LTIMindtree

iNXT
From LTIMindtree

Whitepaper

# Industrial Cloud Computing

## for Manufacturing, Energy and Utilities

# Contents

# Executive Summary

Industrial cloud computing harnesses cloud technologies specifically designed for industrial sectors such as manufacturing, energy, and utilities to drive operational efficiency and data-driven decision-making. By enabling real-time data collection, analysis, and visualization from the industrial shop floor, it enhances the performance, predicts failures, and optimizes processes. This approach emphasizes advanced data management from industrial equipment, sensors, and control systems—extending beyond traditional IT infrastructure to meet the unique demands of industrial environments with the help of cloud technologies.

# Introduction

Industrial cloud computing refers to the strategic application of cloud technologies designed and customized specifically for sectors such as manufacturing, energy, and utilities. It enables real-time data collection, analysis, and visualization from industrial equipment, sensors, and control systems—going far beyond traditional IT infrastructure. By leveraging these capabilities, organizations can enhance operational efficiency, enable predictive maintenance, and make informed, data-driven decisions. The emphasis lies in collect, integrate and managing complex industrial data environments to optimize performance and meet evolving industry demands.

Industrial cloud platforms (ICPs)—also known as vertical cloud platforms—are purpose-built cloud solutions designed to meet the unique operational, regulatory, and technological needs of specific industries such as healthcare, logistics, manufacturing, energy, and utilities.

In contrast to general-purpose cloud platforms, ICPs are designed to:

- Understand and align with **industry-specific workflows.**
- Ensure compliance with **sectoral regulations and security standards.**
- Address **complex challenges** that are often unmet by traditional cloud solutions.

For example, an ICP designed for healthcare will differ significantly from one built for logistics, reflecting the distinct data governance, compliance, and operational requirements of each sector. By embedding domain expertise and specialized capabilities, these platforms accelerate digital transformation and deliver industry-relevant outcomes with greater precision and agility.

# Barriers to ICP Adoption

In today's industrial landscape, digital applications are often siloed within specific business operations or regional plant implementations, necessitating extensive customization. This fragmentation leads to the deployment of multiple applications tailored to individual business needs, resulting in significant maintenance burdens, scalability challenges, and increased technical debt. Legacy systems further complicate digital transformation across business functions, as organizations hesitate to adopt modern technologies that might disrupt the reliability of existing operations. In sectors like energy and utilities, where public service continuity is critical, downtime can have severe consequences—prompting continued reliance on legacy infrastructure. Similarly, in manufacturing, concerns over operational reliability hinder the adoption of advanced digital technologies, limiting improvements in production efficiency and impacting revenue outcomes.

**Customization Challenges in Manufacturing-Specific Business Applications**

Manufacturing industries face distinct challenges when customizing digital applications to meet operational demands:

**Mass Production Efficiency**

Large-scale manufacturing tailored to customer-specific requirements demands flexible and technologically advanced production systems.

**Personalization for User Experience**

Customization enhances usability by aligning software and services with individual user preferences, improving intuitiveness and satisfaction.

**Strategic Differentiation**

Tailored solutions help businesses stand out by offering unique capabilities that cater to niche customer segments, fostering competitive advantage.

**Operational Optimization**

Customized applications streamline workflows, automate repetitive tasks, and enable deeper data insights—boosting productivity and reducing costs.

**Customer Satisfaction and Loyalty**

Meeting specific customer needs through customization leads to improved satisfaction and long-term loyalty.

**Real-Time Data Challenges in Energy and Manufacturing Industries**

Organizations in energy and manufacturing face several industry-specific hurdles when leveraging real-time data:

**Data Complexity**

The volume and variety of industrial data—from sensors, equipment, and control systems—make it difficult to manage and interpret effectively.

**Data Quality and Integration**

Ensuring accurate, consistent data gets integrating it across disparate systems remains a major challenge.

**Cybersecurity Risks**

Real-time data flows increase exposure to cyber threats, requiring robust security frameworks to protect sensitive operational information.

**Legacy System Constraints**

Many industrial environments still rely on outdated infrastructure, limiting the adoption of modern data solutions and real-time analytics.

**Regulatory Compliance**

Strict industry regulations demand careful handling, storage, and processing of real-time data to avoid legal and operational risks.

**Reactive Maintenance Practices**

Unplanned or corrective maintenance approaches that respond to equipment failures or performance issues as they occur, rather than preventing them proactively.

# Operational Visibility Challenges in Manufacturing and Energy Industries

Manufacturing and energy sectors face significant limitations in achieving end-to-end visibility and control over their operational workflows due to continued reliance on legacy systems. The lack of real-time integration across devices and plants with digital applications hinders the ability to simulate production processes and establish a centralized command center view. This fragmentation restricts informed decision-making and impedes efforts to modernize operations effectively.

Current industry applications operating on on-premises infrastructure face scalability limitations, hindering the adoption of advanced technologies such as digital triplet—comprising digital twin and AI-driven capabilities.

Integrating historical and real-time data for AI training is currently constrained by the scalability challenges of on-premises infrastructure. Vertical and horizontal scaling limitations in traditional data centres hinder performance and flexibility. Additionally, the process is time-intensive and incurs high capital costs—including expenses for data centre rental, cooling systems, electricity, and water—making it inefficient for advanced technologies like AI and digital twin deployment.

# Unlocking Industry Transformation through Cloud Adoption

The challenges outlined above can be effectively addressed through the adoption of industry-specific cloud platforms. These platforms integrate traditional cloud services with tailored capabilities for sectors like manufacturing, energy, and utilities, enabling organizations to overcome vertical-specific complexities and accelerate time-to-value.

By leveraging composability, these platforms make it easier to deploy differentiated innovations. They harness advanced technologies such as Cloud IoT, integrated data fabrics, packaged business capabilities via marketplaces, edge engineering, AI, and composability tooling—providing the agility needed to respond to rapid industry changes.

Data integration hurdles are resolved through industry-standard data integrators, which seamlessly connect cloud-native services with legacy systems using JDBC and ODBC drivers. Scalability concerns are mitigated by cloud platforms designed for industrial use, offering enhanced business capabilities and cost efficiencies that significantly reduce Total Cost of Ownership (TCO).

# Realizing the Vision of Industry Cloud Platforms

Industry Cloud represents a connected digital ecosystem that unifies devices, data, applications, and services to enable scalable, industry-specific use cases. These platforms are agile and composable, built on a catalog of modular, industry-tailored building blocks and services that deliver measurable business outcomes through cloud-native tools and technologies.

To realize this vision, organizations must build a secure, scalable, and flexible Industry Cloud Platform capable of integrating, storing, transforming, and visualizing data for actionable insights. The solution architecture includes:

### Industrial Edge Integration

- **Edge Engineering:** Bridges OT and IT systems through an interconnected network of sensors and actuators.
- **Industrial Agents:** Context-aware, purposeful agents that support autonomous decision-making at the edge.

### OT Layer Enablement

- **MES, SCADA and Historian Systems:** Serve as the memory core of production operations.
- **Industrial Standardization:** Establishes a unified namespace and standardized data models for consistent industrial data handling.

### IT Layer Connectivity

- Industrial Cloud Middleware: Seamlessly connects enterprise systems with hyperscale platforms.
- Digital Triplets (Digital Twin + Industrial AI): Enables scenario simulation and closed-loop optimization.
- Cloud Data Platforms: Incorporate data Lakehouse/warehouse architectures with industry data fabrics for robust data management.
- Unified Command Center: A single-pane-of-glass view for proactive, real-time operational decision-making.
- Smart ESG 2.0: Supports sustainability goals by contributing to global carbon footprint reduction through intelligent industrial practices.

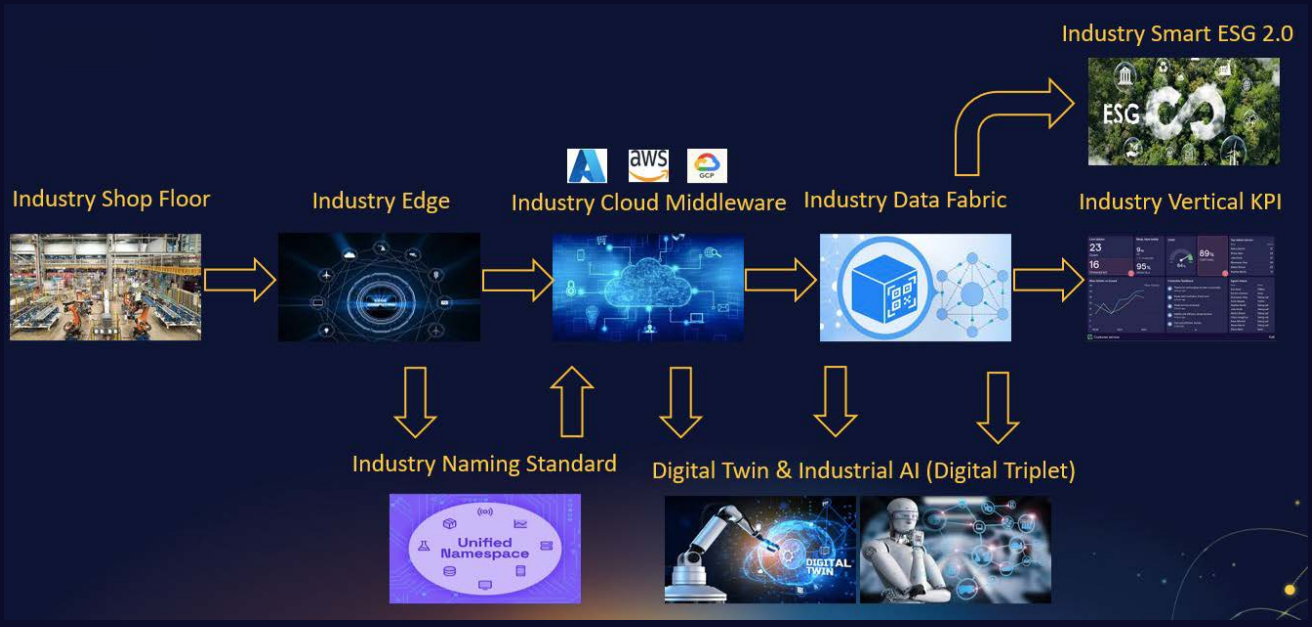


Figure 1: Comprehensive View of Industrial Cloud Computing

# Driving Industry Growth through Cloud Solutions

Composable Industry Cloud Platform for IoT–Solving Industrial 5.0 Challenges: The Industry Cloud Platform for IoT adopts composable architecture, supported by a catalog of modular building blocks designed to address complex Industrial 5.0 challenges across manufacturing, energy, utilities, ESG, and connected products.

At LTIMindtree, the platform operates via three solution streams:

- **Industry-Standard Tools**
  Third-party products from leading vendors that align with industrial protocols and standards.
- **Cloud-Native and PaaS Services**
  Offerings from hyperscalers such as Azure, AWS, and GCP, enabling scalable and flexible deployment.
- **LTIM's Proprietary iNXT Platforms**
  Purpose-built solutions tailored to industrial use cases, offering deep integration and domain-specific capabilities.

Each building block of the platform can be implemented using tools, PaaS Services, or proprietary platforms, allowing organizations to select the best option for their needs and digital maturity.

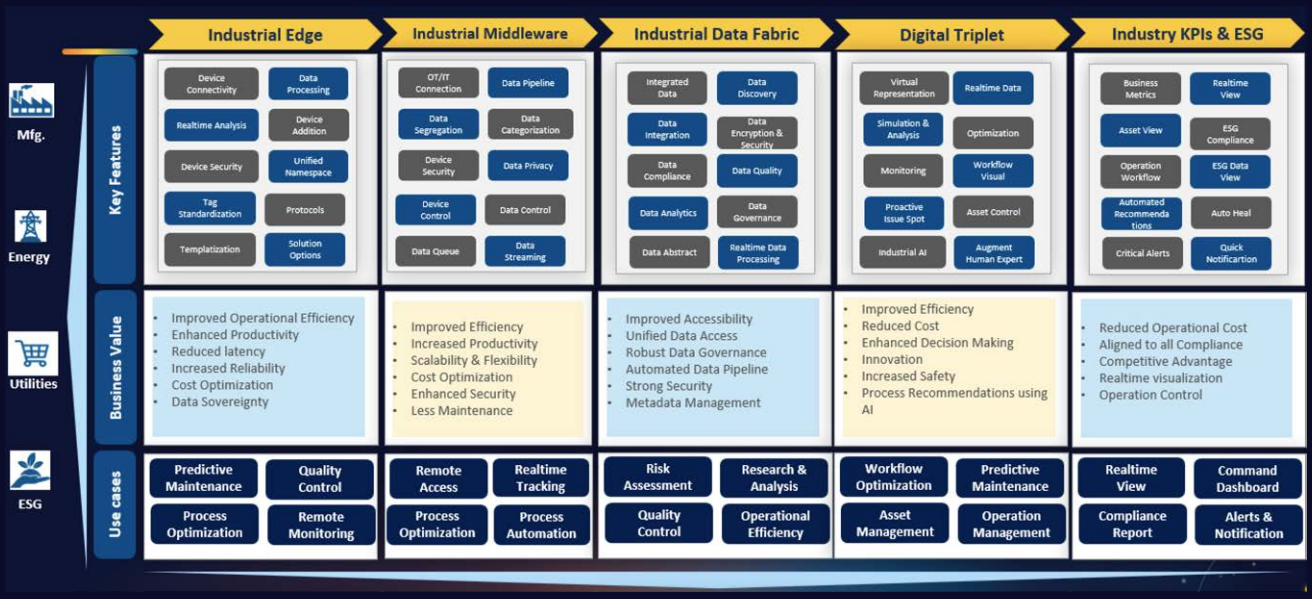


Figure 1: Comprehensive View of Industrial Cloud Computing

Industrial Edge refers to the deployment of edge computing technologies within industrial environments to enable real-time data processing, low-latency decision-making, and IT-OT convergence. It bridges the gap between Operational Technology (OT) systems like PLCs, SCADA, MES, and Historian, and Information Technology (IT) platforms such as cloud and analytics engines.

Industrial Edge plays a pivotal role in enhancing operational efficiency, productivity, reliability, and low-latency performance by enabling seamless connectivity to industrial devices, sensors, and actuators. It supports real-time data analysis through standardized protocols and unified namespace concepts, including tag standardization, consistent and actionable data across operations.

Beyond connectivity, Industrial Edge empowers execution of Industrial AI scenarios such as predictive maintenance, process optimization, and remote quality monitoring, even on low-power devices.

Functioning as a bridge between Operational Technology (OT) and Information Technology (IT) networks, Edge acts as a buffer to the cloud—especially in environments with limited or unstable network access. It facilitates real-time data transfer from systems like PLCs (Programmable Logic Controller), SCADA (Supervisory Control and Data Acquisition), sensors, MES (Manufacturing Execution System), historian, and LIMS (Laboratory Information Management Systems) to cloud using protocols such as MQTT, ensuring continuous data flow and visibility across the enterprise.

LTIM supports Industrial Edge to customers with these options:

| Tools/Third-party products | Cloud Native/PaaS | iNXT Platform |
|---|---|---|
| Litmus Edge<br>Aveva<br>Kepware<br>Ignition Edge | Azure edge Runtime<br>AWS IoT Greengrass | Edge NxT |

Tools like Litmus, Ignition, and Kepware offer pre-built device drivers that enable seamless connectivity to shopfloor equipment. These edge solutions standardize data exchange between industrial devices and OT/IT systems using both open standards and proprietary industrial protocols, ensuring secure and scalable integration across manufacturing, energy, and utility operations. They can function independently or be deployed alongside cloud provider edge VMs and runtimes.

At the core of IT/OT convergence is Industrial Middleware, which facilitates real-time data ingestion from devices into the IT layer. This middleware queues incoming data applies in-stream analytics and transformation logic and delivers actionable insights for rapid decision-making.

These services support protocols such as MQTT, AMQP, HTTP, and HTTPS, and include protocol transformation capabilities to ensure seamless data flow. MQTT is commonly used for connectivity for device telemetry, with Unified Namespace (UNS) standardization occurring at the MQTT layer. Open-source platforms like HiveMQ, Kafka, and Cirra Link play a key role in forming and maintaining the UNS.

The middleware layer receives real-time telemetry and UNS data from systems like PLCs, SCADA, MES, Historian, and LIMS, acting as the critical bridge to cloud platforms. This is where OT-IT integration occurs by supporting scalable, secure, and intelligent industrial operations.

## Industrial Data Fabric for a Connected and Intelligent Industrial Ecosystem

Industrial data fabric serves as the backbone for building a connected industrial ecosystem, seamlessly integrating siloed data across customers, suppliers, and partners. It enables the digitalization of supply chains and manufacturing processes, helping industries overcome the limitations of rigid legacy systems. By consolidating, analyzing, and democratizing data from the factory floor to the end of the supply chain, it enhances performance visibility and provides a unified command center view for pro-active decision-making.

### Data Integration and Transformation

- OT data is integrated with the IT layer via industrial middleware, while historical data is connected through data integrators and SQL connectors.
- Data is transformed, standardized, and processed within a cloud data platform, then contextualized using master data and metadata, and stored in centralized data warehouses or lake houses.

### Data Activation and Consumption

- Contextualized data is activated for consumption, enabling real-time insights across business functions.
- Industrial Data Fabric encompasses data integration, standardization, transformation, quality, and governance.
- It ensures secure data cataloging and sharing with various consumers, forming the foundation of a Cloud Data Platform that supports secure and scalable data access.

### Implementation steps for Industry Data Fabric

- **Identify industrial data**
  Capture data from sensors, assets, enterprise systems, and operational layers.
- **Unify the data**
  Integrate OT, IT, and enterprise data using Industrial Edge connectors and standardize it into a unified namespace.
- **Contextualize the data**
  Transform and enrich data within the cloud data platform for meaningful insights.
- **Activate the data**
  - Deploy digital twin models
  - Implement Industrial AI and Agentic AI
  - Build decision support systems for field operations
  - Create dashboards, reports, and alerting mechanisms for rapid response
- **Democratize the data**
  Govern and securely share data across stakeholders to foster transparency and collaboration.

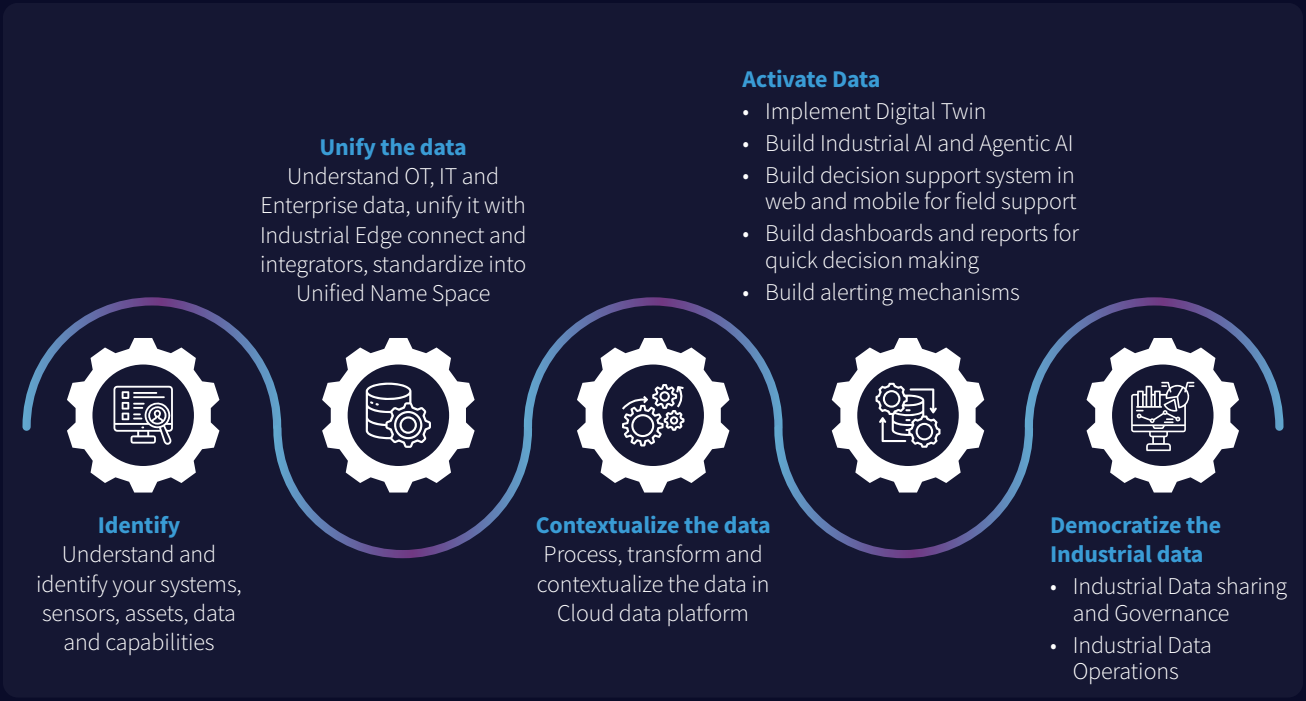


Figure 3: Implementation Steps for Industry Data Fabric

**Digital Triplet: Merging Digital Twin and Industrial AI for Intelligent Operations**

Digital triplet is a transformative concept that combines digital twin and Industrial AI to enable real-time monitoring, analysis, and autonomous decision-making across the entire product lifecycle. It involves building context-aware, purposeful AI systems that simulate physical assets as virtual models, offering detailed snapshots of product states at specific points in time to enhance operational efficiency.

**Key use cases include:**

- Predictive maintenance
- Asset management
- Workflow optimization
- Operations management

**Industrial KPIs and Smart ESG: Unified Operational Intelligence**

To support governance and control, Industrial KPIs and Smart ESG provide a comprehensive command center view of operational metrics. This includes:

- Real-time operational visibility
- Asset performance overviews
- ESG compliance parameters
- Critical alerts and notifications

These insights use industry-standard tools, services, and platforms to help organizations make proactive, informed decisions that support sustainability goals.

| Tools/Third-party products | Cloud Native/PaaS | iNXT Platform |
|---|---|---|
| Aveva | PowerBI | Smart ESG 2.0 |
| Cognite | Qlik | SSV |
| Palantir | Tableau | |
| Dassault | Looker | |

**Case Study: Transforming Legacy IoT for a Global Elevator Manufacturer**

LTIMindtree partnered with a leading US-based elevator manufacturer to modernize its legacy IoT systems into a global industry cloud IoT platform. This transformation was part of a condition-based maintenance initiative spanning multiple regions.

- Scope: Designed for 284,000 units (elevators and escalators) across North America, EMEA, and APAC, with deployment in 100+ countries.
- Use Cases: Real-time performance monitoring and predictive analytics using historical service call data.
- Solution Highlights:
- Built reusable data pipelines to ingest sensor data globally.
- Developed a highly available and scalable Global IoT hub on the cloud.

This initiative highlights LTIMindtree's capability to deliver scalable, intelligent, and resilient industrial solutions tailored to global operations.

# Conclusion

The industrial cloud platform leverages a powerful set of technologies designed to deliver real, measurable impact across manufacturing, energy, and utility sectors. With a modular, composable architecture, it allows organizations to scale efficiently while minimizing complexity and technical debt. The industrial data fabric connects and contextualizes siloed data, and packaged capabilities with APIs accelerate solution development and integration. AI and machine learning drive predictive insights and intelligent automation, while digital twins and simulations enable real-time monitoring and scenario planning. Crucially, sustainability is built in, aligning day-to-day operations with ESG goals. Backed by LTIMindtree's iNXT suite, businesses can confidently adopt and scale Industry Cloud solutions at every layer of their operations—faster, smarter, and with lasting results.

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Meena is the practice head of industrial middleware and data engineering at LTIMindtree's iNXT service line that focuses on building large scale Cloud, IoT and data platforms. She is a renowned multi-cloud expert professionally certified in Azure, AWS, GCP and Databricks. She helps our customers with technical advisory, design, architecture, and implementation of cloud-based IoT and data platforms. She is LTIM's AWS technical Ambassador and has co-authored books on Microsoft Synapse Analytics.

## Mohamed Imran

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Mohamed Imran is a highly experienced senior solution architect with over two decades of expertise in designing and architecting innovative data, connected IoT and cloud solutions. With specialization in Microsoft .NET, Data, Microsoft Azure, AWS, and GCP, Imran has led successful large-scale customer implementations and pre-sales engagements across global markets, consistently driving impactful business outcomes. Known for bridging business goals with technology strategies, Imran excels in crafting compelling proposals with technology solutions, RFP responses, technical advisory and documentation. A passionate advocate for emerging technologies and client success, Imran continues to shape enterprise digital transformation initiatives worldwide