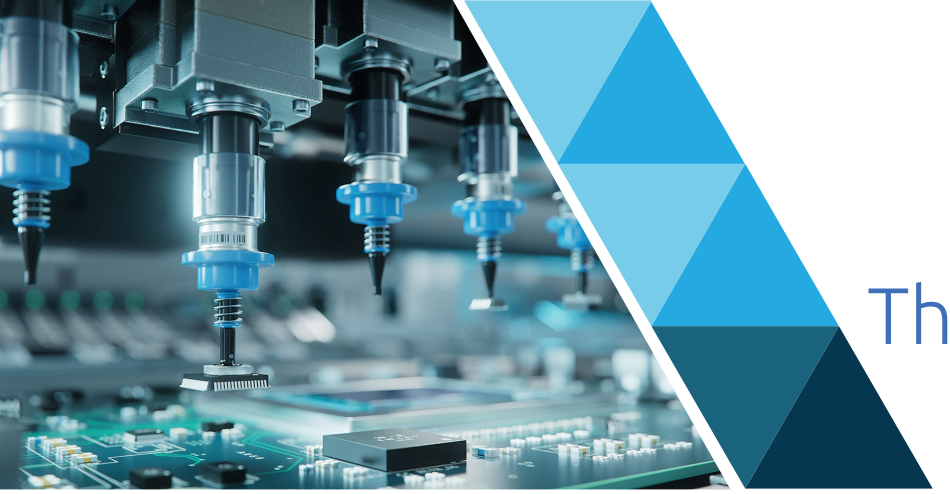


Micro.ai

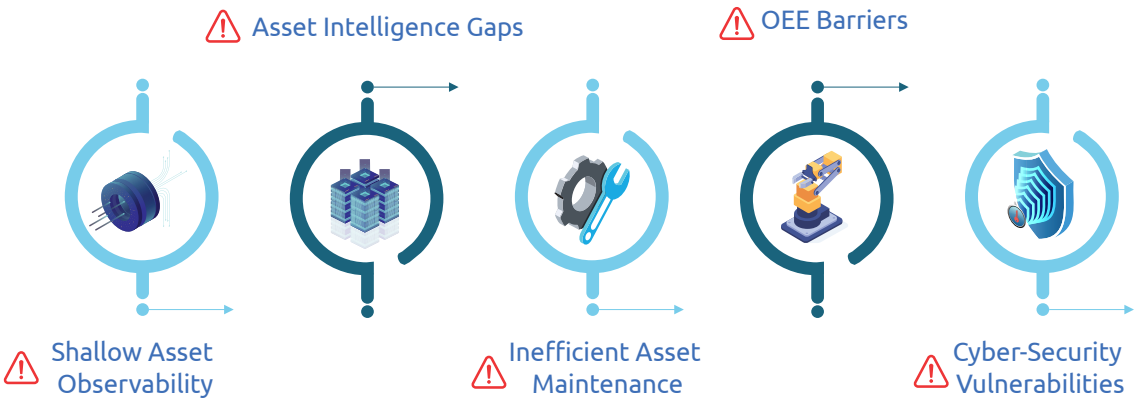
The Digital Factory Realized

MicroAI Factory™ -
A Plug and Play Solution to Enable Predictive Manufacturing

Most manufacturing environments today are highly automated. Machine and process automation are essential to producing high volumes of high-quality products at a competitive cost. The evolution from the semi-automated to the fully automated is reaching its endpoint across most manufacturing sectors.

The next evolution will involve going beyond factory automation and into factory intelligence…from the automated factory to the smart/digital factory. This will be a continuing imperative within many Industry 4.0 initiatives and will be driven by new Embedded and Edge AI technologies.

The vision of predictive manufacturing has been impeded by the reality that existing AI solutions are not close enough to the manufacturing machines, devices, and processes that they are meant to optimize. This problem is compounded by having to send massive amounts of asset data to the cloud for processing. The pathway to predictive manufacturing can be impeded by :



The Barriers and the Solutions

Barrier - Shallow Asset Observability

Manufacturing machines and devices lack the deep observability required to produce deep insights into performance, health, and security. As a result, critical production equipment is sub-optimized in terms of output, reliability, operating costs, and cyber integrity. The lack of deep, asset-centric, AI-enabled observability creates a host of problems within the manufacturing ecosystem:

Watching But Not Learning

Observability is about generating actionable insights from the data generated by the devices and machines within the manufacturing infrastructure, insights that enhance the operation's ability to maximize OEE (overall equipment effectiveness) and security. Observability goes well beyond static monitoring and logging.

Factory floors are plagued by a host of problems resulting from legacy solutions that watch but that do not actively learn. This observability shortfall produces numerous barriers to operational excellence.

Lack of Customized Control

Manufacturing environments contain a wide variety of devices and machines. Those assets perform a range of operations, from the complex to the simple. They also operate in conditions that can vary widely from asset to asset.

The lack of deep asset observability inhibits the gathering of insights into the effects of varying environmental conditions and the impacts on machines that are similar in design but that perform dissimilar functions. Legacy, one-size-fits-all, asset management solutions do not adequately address the diversity and complexity of modern manufacturing ecosystems. Existing solutions do not provide the asset-centricity required to deliver customized intelligence to mission critical devices and machines.

Slow Response to Anomalies

Factory automation today is hardly recognizable from automation that existed just a few decades ago. Factories now operate on volume scales that continue to increase due to ongoing advancements in Industry 4.0 – enabled automation. One drawback to this increased speed is the impact on quality and waste in the event of an asset malfunction.

This problem is exacerbated by the lack of deep, real-time, asset observability that would provide immediate detection and notification of an asset performance anomaly.

Inability to Predict

The inability to generate timely, accurate, actionable, predictive analytics is a prohibitive limitation in fully optimizing the performance and security of production OT assets. Common problems include:

Problem	Cause	Impact
Unplanned Downtime	Lack of predictive insights into asset health and performance	Costly asset downtimes, reduced output, and inconsistent quality
Stagnant OEE	Inability to break the 70% OEE barrier due to lack of forward-looking analytics	Sub-optimized asset performance impedes operational excellence
Cyber-Security Blind Spots	Lack of deep asset observability creates cyber-security blind spots	Manufacturing assets are increasingly vulnerable to attack (zero-day, ransomware, etc.)
Lagging Market Share	The inability to predict rather than react to quickly evolving operational conditions and market demands.	Gradual loss of customer confidence and erosion of market share

The fact that machines and devices are automated does not imply that they are smart. Automation does not equate to intelligence.

Solution – Observability that Learns

Utilizing breakthrough embedded and edge AI capabilities, MicroAI Factory brings real-time observability to any type of manufacturing device or machine. Factory delivers the deep insights needed to fully optimize the performance of the entire factory floor. A new observability paradigm that includes:

Dynamic Learning

Embedded AI an ML algorithms learn the normal operating behavior of an individual machine or a group of machines. Deep federated learning provides the accurate baselines required to detect performance anomalies of any size or duration.

MicroAI Factory utilizes multidimensional behavioral algorithms to produce recursive analysis, training, and processing. This enables a continuous evolution of the Edge-native AI model that takes place directly on the endpoint.

Endpoint Monitoring

Intelligence that is embedded into the MCU/MPU of the manufacturing asset to provide deep insights into real-time performance, health, and security. AI at the extreme edge provides deeper, more intimate, insights into asset health and performance that have not been available with traditional AI solutions.

MicroAI Factory provides seamless and secure ingestion of data from a wide variety of manufacturing devices and machines (sensors, robots, SMT equipment, fabrication machines, field assets, etc.).

Recursive Analysis

MicroAI Factory utilizes multidimensional behavioral algorithms to produce recursive analysis, training, and processing. This enables a continuous evolution of the Edge-native AI model that takes place directly on the endpoint. Recursive analytics produce predictive insights into future asset health and maintenance requirements enabling a transition from reactive to predictive asset management.

Insight Mining and Distribution

A centralized visualization engine provides continuous observability into the status of connected devices and machines. The embedding and training of intelligent workflows automate the process of performance alert notifications and implementation of rapid threat mitigations.

Presentation of real-time asset performance data via user-friendly, customizable, drag and drop dashboards. Data is customized to meet the specific requirements of various operational and business stakeholders.

Barrier - Asset Intelligence Gaps

The absence of endpoint and edge intelligence restricts the ability to attain asset-specific insights and to develop predictive maintenance models. This creates numerous blind spots across the entire factory floor; blind spots that can be operationally crippling.

Disparate Command and Control

Many manufacturing environments still rely on control applications that are siloed both in terms of design and communication. Those manufacturers struggle to establish—and maintain—a cohesive and holistic view of real-time events across the production ecosystem.

A centralized, AI enabled, command and control center is needed to aggregate, synthesize, and react to the volumes of data generated within the factory floor. Left unaddressed, these intelligence gaps create control blind spots that impede any drive towards true operational excellence.

Inefficient Monitoring and Reporting

Machines and devices do not have the ability to self-monitor or self-report. Critical performance insights go undetected and/or unreported. Closing these performance gaps will require a solution that provides local synthesis, analysis, and communication of machine data—in real time. This next-generation technology will need to significantly reduce sluggish data analysis and communication caused by data latency issues.

Asset Performance Inconsistency

Highly automated factory floors typically have several machines that perform similar functions. However, every machine has its own unique operating characteristics and performance idiosyncrasies. In addition, many manufacturers utilize similar assets that can be located within individual factories across a diverse range of geographic locations and environmental conditions.

The inability to embed customized intelligence into individual machines results in a production ecosystem that cannot perform at maximum capacity. Manufactures need a comprehensive embedded AI/ML solution that can fully optimize asset performance based on intimate insights into all the various factors that impact the performance of every machine.

Problem	Cause	Impact
Siloed Command and Control	Control systems and applications that are disconnected, non-communicative, and operationally static	Crippling intelligence gaps create control blind spots that impede creation of a cohesive view of production performance
Non-Impactful Reporting	Lack of AI-enabled data visualization supported by embedded intelligent workflows	Performance anomalies are not visualized in real-time and reporting routines are prone to error
Non-Unified Management	Lack of a comprehensive, consolidated, view of all operational functions within the manufacturing ecosystem	Inconsistent performance across the factory floor, slow response to performance deviations, and inaccurate assessments of combined manufacturing performance
Non-Evolving Intelligence	Legacy applications cannot be customized to account for individual asset eccentricities and environmental conditions	Similar assets perform at inconsistent levels resulting in production outputs that are unpredictable and non-optimized

Industry 4.0 initiatives and will be driven by new Embedded and Edge AI technologies.

Solution – Factory Ecosystem Intelligence

Machine and process-intensive operations need a solution that combines the enablement and training of asset-specific AI/ML algorithms, the application of AI to create intelligent workflows, and the ability to quickly synthesize and visualize data—all within a platform that provides ecosystem-wide intelligence and visibility.

MicroAI Factory was developed specifically to provide manufactures with AI-enabled intelligence and insights that improve factory floor performance. MicroAI Factory establishes a single point of reference, promotes deep federated learning, and creates accountability for factories on a global scale. A complete ecosystem of intelligence that provides unified management and control.

Problem	The MicroAI Factory Solution
Siloed Command and Control	**Single or multiple factory coverage:** MicroAI Factory can be integrated into processes and assets within a single factory or scaled across an entire network of factories, creating a network of intelligence and control
Non-Impactful Reporting	**Predictive insights:** Predictive analytics mitigate the impact of performance issues, enable a transition to predictive maintenance, and provide intelligent workflow control of alerts and reporting
Non-Unified Management	**Unified control:** MicroAI Factory eliminates the need for multiple control systems and applications by combining a full-suite of AI-enabled capabilities into a single plug-and-play platform
Non-Evolving Intelligence	**Unlimited customization:** Embedded intelligence continuously learns and evolves to provide full optimization of individual devices, machines, and processes

Siloed applications prohibit a unified view of real-time operational and security conditions across the entire production ecosystem. Decisions and actions are taken in isolation within diminished or counter-productive results.

The MicroAI Factory Ecosystem of Intelligence

MicroAI Factory provides a complete ecosystem of factory intelligence. Factory embeds intelligence into every critical device, machine and process, and then provides non-siloed data-ingestion and feedback loops that provide fine tuning of factory performance.

Barrier - Inefficient Asset Maintenance

Machine output and uptime are critical KPIs (key performance indicators) for every machine-intensive enterprise. Lack of real-time insights, unscheduled downtimes, and static maintenance routines can all combine to create a production ecosystem that performs well below its optimum capability.

Preventive maintenance is the legacy approach to machine optimization. For several decades that approach was sufficient to maintain average levels of OEE. To gain and maintain competitive advantage “average” performance is no longer sufficient. Manufactures across every industry segment are now looking at Edge and Embedded AI/ML solutions to power a shift from preventive to predictive maintenance.

The primary differences between predictive and preventive maintenance are summarized below.

	Predictive (AI/ML Enabled)	Preventive (AI/ML Not Enabled)
Maintenance Triggers	Based on analysis of real-time and historical asset performance data. Supported by device and machine AI-enabled endpoint analytics.	Dependent on static, manual, schedules and routines. Often hindered by lack of insight into current asset health.
Operational Impact	Maintenance performed when needed to maintain asset health, minimizing production impact. Higher OEE scores.	Maintenance often performed too early or too late, resulting in non-optimized performance and/or unnecessary downtimes.
Business Impact	Reduced maintenance costs, increased output, better resource utilization, and longer asset lifespans	Higher maintenance costs, non-productive maintenance routines, shorter asset lifespans, and sub-par OEE.
Competitive Impact	Higher production rates + longer asset lifespans + reduced maintenance costs = lower production costs and enhanced competitive position.	Non-optimized production capacity + degraded asset health + reliance on human-dependent, non-automated, processes = higher production costs, higher prices, and competitive weakness.

Solution – Predictive Maintenance

The vision of predictive maintenance is now an attainable reality with the advent of AI-enabled predictive analytics. MicroAI Factory provides the predictive intelligence to power the transition from static preventive maintenance routines to predictive capabilities that will revolutionize asset maintenance.

Machine-Centric Intelligence

Embedding and training AL and ML algorithms directly onto the MCU or MPU of the manufacturing device or machine. MicroAI Factory customizes AI algorithms based on the specific operational and/or environmental parameters of the asset providing breakthrough predictive insights into maintenance requirements.

Self-Learning

AI and ML algorithms learn the normal behavior patterns of the asset under various operational conditions. This self-learning occurs with no requirement for human intervention and provides performance baselines that are based on actual performance vs static specifications.

Predictive Analytics

Real-time, asset-specific, performance data is automatically collected and analyzed to produce predictive maintenance intelligence based on current and projected asset health and performance. Maintenance is performed when it is actually needed. Unnecessary machine downtimes are eliminated while also reducing maintenance costs.

Catastrophic Failure Prevention

Local, real-time, predictive analytics that detect and alert on the possibility of device or machine failure. Intelligent, automated, workflows that provide rapid alerts to ensure rapid response and fault mitigation. Preventive maintenance that extends asset lifespans and improves factory floor safety.

Barrier – OEE Stagnation

OEE is a measure of how well a piece of equipment (or a complete ecosystem of machines) is performing compared to its full operating potential. It is used to determine the percentage of manufacturing time that is truly productive. Poor OEE performance impacts productivity, competitiveness, and profitability.

An example:	OEE = Availability x Performance x Quality
Availability	A machine was scheduled to run for 8 hours but only ran for 7. 7/8 = 87.5%.
Performance	A machine has an optimum output of 5,000 units during an 8-hour shift but only produces 4,400. 4400/5000 = 88.0%
Quality:	The machine produced 4,400 units during the 8-hour shift but only 4,100 of them passed quality inspection. 4200/4400 = 95.50%

In the above example the calculated OEE would be 0.875 x 0.880 x 0.955 = 73.5%
Many manufacturers have been operating at OEE levels of 60 – 70% over the past couple of decades. That has enabled a transition from a purely reactive manufacturing environment to one that is more planned. The next threshold will be predictive manufacturing that produces OEE performances of 80 - 90%. What are the barriers to achieving higher levels of OEE?

Excess Machine Downtime

Critical assets are taken offline due to breakdown, sluggish performance, or unnecessary maintenance. This is often the result of a lack of intimate, real-time, insight into machine health.

Product Quality

The quality of the product(s) being produced is one of the components within an OEE calculation. Machines that produce sub-spec products will impact OEE performance.

Short Asset Lifespans

Non-optimized asset lifecycle management shortens the operational life of assets. Production output is degraded while replacement machines are procured and installed.

Process Control Limitations

Equipment that is too dependent on manual processes and/or human intervention will not reach optimum performance. Manual processes and humans are prone to error.

A 15% improvement in OEE can equate to a 17% increase in productivity. An operation producing $60M worth of products can increase their output to ~ $70M.

Solution – Breakthrough OEE Intelligence

Utilizing next generation edge and embedded AI technologies, MicroAI Factory provides breakthrough capabilities in OEE optimization. Manufacturers will be able to utilize edge and embedded AI/ML solutions to reach levels of OEE that just a few years ago seem unattainable. OEE stagnation will be overpowered by:

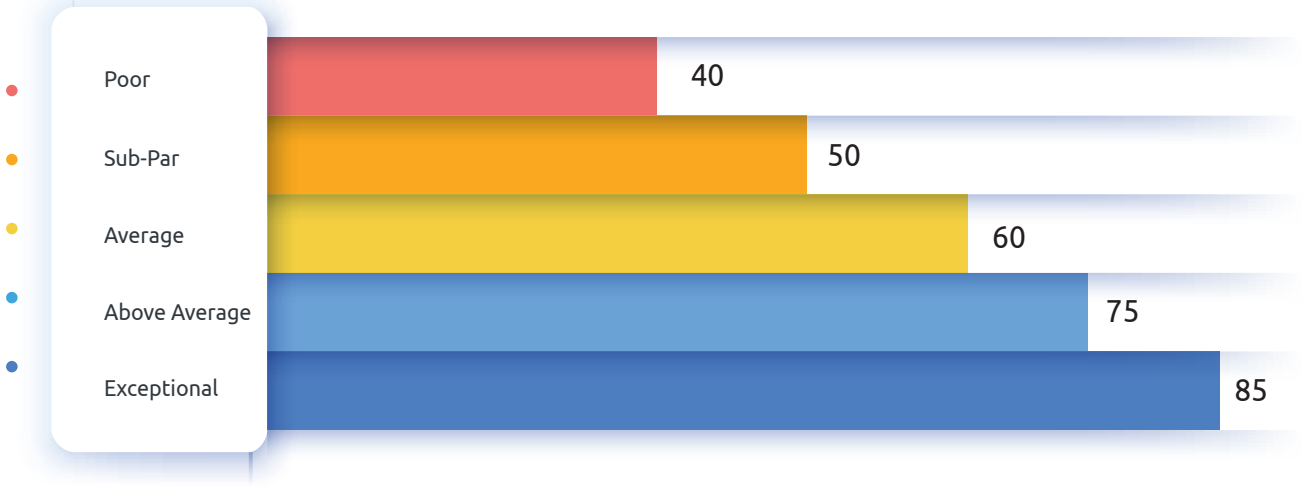
- Transforming machines and devices from human-managed to self-managed entities
- Providing early detection of performance anomalies
- Providing real-time insights on potential failure and/or sub-par performance
- Enabling self-learning algorithms that provide live heath score updates
- Using asset-specific heath data to develop “Days to Maintenance” (i.e., predictive maintenance) intelligence

Higher OEE – The Impact

Higher OEE scores results in positive impacts that are both wide and deep.

- A typical manufacturing operation has an average OEE of 60 to 70%. MicroAI Factory can improve OEE to ~ 85%.
- A 15% improvement in OEE can equate to a 17% increase in productivity. An operation producing $60M worth of products can increase their output to ~ $70M.
- Improved OEE equates directly to a reduction in asset maintenance costs. Unnecessary maintenance is eliminated via the implementation of predictive maintenance.
- Production costs are reduced. This results in improved product pricing as well as healthier bottom lines.
- Higher OEE scores translate to improved quality of the products being produced. Machine and device performance are more reliable and more predictable.
- OEE scores of 85% or better indicate a high level of predictability across the entire enterprise. This has positive implications for the entire company.

OEE Score (%)



Poor	Frequent, unplanned down-times. Low and inconsistent output. High scrappage rate. Long delivery lead-times. Short asset lifespans. High operational costs.
Sub-Par	Minimal OEE control. Continued reliance on reactive maintenance. Product output still less that normal capacity. Inconsistent quality of products produced. Costs still too high to be competitive.
Average	Operationally average. Machines and processes operate at average rates. Typically, sill reliant on manual maintenance processes. Have reached a state where embedded intelligence is needed to further maximize performance.
Above Average	Some advanced OEE control mechanisms in place. Assets and processes are performing above the norm. Some predictive analytics are in place. Assets are better managed, producing longer lifespans.
Exceptional	Embedded and Edge intelligence are being used to provide best-in-class OEE scores. Transition to predictive maintenance has been completed. True operational excellence has been achieved, producing segment-leading costs and pricing.

Barrier - Cyber-Security Vulnerabilities

Yesterday's cyber-security is not effective against today's increasingly sophisticated cyber-criminal. The threat landscape is constantly evolving, driven by malicious actors with a fully weaponized arsenal of tools and methodologies.

Manufacturers face a host of complex challenges that create a cumulative effect of leaving critical assets and data vulnerable to a wide range of cyber-attacks (zero-day, ransomware, DDoS, etc.).

Overwhelming Volume

Global cyber-attacks are increasing at a rate of ~ 300% year over year. The sheer volume of attacks overwhelms the personnel and existing tools responsible for cyber protection.

Power and Memory Limitations

Many production assets are controlled by IIoT devices that operate on low power and limited memory. These devices are less adaptable to traditional security measures and more vulnerable to attack.

Connectivity Problems

Many manufacturing ecosystems contain devices and machines that have inconsistent connectivity. Connectivity disruptions increase the risk of cyber intrusion.

Inability to Predict Threats

Most legacy cyber-security applications are purely reactive. Asset stakeholders have no ability to predict potential cyber threats or to take preventive action.

High Cost of Data Processing

Heavy reliance on cloud-based data processing adds significant cost to security programs. Configuration costs can also be prohibitive. Manufacturers are often forced to sacrifice security in favor of cost.

Ransomware has emerged as the preeminent cyber-threat to companies in the manufacturing sector. It is estimated that ~ 70% of manufacturing companies have experienced at least one ransomware attack over the past five years.

A ransomware attack can have devastating consequence for the manufacturer.

Disruption of operations

Depending on the scope of the attack, a single asset, an entire factory, or a chain of interconnected factories can be disabled. After the ransom is paid it can take weeks or months to recover to normal operational status.

Loss of critical data

A ransomware attack can result in the temporary—or sometimes—permanent loss of sensitive data. This data can be related to asset performance, financials, suppliers, etc.

Degradation of supply chain

Suppliers can be impacted by a ransomware attack on a manufacturing company. Suppliers may be hesitant to continue a business relationship with a company that appears vulnerable to cyber-attack.

Loss of reputation and market share

Operational and financial disruptions can create a loss of confidence within the company's targeted market. Market share can be temporarily or permanently impacted.

Solution – Zero Trust Cyber-Security

MicroAI Factory deploys plug-and-play security directly into the devices, machines, and processes within the manufacturing infrastructure. AI-enabled security that learns the normal state of asset behavior and provides early-stage detection of profile deviations caused by cyber intrusion. An arsenal of capabilities to create a power Zero Trust security state.

Machine and Process Centricity

Legacy security applications are typically too generic in functionality to provide hardened security at an asset-by-asset level. Manufacturers need cyber-security that can be deployed at the individual machine or process level. MicroAI Factory provides the flexibility and customization required to meet today's diverse threats.

Local Monitoring and Processing

Processing critical data at the endpoint eliminates delays resulting from unpredictable data latency. Local processing also reduces the amount of data that is exposed to cyber-attack.

Quicker Alerts and Rapid Mitigation

Endpoint security enables quicker detection and reaction to Zero-Day infections – staying one step ahead of hackers. Threat detection and response occurs in minutes instead of hours or days.

Predictive Cyber-Security

Prediction vs reaction provides a powerful advantage. Predictive analytics produce actionable insights into future threats, enables a transition from reactive to predictive security.

Seamless Integration

Quickly onboard and validate security protocols into devices within the manufacturing ecosystem. Eliminates the need for expensive external hardware and costly data labeling.

Cyber threat detection that is 400x faster than traditional cyber-security capabilities. Detection and mitigation in time to avoid compromise of machines and data.

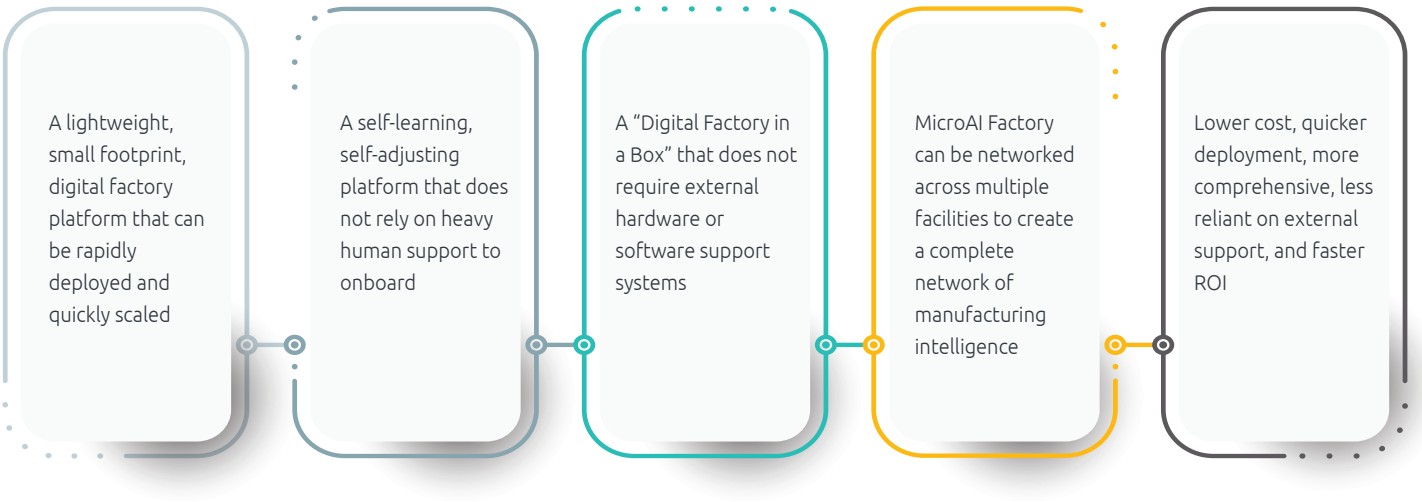
Summary

The Digital, Predictive, Factory Realized

Unlike other solutions on the market, MicroAI Factory can be deployed and providing predictive factory benefits within a matter of weeks. MicroAI Factory eliminates the prohibitive cost, resource consumption, and risk associated with other AI-enablement products.

MicroAI Factory Features	Manufacturing Impact
Centralized, self-contained, endpoint-based, performance monitoring	**Deeper observability:** Provides real-time device and machine-centric performance monitoring and reporting
Edge-native AI embedded and trained into the asset endpoint	**Predictive insights:** Provides predictive analytics that mitigate the impact of performance issues and that enable a transition to predictive maintenance
Historical trend analysis at the individual machine, device, process, or factory level	**Predictive manufacturing:** Enables the prediction of future asset and process behavior as well as productively levels of lines and shifts
Embedded intelligent workflows that learn and evolve	**Optimized processes:** Improves process performance, eliminates redundancy, and minimizes human intervention
Customizable, scalable, and asset-specific security algorithms	**Zero Trust Cyber Security:** Provides quicker detection and response to Zero- day cyber-attacks (detection in minutes vs days)
Flexible and scalable implementation	**Single or multiple factory coverage:** Can be integrated into a single factory or scaled across an entire network of factories, creating a network intelligence

Rapid and Cost-Effective Deployment



About MicroAI™

Micro.ai

Based in Dallas, Texas and founded in 2018, MicroAI is an award-winning, AI-driven technology company that designs, develops, and deploys next-generation IoT solutions for OEMs, network operators and enterprises.

A joint venture of Systena America and Plasma, MicroAI's proprietary algorithms power our AtomML solution, which is small enough to live on a connected device. MicroAI is redefining artificial intelligence at the network edge, delivering powerful edge AI and machine learning solutions that help enterprises and industrial companies achieve deeper insights into the behavior of machines and processes within their organization. MicroAI's AtomML technology curates raw IoT data on the network edge rather than in the cloud, helping companies discern valuable data and quickly spot anomalies by triggering actionable insights and alerts. Devices are trained in the local environment, allowing for personalization while providing the highest levels of security and privacy. With deployments in industries such as oil and gas, manufacturing, agriculture and telecom, our solutions help companies optimize the performance and security of their assets in a highly connected world.

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