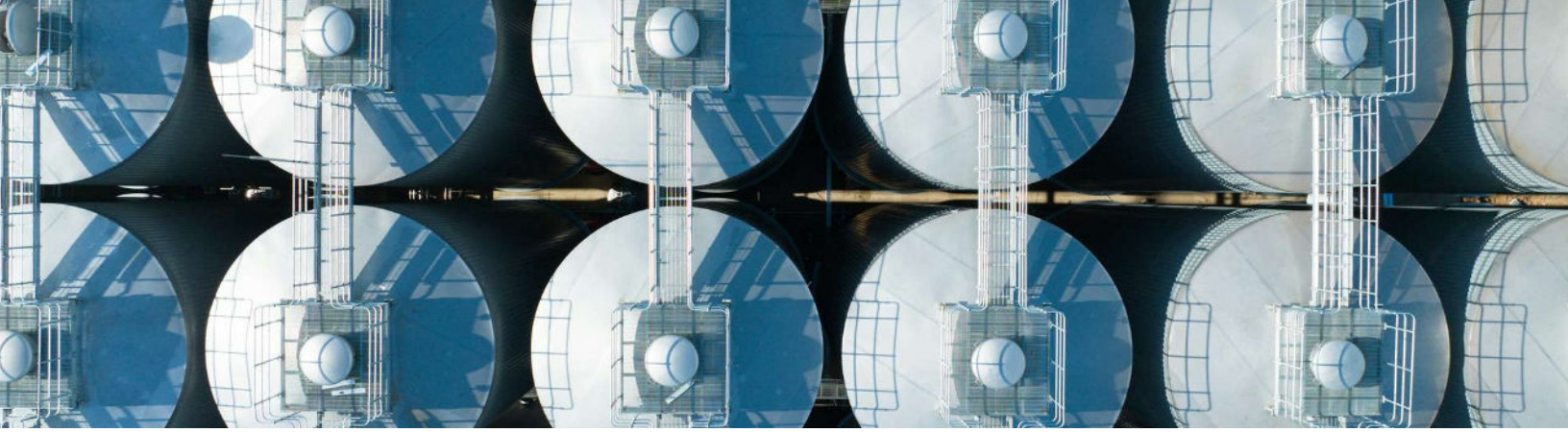
## Executive Summary: AI's Promise Depends on the Architecture Beneath It

Analysts have introduced the term Industry 5.0 to describe the next evolution in manufacturing—a phase that emphasizes human-centric innovation, sustainability, and resilience, all while leveraging advanced technologies like AI and IoT to drive productivity gains. Unlike Industry 4.0, which focused primarily on connectivity and IoT, Industry 5.0 seeks to blend human creativity with machine efficiency—ultimately creating smarter, more adaptive industrial ecosystems. Whether this represents a true fifth industrial revolution or is viewed as a natural evolution of Industry 4.0, the shift is unmistakable: manufacturers are moving from connectivity-led transformation to intelligence-led transformation—placing new demands on how industrial data is structured, contextualized, and delivered.

As a result, AI is rapidly reshaping investment priorities across manufacturing. Organizations are launching new technologies and pilot initiatives at an unprecedented pace—some guided by clear ROI objectives, others driven by competitive pressure and the fear of falling behind. Yet many of these initiatives encounter the

same obstacle: while AI capabilities advance quickly, the underlying industrial architectures required to support them have not kept pace—particularly the data operations needed to orchestrate, contextualize, and govern OT data at scale.

The foundation for this transformation was laid during Industry 4.0, which connected machines and sensors at scale. By 2030, manufacturing is expected to generate 4.4 zettabytes of operational technology (OT) data, according to [ABI Research](#). **Yet only about 5% of this data is effectively utilized today, largely due to fragmented silos and lack of contextualization.** This gap underscores the urgent need for modernized architectures that enable secure, interoperable, and contextualized data flows—a prerequisite for unlocking AI-driven insights across the enterprise.



## AI and IoT are Transforming Manufacturing... *but connectivity alone isn't enough*

AI is no longer a futuristic concept; it is actively transforming predictive maintenance, quality control, and supply chain optimization. Manufacturers are investing heavily in AI-driven analytics to improve efficiency and reduce downtime.

Similarly, IoT continues to accelerate, connecting assets and enabling real-time monitoring for asset health, overall equipment effectiveness (OEE), connected work cells, and more.

The convergence of AI and IoT is reshaping manufacturing from the inside out—but the winners aren't just connecting more devices; they're delivering

more context. As manufacturers move away from rigid, stovepipe systems that are costly and complex to integrate, they're embracing edge-first, event-driven architectures that support secure, flexible, and scalable data flows across the enterprise. This shift reflects a broader industry mandate: **AI can only accelerate decisions and unlock insights when OT data is not only collected, but also structured, contextualized, and delivered where it's needed.** By modernizing their connectivity and data foundations, manufacturers can turn fragmented signals into actionable intelligence—fueling smarter operations, faster innovation, and a more resilient industrial ecosystem.

## The Context Gap: Where AI Initiatives Stall

Manufacturers are awash in OT data but starved for usable information. AI value only appears when raw signals are turned into contextualized, trustworthy data products that flow to the right consumers at the right time. But the roots of this challenge extend back to Industry 4.0 itself. Even as it enabled the widespread connectivity of devices and systems, it failed to solve the persistent fragmentation of OT data. Critical information often resides in siloed applications such as SCADA, MES, and historians, making it difficult to integrate with IT systems for advanced analytics.

Addressing these issues isn't just a matter of connecting more systems. While Industry 4.0 brought waves of device and system connectivity, it never fully resolved the underlying problem: the data flowing from these systems remained siloed, fragmented, and difficult to operationalize at scale. Solving these challenges demands reimagining the industrial data architecture altogether—paving the way for modern, scalable approaches that finally unlock the value trapped in OT data.

**This challenge is exacerbated by:**

- **Lack of standardization:** Proprietary protocols and inconsistent data models hinder interoperability.
- **Scalability issues:** Point-to-point integrations create brittle architectures that cannot scale.
- **Growing contextualization gap:** Raw data without context limits its usefulness for AI and IoT applications.



## Evolving IT-OT Architectures for an AI-Ready Future

There is no one-size-fits-all approach to industrial data operations and IT-OT integration. Historically, stovepipe architectures dominated, relying on point-to-point integrations up and down the stack—with contextualization only happening in end applications. As manufacturers modernize, these legacy patterns rarely disappear all at once; instead, new models are introduced incrementally, layered alongside existing systems as architectures and use cases evolve.

Today, more modern approaches take a fundamentally different approach by distributing contextualization across the data pipeline. One common method is the **unified namespace (UNS) model**—a hub-and-spoke architecture that centralizes data for broader access

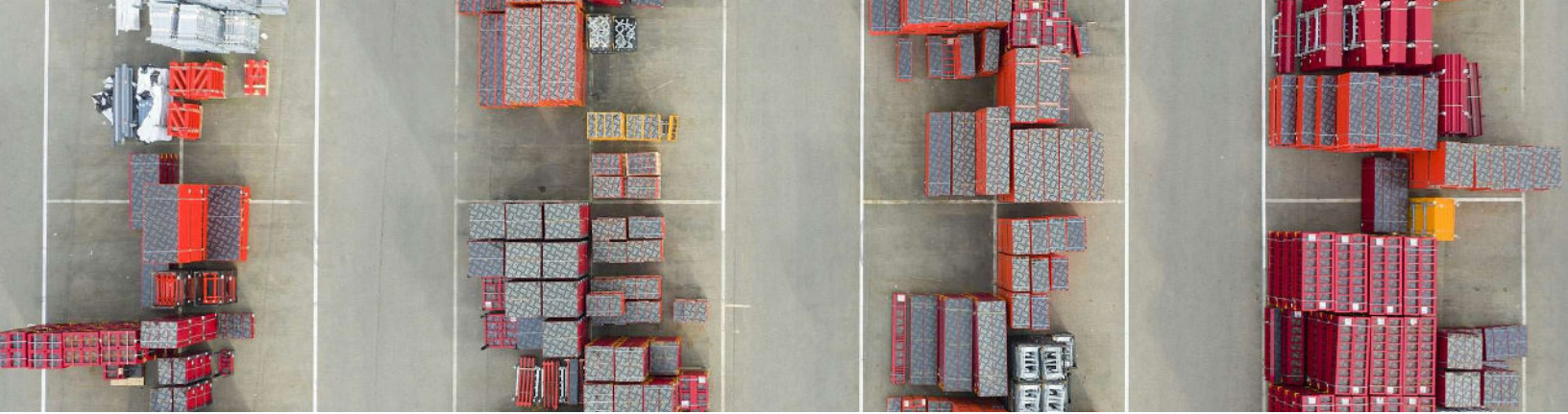
and eliminates the need for more fragile custom integrations. Others adopt **cloud-first strategies**, sending data to a central repository where context can be applied more consistently.

As these modern patterns mature, they naturally point toward the next horizon: **model-based enterprise principles** that enable truly scalable, standardized, and semantically rich data models capable of supporting AI at enterprise scale. This evolution allows manufacturers to move beyond simply transporting data toward building a resilient, future-ready architecture—one where OT data is accurate, contextualized, and ready to power innovation across the entire business.

### The Evolution of OT-IT Architectures

Architectures evolve over time. Most manufacturers adopt a combination of approaches based on industry, company, and use case.

| Traditional   | Current Approaches to IDO   |  | Future of IDO   |
|---|---|--|---|
| <p><b>Contextualize in Consumers</b></p> <p>End Applications</p> <p>Stovepipe architectures</p> <p>Context duplicated and diverged across silos</p> | <p><b>Contextualize in Distribution</b></p> <p>Unified Namespaces</p> <p>Hub &amp; Spoke Architectures</p> <p>Context added in data pipelines and message brokers</p> | <p><b>Contextualize in Repository</b></p> <p>Industrial Data Management</p> <p>Data platforms, archives, and lakes</p> <p>Context in metadata catalogs enhances models</p> | <p><b>Contextualize at Source</b></p> <p>Model-Based, Schema-Aware Ecosystems</p> <p>Semantic consistency across enterprise</p> <p>Context managed and governed for all systems</p> |



# Industrial Connectivity: The Backbone for AI-Ready Operations

Industrial connectivity is the foundational enabler of modern data operations. No matter how advanced an organization's AI ambitions may be, those investments cannot deliver value without a reliable way to connect, normalize, and secure data across the diverse landscape of OT assets. As manufacturers modernize legacy architectures, connectivity becomes more than a transport mechanism—it becomes the strategic layer that unifies fragmented systems and transforms raw signals into usable, trustworthy information.

## Standardizing Data Across Diverse OT Environments

While traditional approaches often foster siloed environments that make contextualization all the more challenging in upstream applications, today's industrial connectivity solutions change this dynamic by abstracting devices from applications and converting proprietary data into open, secure standards such as OPC UA, MQTT, HTTP, and database formats. This standardization creates a single, consistent interface for OT data, dramatically simplifying IT-OT integration and reducing the operational burden of maintaining custom or one-off integrations.

## Enabling Industrial Data Ops at Scale

A robust Industrial Data Ops (IDO) strategy requires more than data transport—it requires orchestrating, contextualizing, governing, and delivering OT data for AI, digital twins, cloud analytics, and machine learning. Industrial connectivity solutions serve as the foundation for this work by ensuring that OT data is:

- Accessible across all device types
- Normalized and consistent across formats
- Securely transmitted to enterprise systems
- Ready for contextualization in distribution, at the repository, or at the source

By eliminating siloed data flows and inconsistent integrations, connectivity becomes the operational backbone for enterprise-wide data use.

## Supporting Unified Namespace Architectures

By feeding clean, normalized, event-driven data into a central hub, modern industrial connectivity solutions eliminate the complexity of point-to-point integrations and enable consistent access to OT data across MES, SCADA, historians, ERP, cloud platforms, and IoT applications. This approach not only streamlines data access but also creates the semantic consistency and scalability required for enterprise-wide transformation.

## Accelerating Transformation Through Containerized Connectivity

Connectivity is also evolving to support more modern, mature deployment models. Containerized, Linux-based platforms give organizations greater flexibility in how and where industrial connectivity is deployed—reducing operational overhead, improving portability, and enhancing security. Containerized solutions integrate with modern orchestration tools to enable consistent, repeatable deployments that scale across sites and infrastructure without the complexity of traditional Windows-based systems. These lightweight, high-performance architectures strengthen an organization's ability to run event-driven data flows at the edge, where responsiveness and security are paramount.

A robust industrial connectivity strategy ensures that organizations can not only access their OT data—but they can **trust it, scale it, and use it to power truly data-driven operations**. And when manufacturers strengthen the backbone of their AI and digital transformation initiatives, the conversation naturally shifts from abstract principles to proven practice: modern industrial connectivity is no longer theoretical—it's validated every day on factory floors around the world.

**Today, Kepware is used by 75 of the Top 100 global manufacturers, incorporating over 30 years of expertise to provide the foundation for diverse data to flow seamlessly into AI, analytics, and enterprise systems.**

Leading manufacturers have already demonstrated the impact. [HNI Corporation](#) used Kepware to quickly integrate legacy assets and unlock real-time visibility across sites, while [Electrolux](#) standardized connectivity to transform fragmented machine data into insights that improved quality and uptime. And with advancements like [Kepware Edge](#) and Kepware+ Manager, Kepware is driving containerized, Linux-based connectivity that powers today's edge-first, event-driven architectures.

For manufacturers accelerating toward Industry 5.0, modernizing the connectivity layer becomes the essential first step—one that enables every downstream investment in analytics and AI to deliver on its promise. But before any organization

can optimize its operations or unlock new forms of intelligence, it must first understand its current state. Which systems operate in isolation? Which work together? And most importantly, does the architecture in place allow data to be used in all the ways modern manufacturing now makes possible?

Taking this big-picture view helps leaders see where fragmentation still exists, where integration can help, and where new approaches are needed to support scalable, future-ready data flows. When organizations establish a consistent, secure, and interoperable approach to connectivity, they create a foundation for trustworthy data to move freely across the enterprise—fueling everything from UNS strategies to edge-driven AI.

**As manufacturers evaluate how to modernize their data foundations, choosing the right connectivity strategy becomes a pivotal decision. Explore the Tech-Clarity Buyer's Guide to understand the key criteria for evaluating today's connectivity landscape and selecting an architecture built for the future.**

**Read the Guide**

