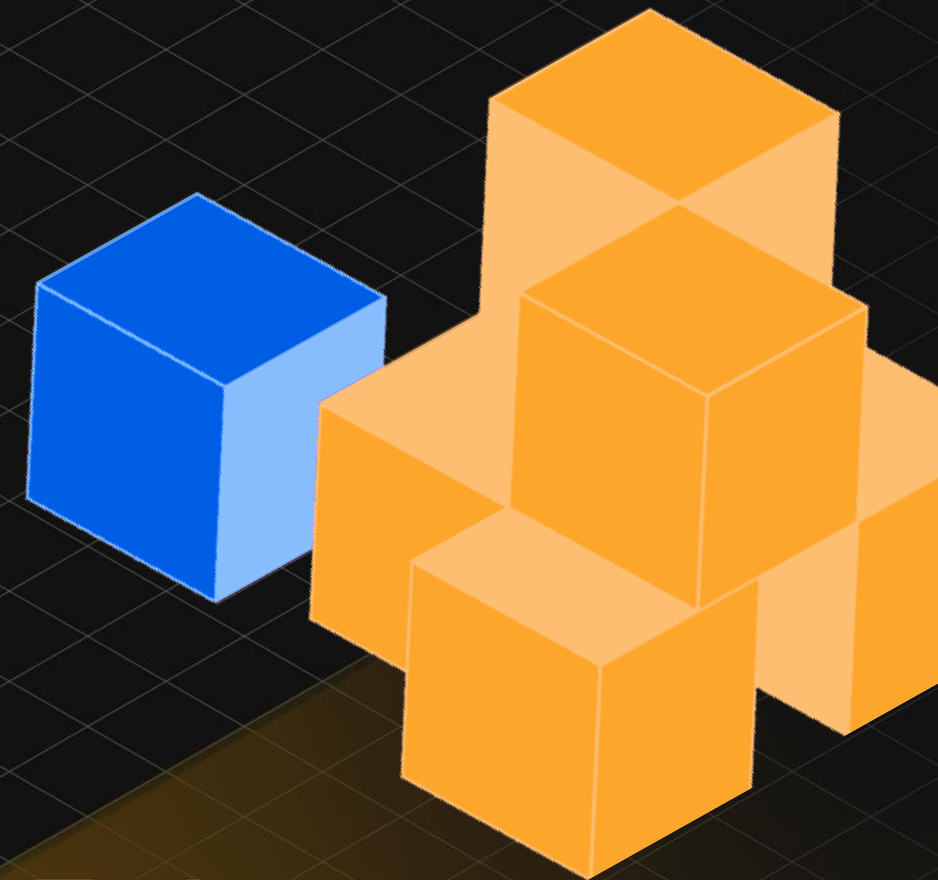
SymphonyAI



WHITE PAPER

Self-defined intelligent Digital Twins: The next era of autonomous, contextualized operations

INDUSTRIAL

Self-defined intelligent Digital Twins: the next era of autonomous, contextualized operations

About SymphonyAI

SymphonyAI is building the leading enterprise AI SaaS company for digital transformation across the most critical and resilient growth verticals, including retail, consumer packaged goods, finance, manufacturing, media, and IT/enterprise service management. SymphonyAI verticals have many leading enterprises as clients. Since its founding in 2017, SymphonyAI has grown rapidly to 3,000 talented leaders, data scientists, and other professionals. SymphonyAI is an SAIGroup company, backed by a $1 billion commitment from Dr. Romesh Wadhwani, a successful entrepreneur and philanthropist. More at www.symphonyai.com.

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Introduction and market dynamics

Executive summary: real-time, contextualized operations through self-defined Digital Twins

In today's volatile industrial landscape, manufacturers and energy operators are under unprecedented pressure to achieve operational excellence, sustainability, and agility. As facilities and supply chains grow in complexity, the need for real-time, unified insight is more pressing than ever.

Digital twins—a dynamic, digital representation of physical assets, systems, and processes—have emerged as a cornerstone of the next industrial revolution. According the Gartner, by 2026, 75% of organizations implementing IoT projects will have implemented at least one digital twin highlighting the growing strategic importance of this technology (Source: Gartner Market Guide for Digital Twin Solutions, 2023). These digital twins require a unified data model to aggregate and contextualize all relevant data types (historical and real time, structured and unstructured) as the foundation of scalable, flexible digital twins.

75%

of organizations implementing IoT projects will have implemented at least one digital twin highlighting the growing strategic importance of this technology

The traditional digital twins of the past are not enough. Siloed data sources, static models, and disconnected visualizations hamper true transformation. SymphonyAI's IRIS Foundry empowers organizations to harness self-defined, intelligent digital twins at scale—delivering real-time, contextual understanding and autonomous decision-making with flexibility and speed.

Digital Twin maturity curve

Data collection
Basic connectivity to assets and systems. Manual data aggregation; siloed data sources.
STAGE 1

Visualization
Data unified in dashboards. Static models; real-time monitoring.
STAGE 2

Simulation
Dynamic models; ability to simulate scenarios and conduct root-cause analysis.
STAGE 3

Automation
Closed-loop optimization and automated workflows.
STAGE 4

Intelligent Digital Twins
Unified, model-driven twins. Self-learning, context-aware, adapts to changing assets, processes, and business goals.
STAGE 5

Evolving needs in modern manufacturing: key challenges and opportunities

According to IDC's latest research, worldwide spending on digital twin solutions is accelerating rapidly, projected to reach $24.7 billion by 2025, driven by the growing need to manage increasingly complex industrial operations (Source: IDC Worldwide Digital Twin Software Platform Forecast, 2023-2027).

$24.7 B

According to IDC's latest research, worldwide spending on digital twin solutions is accelerating rapidly, projected to reach by 2025

Manufacturers across the globe are striving to transform their operations, aiming for unprecedented levels of agility, efficiency, and competitiveness. However, as they advance along the path of digital transformation, several persistent challenges continue to hinder progress and dilute the impact of new technologies. Understanding these obstacles is essential for building a resilient digital strategy and unlocking lasting operational value.

Key challenges currently facing modern manufacturers include:

- **Persistent Data Silos:** Data is trapped within IT, OT, and engineering systems, requiring manual effort to access and unify for analytics or AI.
- **Data Growth Explosion:** Industrial data generation is outpacing current management capabilities, with growth projected at 50% over two years.
- **Lack of Contextualization:** Even when data is consolidated into lakes, its lack of operational context renders it unusable for frontline and data science personnel.
- **Slow Digital Adoption:** Enterprises are stuck in pilot purgatory, unable to scale digital initiatives due to legacy conventions, vendor lock-in, and asset diversity.
- **AI at a Standstill:** Predictive AI models struggle to deliver production value, as manual data wrangling and limited contextual understanding block deployment.
- **Static Visualization Models:** 3D design models quickly become outdated, failing to reflect live operations or sensor data.

Addressing these challenges is crucial for manufacturers seeking to fully capitalize on the transformative potential of digital twins, advanced analytics, and AI. By breaking down data silos, contextualizing information, accelerating digital adoption, and enabling live, real-time insights, manufacturers can position themselves for sustained success in an increasingly digital and competitive world.

SymphonyAI IRIS Foundry: Laying the foundation for intelligent Digital Twins

IRIS Foundry overview: Modular, real-time, and scalable

IRIS Foundry is SymphonyAI's purpose-built industrial DataOps platform, architected to deliver digital twins that are modular, scalable, and context-rich. Unlike traditional platforms of the past, IRIS Foundry is designed for modularity—supporting rapid creation and deployment of "micro twins" tailored for different use cases and teams.

Key foundation elements include:

- **Prebuilt connectors:** Seamlessly integrate IT, OT, and engineering data sources.
- **Polyglot data stores:** Enable flexible handling of diverse data types (time series, documents, 3D models, images).
- **Unified data model:** Standardize IT, OT, and engineering data into a single, extensible model.
- **Unified namespace:** Establish a single, trusted source of operational truth

Unified data model

The semantic backbone of Industrial Digital Twins

At the core of IRIS Foundry is a unified data model that brings together all relevant operational, engineering, and IT data—regardless of source, format, or scale—into a single semantic layer. By harmonizing data through automated contextualization and knowledge graphs, the unified data model breaks data silos and enables modular, scalable digital twins.

This empowers every user, from field technician to data scientist, to interact with trusted, contextualized information that reflects the ever-changing realities of industrial operations. Further, robust governance and domain-driven data ownership ensure that the unified model remains trusted, extensible, and fit for all critical use cases.

Knowledge Graph / Cortex

The dynamic network linking data, assets, and operations

The Knowledge Graph, or Cortex, maps the complex relationships among assets, processes, events, and documents across industrial environments. By dynamically connecting and contextualizing information from IT, OT, and engineering sources, it provides users with intuitive navigation and unified access to relevant data.

This interconnected structure enables flexible search, advanced analytics, and rapid insight generation—ensuring that data remains meaningful, up-to-date, and actionable as operations evolve. The Knowledge Graph is foundational for enabling autonomous workflows, cross-domain visibility, and scalable, intelligent Digital Twin ecosystems.

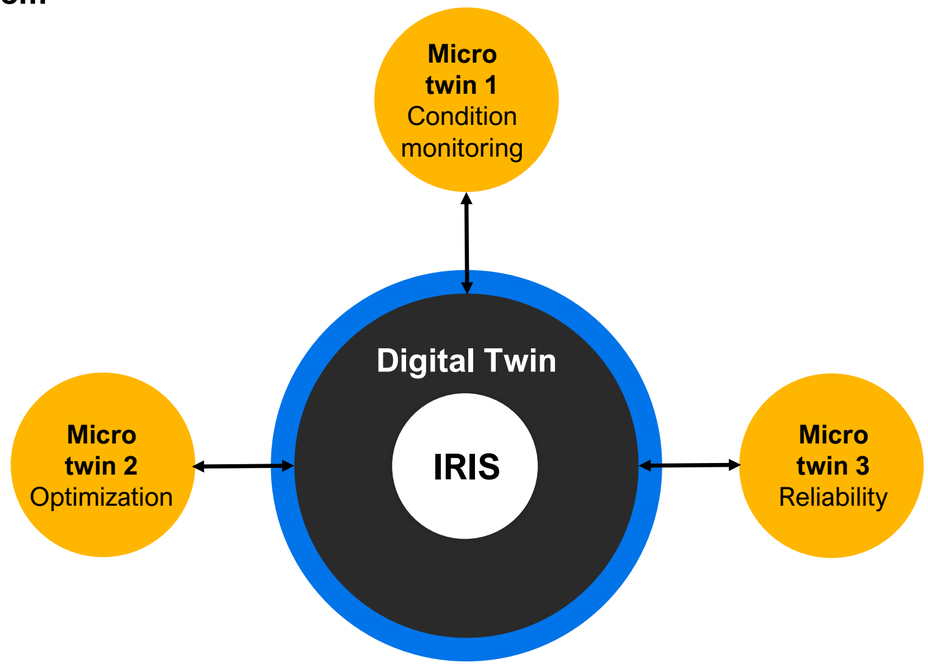
Industrial DataOps: the bedrock of scalable Digital Twin ecosystems

Modern digital twins don't exist as a single massive model. Instead, they form a networked ecosystem, or "micro twins", each focused on a purpose such as condition monitoring, optimization, or reliability. This modularity allows each twin to evolve and scale independently, supporting true agility and encapsulating domain-specific knowledge.

Orchestrating such a sophisticated ecosystem requires a robust and intelligent approach to data management. This is where Industrial DataOps becomes indispensable. Industrial DataOps acts as the connective tissue and operational backbone for digital twin environments, automating the ingestion, contextualization, and governance of data at enterprise scale.

At its core, Industrial DataOps harnesses advanced AI-powered ingestion techniques to extract and contextualize information from diverse sources, such as engineering diagrams, sensor streams, and operational records. This automation transforms raw, disparate data into structured, meaningful insights, which are then organized within a unified operational knowledge graph. The knowledge graph not only reflects the true hierarchy and relationships of assets and processes but also supports lineage tracking, compliance, and ongoing governance—ensuring continuous accuracy and trustworthiness as operational realities change.

Micro twins ecosystem



Micro twins: Building blocks for domain-specific models

Within this framework, micro twins emerge as the fundamental building blocks for digital transformation. Each micro twin is fed by both real-time and historical data, allowing it to maintain a persistent, evolving digital context of its subject asset or process. In turn, these micro twins serve as the launching point for analytics, visualization, and AI-driven workflows, enabling organizations to deploy and scale solutions that are finely tuned to their most pressing operational needs.

Ultimately, the fusion of Industrial DataOps and modular micro twins delivers a powerful foundation for industrial innovation. Together, they make it possible to build, maintain, and expand digital twin ecosystems that are scalable, resilient, and continuously aligned with the rapidly changing dynamics of modern manufacturing and operations.

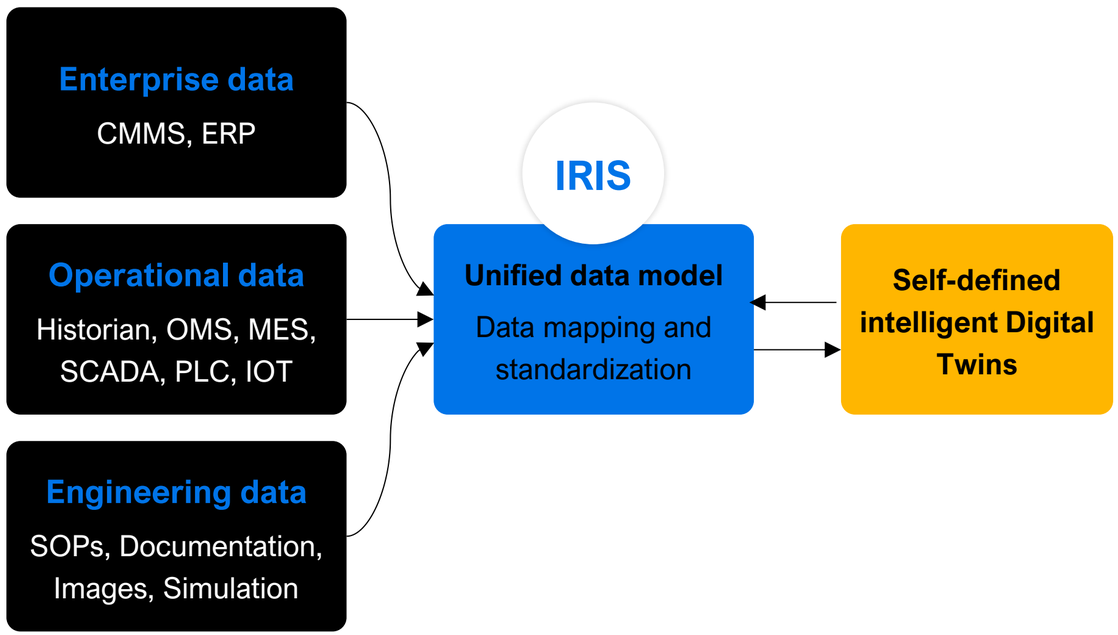
Architecture and core capabilities of self-defined intelligent digital twins

Building self-defined intelligent Digital Twins: Architecture, flexibility, and scale

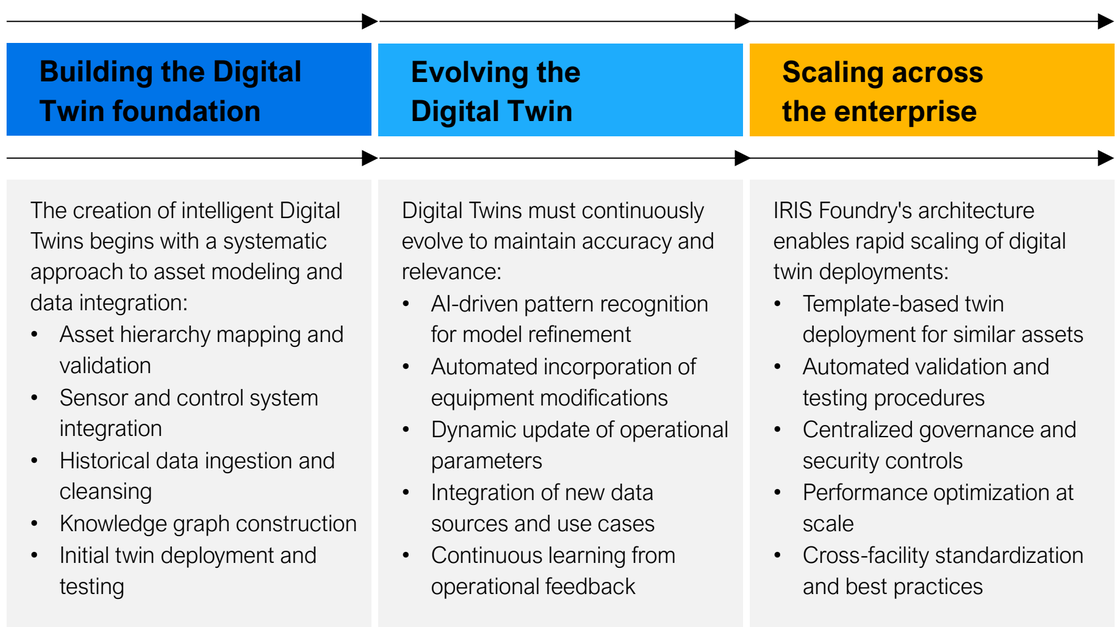
The next evolution in digital twin technology is embodied in self-defined intelligent digital twins—dynamic, autonomous systems that organize, update, and contextualize themselves in real time with minimal manual intervention. At the heart of this transformation is SymphonyAI's IRIS Foundry, which integrates the latest advances in artificial intelligence, data engineering, and visualization to deliver a digital twin framework that is both flexible and infinitely scalable.

Central to this architecture is an AI-powered ingestion engine. IRIS Foundry uses advanced algorithms to extract and map asset information from a vast array of sources, including engineering diagrams, sensor feeds, and operational documentation. This autonomous data ingestion process ensures that the digital twin is always synchronized with the latest state of the physical asset or process it represents. Paired with dynamic data integration capabilities, IRIS Foundry's polyglot data stores and unified namespace create a harmonized, trusted data foundation. This enables organizations to collapse traditional IT, OT, and engineering data silos, offering a single, holistic operational view—a "single pane of glass"—that accelerates decision-making and drives operational excellence.

From data streams to unified twin



The Digital Twin lifecycle: Build, evolve, scale



Contextualization at the core: Knowledge graphs and augmented navigation

Effective digital twins do more than aggregate data; they create context. IRIS Foundry achieves this through an industrial knowledge graph that interconnects assets, processes, documents, and events across the enterprise. This semantic layer enables unified searchability, allowing users to easily find and relate operational data across assets and event histories.

The system's augmented navigation capabilities empower users to explore these interconnected relationships through an intuitive interface, featuring clickable links within 3D and 2D environments, as well as within related technical documents. By seamlessly integrating operational, engineering, and maintenance perspectives, IRIS Foundry ensures that every user can extract insights tailored to their specific function—whether they are on the plant floor, in the control room, or within data science teams.

Intelligent application layer: Dynamic app building with AI agents and Copilots

Going beyond the mere unification of data, SymphonyAI deploys an intelligent application layer within IRIS Foundry. Here, AI agents—known as IRIS Copilots—deliver powerful natural language search, visualization, and automated recommendations. These Copilots are both domain-aware and role-based, allowing users to interact with digital twins through intuitive conversational interfaces, whether in pre-built applications or in environments customized to their specific workflows.

The platform's generative and predictive AI capabilities are equally transformative. Leveraging industrial large language models (LLMs), IRIS Foundry can generate synthetic data, forecast operational outcomes, and detect anomalies at enterprise scale. The dynamic app building environment, with visual tools and AI-guided templates, enables rapid assembly and deployment of new workflow applications. This dramatically accelerates innovation and empowers organizations to remain agile in the face of changing operational requirements.

Real-time 3D/2D visualization: From static diagrams to living Digital Twins

IRIS Foundry breathes life into digital twins by merging as-designed and as-operated views in real time. The platform overlays live sensor data directly onto 3D asset models, providing spatially accurate, continuously updated visualizations of operational states. Faults, anomalies, and deviations from expected performance are highlighted immediately, allowing teams to act decisively before minor issues escalate.

Augmented navigation capabilities allow users to move easily between spatial and schematic representations with no loss of context or data, offering a uniquely fluid and immersive user experience. This interactivity enables cross-functional teams to collaborate more effectively and make more informed decisions based on the most current, relevant data.

Industrial DataOps: Orchestrating data quality, context, and governance

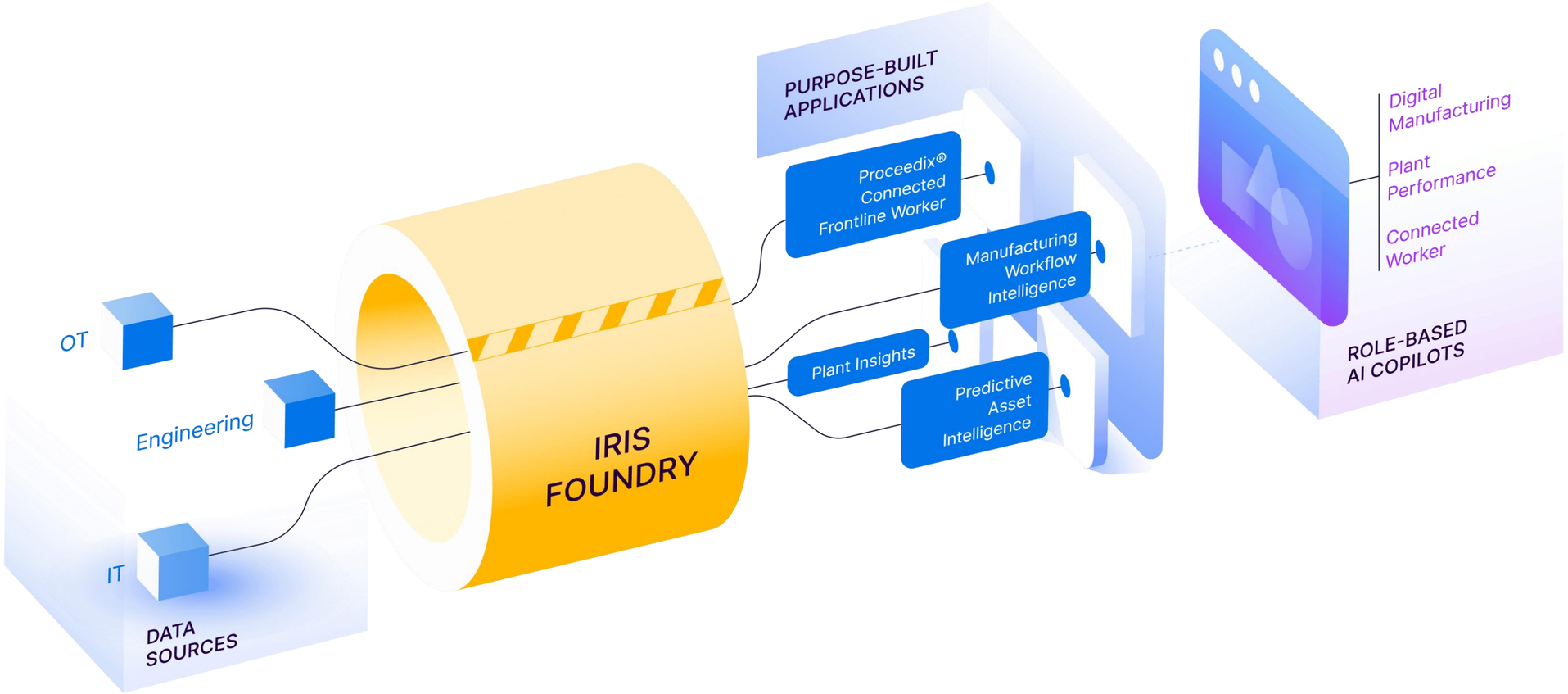
As organizations scale digital twin initiatives enterprise-wide, the importance of robust Industrial DataOps becomes paramount. IRIS Foundry incorporates an extensive suite of DataOps capabilities, including prebuilt connectors for rapid onboarding of data from all major IT, OT, and engineering systems. Automated mapping and data lineage features ensure that as systems and assets evolve, the accuracy and traceability of information are maintained.

Built-in governance and security protocols, such as compliance management, audit trails, and role-based permissions, provide confidence that every digital twin operates on trusted data. These measures collectively support the continuous improvement and reliability required for mission-critical industrial operations.

From source to application: the evolution of the Digital Twin data model

At the heart of IRIS Foundry's digital twin capabilities lies a sophisticated data model evolution process that transforms raw operational data into actionable intelligence. This multi-stage progression ensures data quality, contextual richness, and optimal performance for diverse use cases.

IRIS Foundry overview



1 Source data model: the foundation

The journey begins with the source data model, which serves as the primary interface to operational reality:

- Captures raw data from hundreds of sources including DCS, historians, ERP systems, and IoT sensors
- Preserves native data formats and sampling rates to maintain fidelity
- Implements robust data lineage tracking for compliance and auditing
- Supports both batch and real-time data ingestion patterns

2 Unified data model: creating context

The unified data model transforms disparate data sources into a standardized, relationship-rich framework:

- Harmonizes naming conventions and units across all data sources
- Establishes semantic relationships between assets, processes, and events
- Implements automated data quality rules and validation
- Enables cross-system analytics and visualization
- Maintains bi-directional traceability to source systems

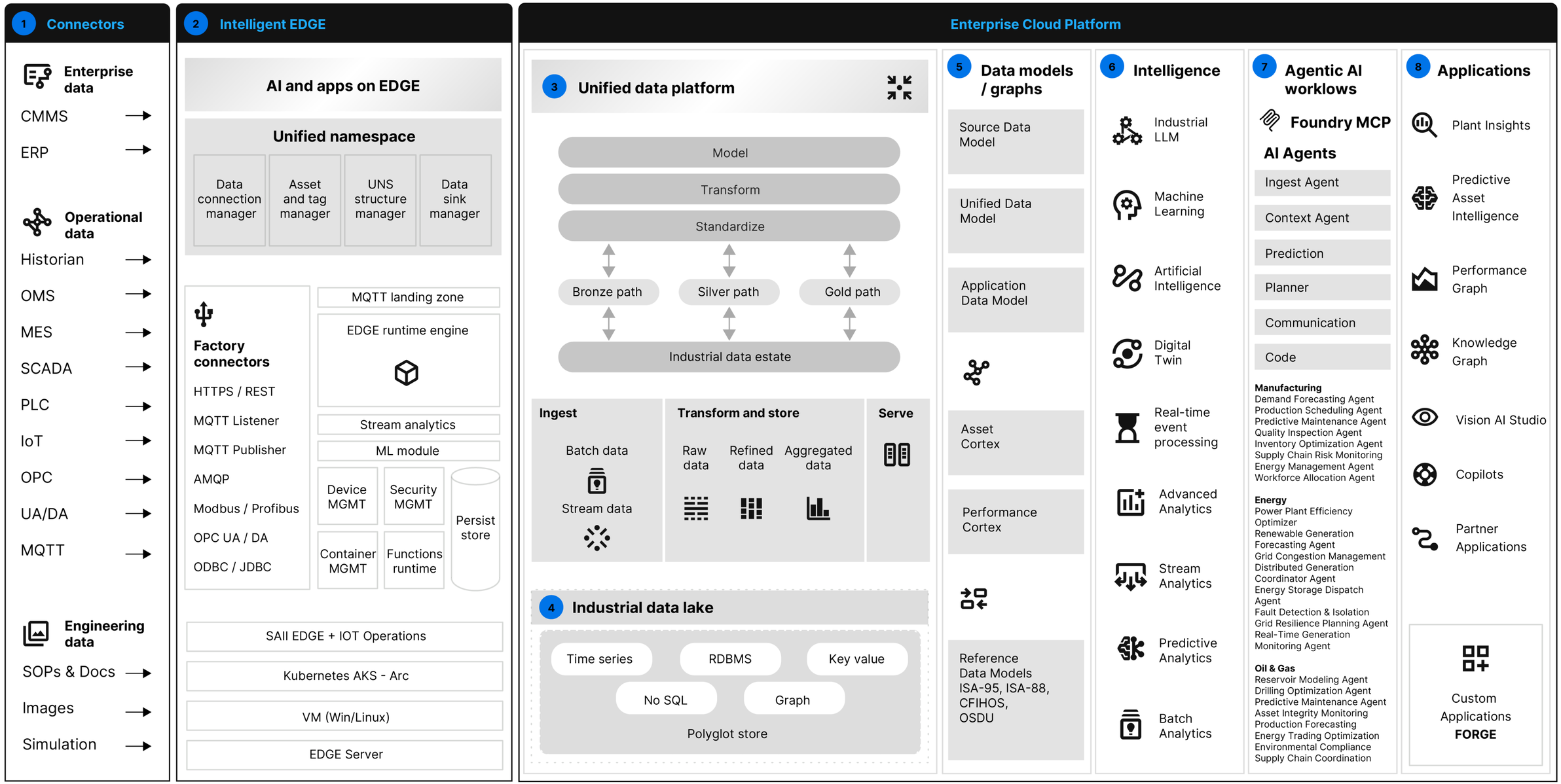
3 Application data model: enabling innovation

The application data model optimizes data structures for specific use cases and performance requirements:

- Creates purpose-built data views for different user roles and applications
- Implements caching and aggregation strategies for real-time performance
- Enables fine-grained security and access controls
- Supports rapid deployment of new micro-twins and applications

IRIS Foundry architecture: Enabling intelligent Digital Twins

At the heart of the intelligent digital twin capabilities lies IRIS Foundry, a comprehensive industrial data platform that unifies edge, cloud, and AI to create intelligent, real-time digital representations of physical operations. The architecture supports the full lifecycle of digital twins—from data ingestion and modeling to insight generation and AI-enabled decision-making.

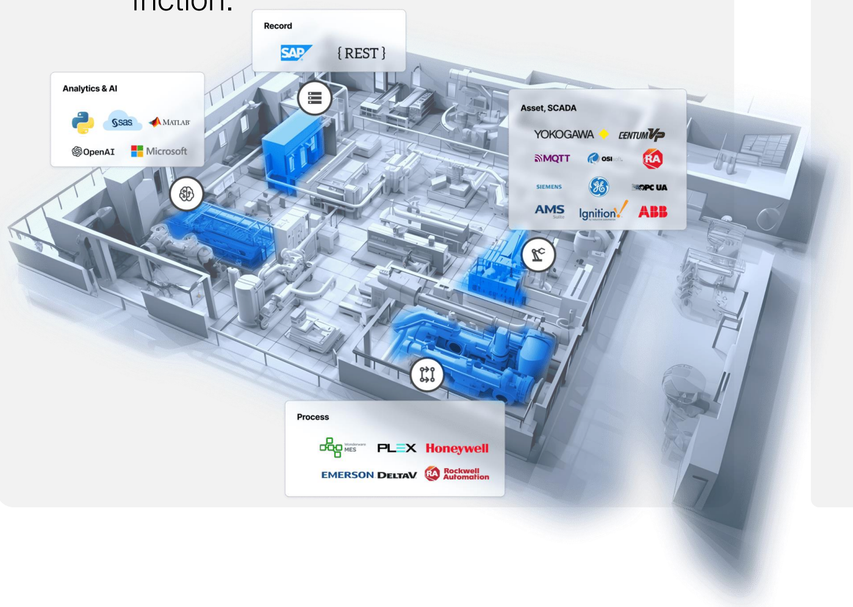


1 Seamless Data Connectivity from Diverse Sources

IRIS Foundry begins by integrating a wide array of industrial data sources through its robust Connector layer. This includes:

- Enterprise data systems like CMMS and ERP
- Operational technology systems such as SCADA, PLCs, MES, and Historians
- Engineering data, including simulation models, documents, and images

Multiple protocol adapters—ranging from OPC UA and MQTT to Modbus and REST—ensure that both legacy and modern equipment are captured into the digital twin ecosystem without friction.



2 Intelligent Edge Processing

The Intelligent Edge layer supports data collection and processing close to the source. Equipped with AI models and streaming analytics capabilities, it enables:

- Real-time processing and event detection at the edge
- Secure device and container management
- On-premises deployment via VMs or Kubernetes clusters

This edge intelligence allows digital twins to respond dynamically to live operational changes while maintaining resilience even in low-connectivity environments.

3 Unified Data Platform for Modeling and Standardization

At the core of the IRIS Foundry architecture is the Unified Data Platform, where raw data is modeled, transformed, and standardized into consistent, high-quality formats.

This transformation is managed through a tiered data path:

- Bronze Path for raw ingestion
- Silver Path for refined, quality-checked data
- Gold Path for aggregated, analytics-ready data

This structured approach enables the creation of scalable, enterprise-wide digital twins with reliable and contextualized data.

4 Industrial Data Estate and Polyglot Store

IRIS Foundry aggregates and stores data in a highly flexible Industrial Data Lake backed by a polyglot store that supports multiple data models and query types:

- Time series
- Relational (RDBMS)
- Graph databases
- Key-value and NoSQL stores

This flexibility allows digital twins to simulate and visualize complex relationships between systems, assets, and events across both time and topology.

5 Rich Data Modeling and Contextualization

To support advanced digital twin functionality, IRIS Foundry provides a layered Data Models and Graphs engine that includes:

- Source and unified data models
- Asset and performance data structures
- Factory and enterprise asset hierarchies
- Standards-compliant models (ISA-95, ISA-88, CFIHOS, OSDU)

This contextual data modeling is what transforms data into a true digital twin: a structured, navigable, and dynamic representation of physical systems.

6 Intelligence and Advanced Analytics

The platform incorporates multiple layers of intelligence to empower digital twins:

- Predictive and prescriptive analytics
- Machine learning and artificial intelligence
- Batch and real-time stream analytics
- Digital twin engines for simulation and operational insight

It also leverages an Industrial Language Model (LLM) to interpret operational language and generate actionable insights, bringing natural-language reasoning into plant-level AI.

7 AI Agents and Autonomous Workflows

IRIS Foundry includes a suite of AI agents that apply intelligence to specific operational domains. These agents automate decision-making, forecasting, and optimization across:

- Maintenance and reliability (e.g., Predictive Maintenance Agent)
- Production (e.g., Scheduling and Planning Agents)
- Energy and ESG (e.g., Power Efficiency and Emissions Monitoring Agents)

These agents are integral to enabling self-healing and self-optimizing digital twins that go beyond monitoring and into autonomous control.

8 Applications and User Interfaces

On the front end, the platform delivers digital twin value through a range of applications:

- Plant Insights and Performance Graphs for real-time operations monitoring
- Predictive Asset Intelligence for health diagnostics and failure prediction
- Vision AI Studio for visual inspections and computer vision use cases
- Knowledge Graphs and Co-pilots that use natural language for query and navigation
- Integration with custom apps and partner solutions via Forge

These applications provide plant personnel with rich, visual, and interactive ways to engage with the digital twin, whether in 2D, 3D, or semantic graph views.

Accelerating business outcomes and use cases

Accelerating outcomes: Speed, scale, and value delivered

Organizations deploying SymphonyAI's IRIS Foundry realize tangible business impact:

- **Up to 60% faster decision-making:** Unified data visualization and AI guidance streamline complex investigations and boost operational agility.
- **Up to 80% reduced incident response time:** Rapid, contextual access to relevant data accelerates troubleshooting and containment.
- **Overcoming vendor lock-in:** Open architecture and prebuilt connectors eliminate dependencies on single-vendor ecosystems or legacy systems.

	IRIS Foundry implementation		
	Before		After
Time to actionable insight	10 to 14 days	→	2 to 4 hours
Incident response time	3 to 5 days	→	<24 hours

Use cases: Self-defined Digital Twins in action

Transforming maintenance, process optimization, and asset management

Self-defined digital twins are driving a new era of efficiency and reliability across core manufacturing functions. In maintenance, predictive twins continuously monitor equipment health, leveraging live sensor data and advanced analytics to anticipate failures before they occur. This foresight enables the automatic generation of work orders and supports a shift from reactive to proactive maintenance, significantly reducing unplanned downtime. In parallel, process optimization twins ingest and analyze real-time production data, using insights to recommend setpoint changes, streamline operations, and maximize throughput and efficiency. Meanwhile, asset performance twins provide a comprehensive view of asset conditions—tracking operational health, scheduling preventive inspections, and proactively managing spare parts inventory. This integrated approach ensures that organizations can optimize the lifecycle and value of their critical assets.

Connected worker enablement

The power of self-defined digital twins extends directly to the workforce through enhanced digital collaboration and insight. Field technicians, equipped with intelligent IRIS Copilots, can interact seamlessly with asset twins while in the field, accessing live overlays of operational data and following tailored, step-by-step troubleshooting instructions. These capabilities empower technicians to make faster, better-informed decisions on the spot, improving both safety and productivity. Operators benefit, too: multi-perspective twin views foster real-time collaboration, enabling cross-functional teams to visualize bottlenecks, coordinate responses, and continuously improve operational outcomes—all within a unified, context-rich environment.

Cross-industry success

The versatility of self-defined digital twins is transforming industries beyond manufacturing, delivering impact at scale. In the energy sector, autonomous process twins are helping operators achieve both production optimization and ambitious carbon reduction targets. Within discrete and process

manufacturing, micro twins monitor overall equipment effectiveness (OEE) and product quality metrics in real time, adapting across production lines and shifts for maximum efficiency. In complex process industries, knowledge graphs serve as the connective tissue that bridges IT and OT data, enabling resilient, end-to-end supply chain management. Across these diverse sectors, the adoption of digital twins is translating to measurable gains in sustainability, productivity, and competitive advantage.

Up to

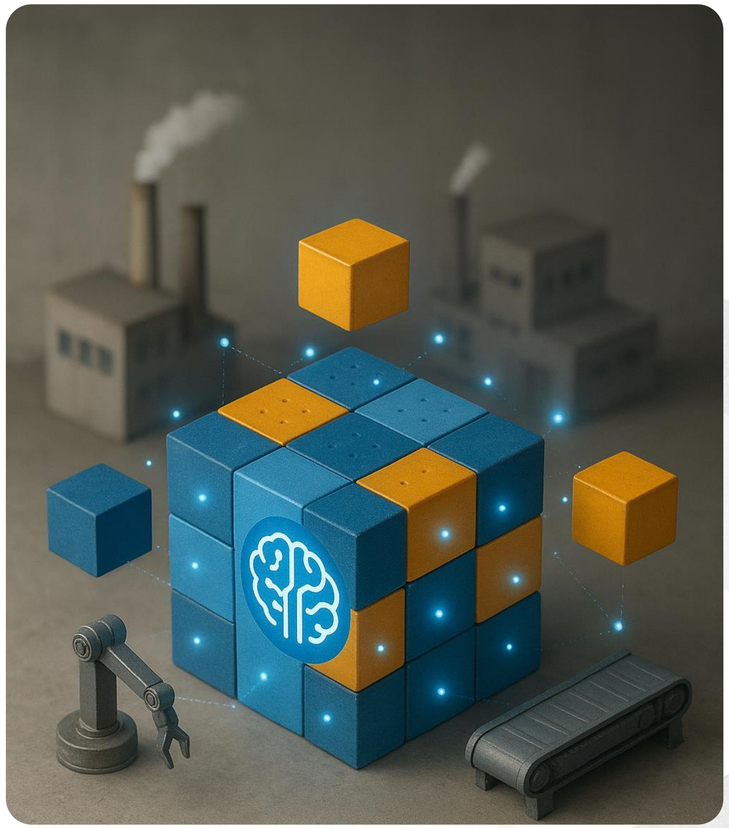
80%

Reduction in incident response time

Organizations leveraging SymphonyAI integrated 3D/2D visualization have seen up to 80% faster response to operational incidents through real-time, contextualized data access

The future of intelligent Digital Twins

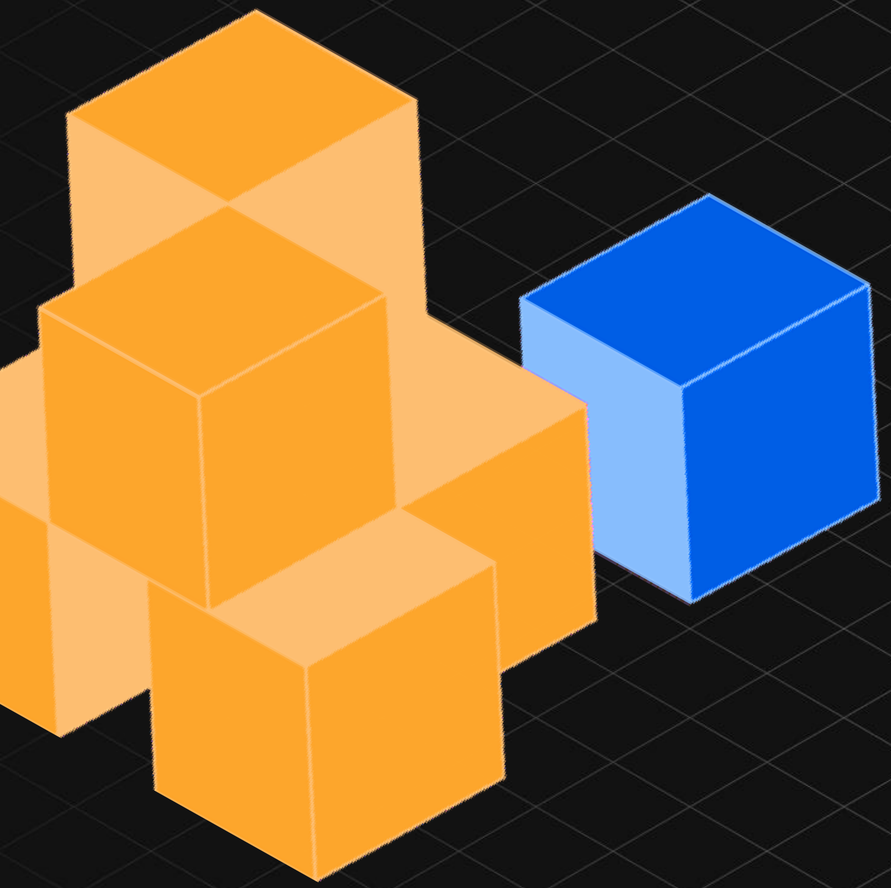
Beyond the twin: The future of modular, self-improving industrial intelligence



The journey of digital twins is just beginning. SymphonyAI's vision for self-defined, intelligent digital twins sets the foundation for the autonomous, self-optimizing systems of the future. As modular micro twins mature, they will increasingly adapt and reconfigure themselves alongside evolving assets and operational processes. Next-generation cognitive agents, powered by advanced AI, will manage complex workflows, execute interventions, and continuously learn from operational experience.

By fostering an open, modular ecosystem, SymphonyAI ensures that enterprises can rapidly integrate emerging technologies and remain agile in dynamic industrial markets. The trajectory of intelligent digital twins promises continuous innovation, operational excellence, and a future where data-driven intelligence is seamlessly woven into every facet of industrial operations.

SymphonyAI



Why SymphonyAI Industrial

Learn more about IRIS Foundry

AI-powered Digital Twin

Digital Twins data sheet

Contact Sales