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Building the data-driven factory:

How leaders unlock manufacturing intelligence

IndustryWeek.

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Executive summary

Manufacturers don't have a data problem—they have a data access problem.

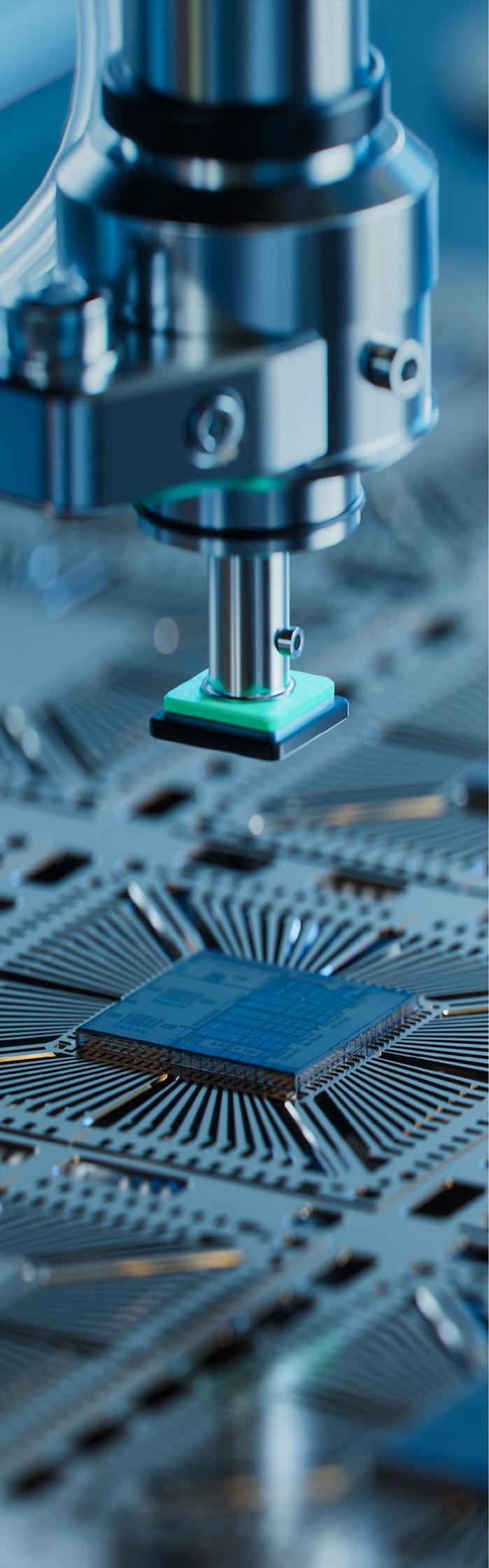
Most plants are already producing enormous volumes of real-time machine and sensor information, but much of it never makes it beyond the factory floor. The most valuable signals—high-frequency, high-resolution Operational Technology (OT) data—are stranded behind legacy wired systems and congested Wi-Fi networks that were never engineered for continuous industrial workloads.

Without reliable access to this data, manufacturers can't scale AI, optimize production in real time, or build the predictive intelligence required for next-generation productivity. AI initiatives stall. Digital twins sit underpowered. Automation remains siloed.

The bottleneck isn't data generation—it's the network providing access to these data sources.

This is where private 5G becomes transformational. Far from a routine connectivity upgrade, private 5G establishes the real-time, high-fidelity data pipeline that advanced manufacturing depends on. It delivers guaranteed performance, deterministic latency, and uninterrupted access to the full depth of OT data—turning scattered machine signals into continuous intelligence that leaders can act on.

With this high-quality data foundation in place, manufacturers can finally unlock the outcomes Industry 4.0 has long promised: higher throughput, fewer unplanned stoppages, tighter quality control, and faster decision cycles powered by trustworthy data.



The evolving value of data and the network barrier

The data imperative—Quality, immediacy, and context over raw volume

For years, the manufacturing sector has been fixated on the pursuit of the big data paradigm. The industry collected more—more sensors, more logs, more storage—with the assumption that volume alone would unlock intelligence. However, today, in an AI and machine learning (ML) world, that assumption no longer holds.

The value of data now lies in its quality, its diversity, and—most critically—its immediacy. Sophisticated AI and ML models depend on a continuous feed of real-time data correlated to the moment an event occurs. Delayed, time-stamped, or incomplete data produces unreliable insights and predictions. The performance and accuracy of a model is only as good as the data fueling it.

The lesson for manufacturers is clear: Don't leave valuable data orphaned on the manufacturing floor.

The data accessibility gap

This challenge lies not in the data generation but in data accessibility. Legacy connectivity infrastructure—wired islands, overextended Wi-Fi networks, and fragmented device ecosystems—cannot deliver the reliable, real-time data foundation that advanced analytics require.

- **Rigid wired systems** restrict flexibility, making it costly and complex to connect mobile assets or retrofit older machines.
- **Traditional Wi-Fi**, even with the improvements in Wi-Fi 6/7, struggles to guarantee the quality of service (QoS), deterministic latency, and interference-free reliability needed for business-critical industrial applications.

Wi-Fi can only get you so far in the pursuit of collecting and actioning high-fidelity data at an industrial scale.

As a result, valuable OT machine and process data remains trapped or delayed, preventing manufacturers from building accurate models or acting on insights in real time. Investments in analytics and AI often fall short, not because the algorithms are insufficient, but because the underlying data is incomplete or unreliable.

Private 5G directly addresses this gap by offering the high-fidelity, predictable wireless foundation required to allow OT data to be continuously available and actionable. This is the first step toward realizing the full potential of industrial AI.



The data problem—Why trapped data limits prediction and real-time control

Manufacturers face three fundamental issues related to data—veracity, velocity, and completeness, all which trace back to the limitations of the network infrastructure.

The crisis of veracity

The most direct threat to AI-driven manufacturing is unreliable data capture. Data veracity—the trustworthiness and accuracy of data—is the first casualty of an inadequate network.

When data is captured over unstable connections (such as intermittent Wi-Fi or complex, classical point-to-point systems), the signals are prone to drops, delays, and jitter (variation in packet arrival time). These disruptions do not merely remove a data point; they compromise the entire stream or data set. A small gap or delay in a sensor reading can make a time-sensitive analysis irrelevant and break the continuity needed for event correlation and real-time interference. A split-second delay in a vibration reading, temperature spike, or acoustic signature can render the entire sequence analytically invalid.

When data integrity cannot be trusted, it breeds distrust in the outputs of analytics and AI models. This erodes confidence and slows the adoption of advanced automation, ultimately limiting the impact of Industry 4.0 initiatives.

The crisis of velocity: Real-time action vs delay

The full value of OT data comes from leveraging it across two distinct, yet interconnected, timeframes. The network must be capable of supporting both:

Real-time data—Immediate action

This data, captured in the moment, enables the immediate action required for operational control. Its primary value is to stop, start, or adjust the process instantly.

- **Operational control**—Automating tasks when a condition is met (e.g., automatically adjusting torque based on immediate resistance).
- **Anomaly detection**—Instantly flagging a severe deviation (like a sudden temperature spike or security breach) as it occurs, enabling a fast, system-level response.

Machine and process data—Predictive and prescriptive power

This data over time (machine data acquisition and production data acquisition), which is collected consistently over minutes, hours, days, and years, provides the predictive and prescriptive power that drives long-term business advantage. The value here is not just knowing what is happening but knowing what will happen and why.



- **Forecasting**—Estimating when components will fail by analyzing historical trends and cyclical behavior.
- **Root cause analysis**—Identifying systemic issues over time rather than treating isolated symptoms.
- **Long-term efficiency**—Comparing current performance to long-term baselines to optimize maintenance schedules and identify gradual performance degradation.

The crisis of completeness: Context without gaps

The network's primary job is to ensure real-time OT data can be reliably combined with the historical context needed for prescriptive decision-making. Modern manufacturing systems bring these streams together through time-series databases and data lakes, creating a foundation where fast, high-volume machine data meets long-term enterprise intelligence.

This integration allows high-fidelity, real-time machine signals to be enriched with historical business context and enterprise data—such as past quality reports, ERP resource planning information, and historical maintenance logs. For example, a vibration sensor may trigger a real-time anomaly, but the historical record determines whether it's truly abnormal or simply a recurring pattern seen before.

This unified view—bridging the moment on the shop floor with broader operational trends—is where meaningful, actionable intelligence emerges.

The connectivity gap: Undermining veracity, velocity, and completeness

Manufacturing leaders are rightly investing heavily in sophisticated analytics platforms, AI model development, and highly skilled data science teams. Yet, these significant investments in capability are often undermined by an insufficient data foundation. Without a network capable of delivering the required high-fidelity, complete OT data, the return on investment (ROI) for advanced analytics will remain frustratingly low. The data used by analytics models today is often limited to the easiest-to-connect sources, leaving vast amounts of valuable, granular information siloed and inaccessible.

- **Siloed operations**—High-value assets like Autonomous Mobile Robots (AMRs) and critical machinery often operate on isolated, disparate networks, preventing a unified view of the entire production line. In addition, traditional industrial communication models restrict data from lower layers from being directly propagated to higher layers, and thus lose context.
- **Predictive models fail**—AI models fed corrupted or intermittent data from unstable Wi-Fi connections can lead to false positives or missed predictions, eroding operator trust and stalling the adoption of advanced analytics.
- **High cost of change**—Adding new sensors or moving machinery often requires ripping up floors to lay new fiber, creating significant capital expenditure and operational downtime, which stifles innovation.



Private 5G—The high-fidelity data extraction engine

Private 5G closes the long-standing data accessibility gap by delivering high-fidelity, high-quality connectivity across the factory. Instead of relying on intermittent or low-fidelity data, manufacturers can access continuous, high-integrity streams—creating the conditions that advanced analytics and AI systems require to operate accurately and consistently.

Guaranteeing data veracity with predictable performance

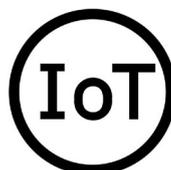
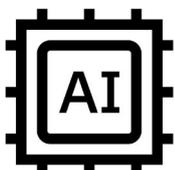
The defining feature of private 5G in the industrial context is its ability to offer Selectable Quality of Service (QoS). This critical capability allows the manufacturer to dynamically allocate network resources based on the unique demands of each application. For instance, a video feed might need high bandwidth (massive machine-type communications QoS), while a machine control loop demands guaranteed low latency (ultra-reliable low latency communication QoS). This policy-driven, deterministic approach directly counteracts the root causes of poor data veracity: jitter and packet loss.

- Ultra-reliable low latency communication (URLLC)**
 This is the highest level of QoS, specifically designed for business-critical industrial applications. It guarantees highly predictable latency (down to milliseconds). This precision is vital for correlating real-time events with sensor data—ensuring that the data point truly belongs to the event it is recording, which is essential for accurate time-series analysis and machine control.
- Minimal jitter and packet loss**
 Unlike Wi-Fi, which operates in shared spectrum prone to interference and unpredictable packet arrival times, private cellular networks use dedicated spectrum and superior radio resource management to ensure minimal jitter and near-zero packet loss. This guarantees the integrity of the data stream, so the AI models receive the complete, uncorrupted fuel they need to drive accurate outcomes.

Unifying mobile and fixed assets

Private 5G solves the connectivity challenge by offering ubiquitous, reliable coverage across the entire factory footprint, even in dense or complex RF environments.

- Seamless mobility**
 Private 5G ensures all high-value mobile assets—including Automated Guided Vehicles (AGVs), Autonomous Mobile Robots (AMRs), forklifts, moving robots, critical tools, and personnel carrying wearables or tablets—operate without dropping connections. It's rapid, seamless handover capabilities—a core cellular feature—maintain continuous data extraction, real-time tracking, and uninterrupted control commands, wherever assets move.
- Cost-effective retrofitting**
 By providing robust wireless coverage, 5G enables the cost-effective connection of legacy equipment that would otherwise require expensive wiring retrofits. This means even old machines can be easily fitted with new, high-density Industrial IoT (IIoT) sensors (e.g., vibration, acoustic, thermal) to transmit granular data, fully integrating previously siloed assets into the central analytics platform.



Enhanced security and operational resilience

In an era of increasing ransomware threats, network-level security is not optional—it is essential. Private 5G fundamentally delivers a security model far stronger than shared or enterprise Wi-Fi.

- **Network isolation**

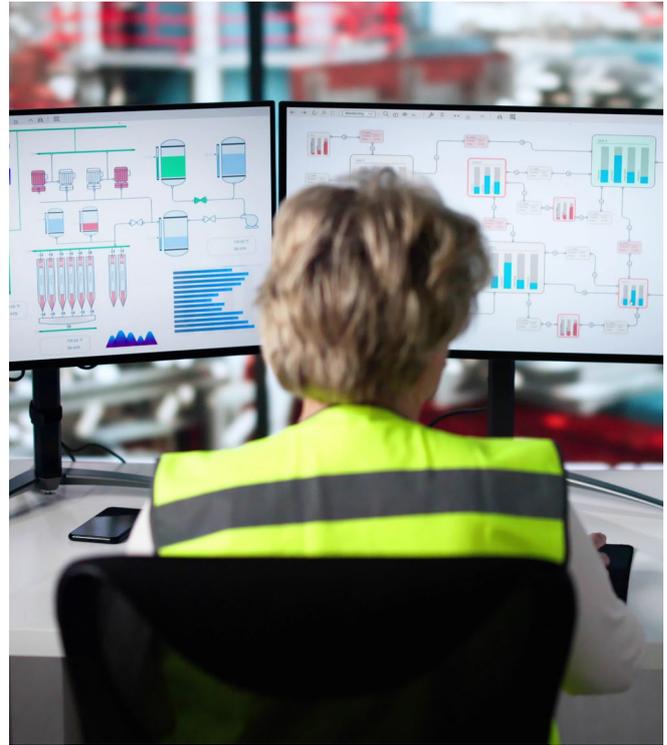
Unlike shared networks, private 5G operates using dedicated, protected spectrum (like industrial or licensed) and a physically or logically isolated core. This ensures that the business-critical OT network's wireless part is completely segmented from the less secure IT environment, drastically reducing the attack surface.

- **Built-in encryption and authentication**

The 5G protocol inherently features robust, state-of-the-art encryption and mutual authentication between the device and the network core. This level of security is applied automatically to all connected devices, protecting sensitive operational data and control signals from unauthorized access and injection.

- **Granular policy control**

Private 5G allows for the creation of specific security policies per device or group, ensuring that only authorized devices can access critical production resources. This fine-grained control is vital for preventing lateral movement by threat actors within the factory network, directly protecting against the operational shutdowns that plague the industry.



The pipeline for high-volume, diverse data

5G is purpose-built for massive data capacity and speed—critical for handling the volume, variety, and velocity of modern OT data streams.

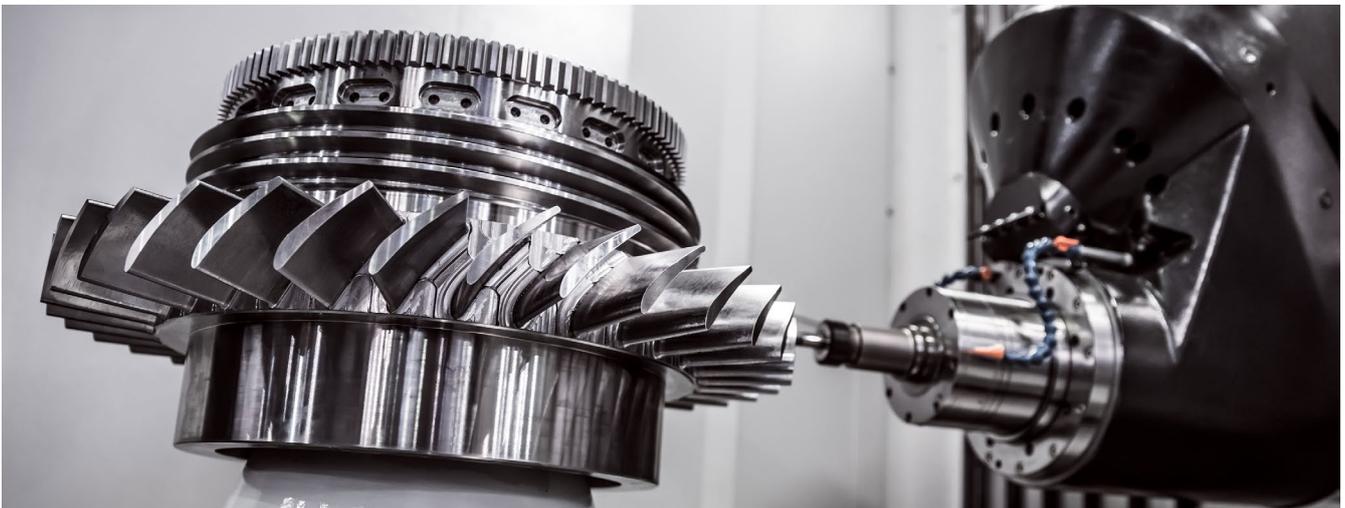
- **Massive capacity**

Supporting massive machine-type communication (mMTC), private 5G connects tens of thousands of devices per square kilometer, future-proofing the factory for a dramatic rise in high-resolution IIoT sensors.

- **High bandwidth data**

Its bandwidth enables continuous streaming of large data types—such as high-definition machine vision and surveillance video, directly to edge computing platforms. This high-volume, high-fidelity data unlocks sophisticated AI applications like automatic defect classification (ADC) and real-time quality control.

In short, private 5G transforms the factory floor from a collection of fragmented, low-quality data silos into a single, unified, high-fidelity data extraction engine.



Accelerating AI value—The critical use cases unlocked by private 5G

The high-fidelity, deterministic data pipeline created by a private 5G network is not an end in itself; it is the essential catalyst that transforms ambitious digital investments into measurable business outcomes. By solving the data accessibility gap, private 5G ensures that AI and ML models are fed the continuous, high-velocity data streams required to transition from simple reporting to truly prescriptive, autonomous operations.

This network foundation accelerates two of the most critical and high-value applications in modern manufacturing—predictive maintenance and real-time quality control.

Predictive maintenance (PdM)—Moving from alerting to prescriptive action

Effective PdM requires the AI model to continuously ingest and analyze high-volume, granular time-series data streams—such as acoustic signatures, high-resolution vibration analysis, and thermal patterns—from hundreds of connected machines.

- **The private 5G difference**

Legacy networks can only support intermittent sensor readings, leading to models that create simple, late-stage alerts ("The machine is failing"). By contrast, private 5G provides the URLLC connectivity needed to stream this high-frequency sensor data continuously, even from previously disconnected legacy equipment.

- **The value shift**

This complete data picture allows the AI model to build a richer, historical baseline, accurately predicting machine failure with sufficient lead time to schedule maintenance

optimally. The system moves beyond simple alerts to prescriptive actions—telling operators what to do, when to do it, and why, maximizing overall equipment effectiveness (OEE) and eliminating costly unplanned downtime.

Real-time quality and yield improvement

Maximizing yield and quality relies on inspecting product flow at scale and in real time. This requires massive bandwidth and extremely low latency for immediate feedback loops.

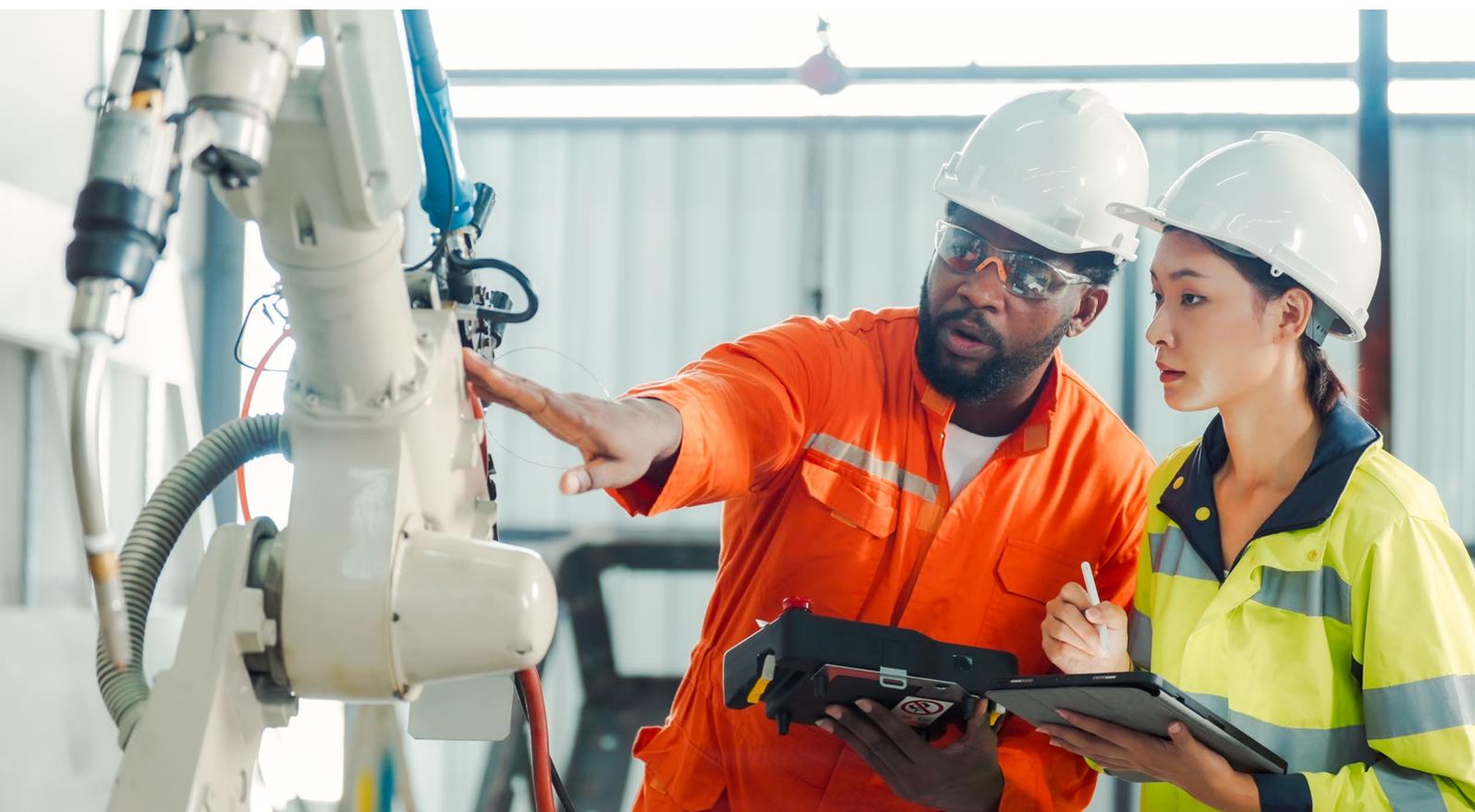
- **High-volume vision data**

Advanced automatic defect classification (ADC) systems rely on high-definition machine vision and 4K video surveillance to inspect goods moving at high speeds. This generates enormous data volumes. Private 5G provides the dedicated, high-speed pipeline required to offload these large video streams directly to edge computing resources for instantaneous processing.

- **Real-time process tuning**

Beyond just identifying defects, the core value lies in process tuning. If an ADC system identifies a defect, the network's deterministic, low latency enables a real-time control loop (RTCL) to immediately adjust the upstream machine parameters (e.g., pressure, heat, injection speed) within milliseconds. This rapid feedback loop allows manufacturers to correct quality issues as they occur, maximizing yield and drastically reducing waste before a large batch is compromised.

By ensuring the network fabric can handle the data variety, velocity, and veracity required by these sophisticated AI systems, private 5G transforms the factory floor into a resilient, self-optimizing system where continuous improvement is the norm, not the exception.



The indispensable core of smart manufacturing

Industry 4.0 success ultimately depends on data quality—specifically, the seamless flow of high-fidelity operational data between the OT and IT worlds. For too long, valuable, granular OT data—the kind needed for prescriptive AI and data-driven real-time control—has been constrained by legacy networks, creating a significant data accessibility gap that undermines digital transformation ROI.

Private 5G is the indispensable solution. It transforms fragmented, unreliable data streams into a unified, secure, high-fidelity data extraction engine. It creates a deterministic, secure data plane that OT and IT can trust, enabling manufacturers to reliably integrate systems (MES, SCADA, ERP, QMS) and push intelligence to the edge where decisions matter. Its core capabilities—URLLC and mMTC with seamless mobility—directly enable the most profitable use cases: moving predictive maintenance from simple alerts to prescriptive action and enabling real-time quality control through instantaneous process tuning. Private 5G ensures that every dollar invested in AI, automation, and IIoT delivers its promised value.

Private 5G also accelerates time to value. With simplified deployment, plug-and-play mobility, and reduced wiring, plants can reconfigure production lines faster and modernize without the delays associated with traditional connectivity upgrades.

To fully realize the value of current and future investments in advanced analytics and autonomous systems, the first strategic priority is establishing this foundational network. Partner with a trusted wireless provider, like Ericsson, to map out a private 5G deployment that immediately begins to liberate your most valuable asset: the high-fidelity data trapped on your factory floor.

To learn more, visit: www.ericsson.com/manufacturing.



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