



How to Achieve Industrial **IoT at Scale**

Pelion.com

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Introduction

The Fourth Industrial Revolution, or Industry 4.0, is redefining manufacturing with unprecedented levels of digital integration. At its core lies the Industrial Internet of Things (IIoT), where machines, sensors, and systems communicate in real time to drive operational efficiency, quality, and innovation. IIoT is no longer optional; it's a key driver of competitive advantage and digital transformation at scale.

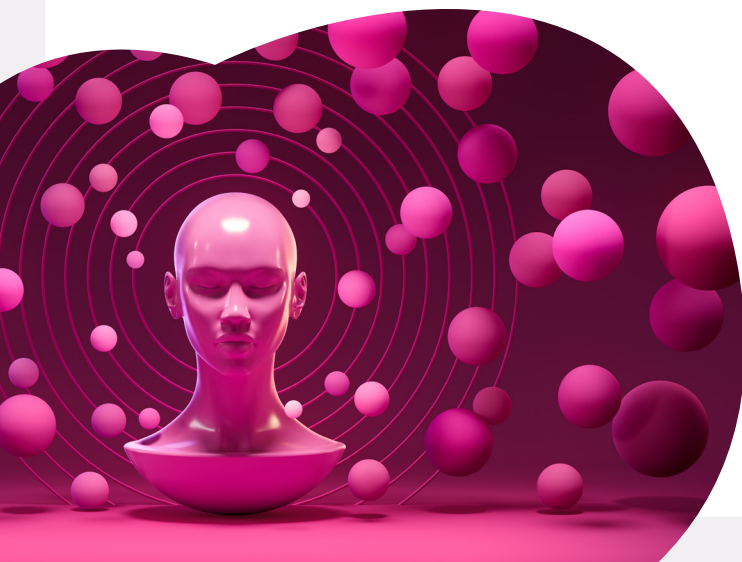
But as global competition intensifies and supply chains grow more complex, IIoT is shifting from experimental pilots to mission-critical infrastructure. With manufacturers aiming to achieve smart factory capabilities, the need to scale IIoT from pilot projects to enterprise-wide deployment has never been more urgent. However, scaling IIoT across multiple sites, countries, and device types can present significant technical and strategic challenges.

This paper outlines how manufacturers can confidently scale IIoT by focusing on five foundational requirements: connectivity, security, integration, management, and global scalability, and draws on real-world examples to highlight best practices and impact.

Key topics include:

- Why IIoT scaling matters: Industry 4.0 demands enterprise-wide, intelligence, agility, and automation at scale.
- Market momentum and opportunity: With IIoT projected to hit \$254.6B by 2033, adoption is accelerating across sectors and regions.
- Tangible benefits: IIoT boosts ROI through predictive maintenance, quality, and efficiency gains.
- Key challenges: Connectivity gaps, legacy integration, and security remain major hurdles.
- Success factors: Scaling requires a unified, secure, and globally consistent platform to unlock IIoT's full potential.

The journey to industrial-scale IIoT is complex, but with the right strategy and infrastructure, it becomes a powerful catalyst for operational excellence and innovation.



Background and Growth

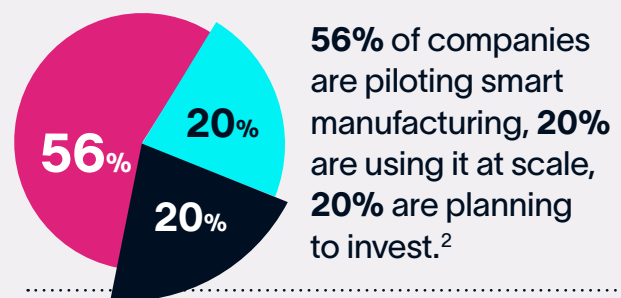
The growth trajectory of the global IIoT market underscores its strategic significance. Valued at USD 102.4 billion in 2024, the market is projected to reach USD 254.6 billion by 2033, expanding at a compound annual growth rate (CAGR) of 10.5%.¹

This sustained growth is being driven by several converging forces:

- **Manufacturing digitalization:** As traditional factories transform into smart facilities, demand for connected devices and systems is accelerating.
- **Operational efficiency mandates:** Rising energy costs, global competition, and sustainability goals are pushing manufacturers to adopt real-time data and automation tools.
- **Supply chain resilience:** IIoT enhances transparency and adaptability in global supply networks, helping businesses mitigate disruptions and respond to demand fluctuations.

Meanwhile, the broader Internet of Things (IoT) market continues to expand at an even faster pace, reaching USD 595.7 billion in 2023 and forecasted to grow to USD 4.06 trillion by 2032, with a CAGR of approximately 24%.

While this includes consumer IoT segments, the industrial domain remains a key growth engine, accounting for a significant and growing share of overall IoT spending.



56% of companies are piloting smart manufacturing, **20%** are using it at scale, **20%** are planning to invest.²

Regionally, Asia-Pacific, North America, and Europe are leading in IIoT adoption, with China, the U.S., and Germany investing heavily in smart manufacturing, factory automation, and industrial AI. Additionally, sectors such as automotive, energy, logistics, pharmaceuticals, and food processing are among the top adopters, using IIoT to improve quality control, asset management, predictive maintenance, and regulatory compliance.

As technological capabilities mature, particularly in areas like edge computing, 5G, digital twins, and AI, IIoT adoption is expected to deepen and expand across verticals. However, scaling IIoT from pilot to enterprise-wide implementation requires overcoming critical challenges in connectivity, security, and systems integration.

By digitizing and connecting every aspect of the manufacturing process, sensors, actuators, and embedded devices collect data from production lines, machines, workers, and the environment. This data feeds advanced analytics and AI systems, enabling real-time decisions, optimized operations, and predictive interventions.

¹ <https://www.fortunebusinessinsights.com/industry-4-0-market-102375>

² <https://www.rockwellautomation.com/en-se/capabilities/digital-transformation/state-of-smart-manufacturing.html>

Key Benefits of Industrial IoT & Smart Manufacturing

The adoption of Industrial Internet of Things (IIoT) technologies is transforming how manufacturers operate, compete, and deliver value. By embedding intelligence into machines, systems, and processes, IIoT delivers tangible business outcomes across the factory floor and beyond. Key benefits include:

Reduced downtime through predictive maintenance

Predictive maintenance, powered by IIoT sensors and AI analytics, can reduce unplanned downtime by up to 50%, extend machine life by 20–40%, and lower maintenance costs by 10–40%.

Example: German manufacturer Siemens uses IIoT-driven predictive maintenance in its gas turbines, identifying faults weeks before failure and reducing unplanned outages dramatically.

Enhanced inventory visibility and supply chain efficiency

Real-time inventory tracking via IIoT has been shown to reduce inventory carrying costs by 20–50% and improve order accuracy by over 30%.

Example: Caterpillar uses IoT-enabled asset tracking across its global supply chain to monitor equipment, shipments, and parts in real time—optimizing inventory turnover and reducing logistics delays.

Improved product quality via automated inspection

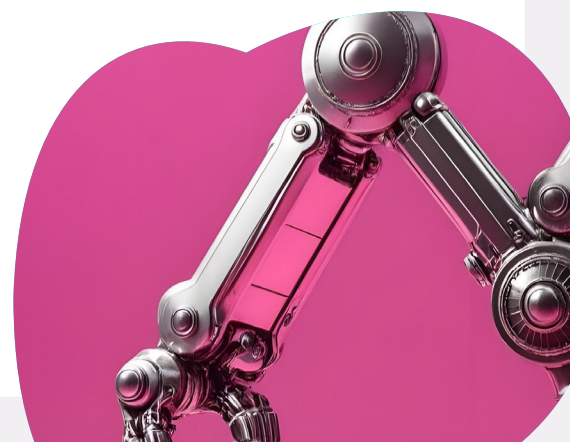
Automated, sensor-driven quality checks using computer vision and AI can reduce defect rates by up to 90% in some high-precision industries.

Example: Hewlett Packard deployed Relimetrics' machine vision for server assembly lines, delivering 99.9% probability of defect detection, reducing audit costs by 50%, and slashing final testing/rework costs by 80%. Though the specific defect reduction percentages aren't stated, the near-perfect detection accuracy suggests defect rates dropped dramatically.

Lower operational costs through energy and resource optimization

IIoT-based energy management systems can reduce electricity consumption by 10–25% and improve overall equipment efficiency (OEE) by 15–20%.

Example: A major Unilever plant achieved a 12% reduction in energy costs after deploying IIoT systems to monitor and optimize HVAC, compressors, and lighting across facilities.



Improved product quality via automated inspection

Advanced computer vision, machine learning algorithms, and high-speed data acquisition systems enable real-time, automated quality checks directly on the production line. These technologies detect micro-defects, surface inconsistencies, or dimensional deviations instantly, allowing for immediate corrective action. This approach not only ensures consistent product quality but also reduces rework, scrap, warranty claims, and customer dissatisfaction.

Example: Electronics manufacturer Foxconn increased defect inspection accuracy by 95-99%, as well as a yield rate above 99% and a reduction in manpower by 50%.

Enhanced inventory visibility and supply chain efficiency

IIoT-enabled tracking solutions, including RFID tags, GPS sensors, and cloud-based analytics platforms, deliver real-time, end-to-end visibility across the entire supply chain. These technologies monitor the location, condition, and status of raw materials, work-in-progress (WIP), and finished goods, enabling lean inventory practices, reducing stockouts and overages, and increasing responsiveness to market demand.

Example: KEB Automation implemented RFID tagging combined with IoT sensors and SAP's warehouse management system to fully automate pallet tracking in their warehouse. This setup enabled near-100% automatic identification of pallets, eliminated manual scanning, and provided real-time inventory visibility. As a result, they streamlined warehouse operations, improved transparency, and increased overall supply chain efficiency.

Lower operational costs through energy and resource optimization

IIoT platforms monitor and analyze real-time data from energy systems, utilities, and production assets to identify inefficiencies and optimize usage. Smart energy management applications can autonomously adjust HVAC, lighting, and machinery based on load, shift schedules, and environmental conditions, cutting waste and improving sustainability.

Example: Nestlé invested €2.3 million in a thermal energy system at its chocolate factory in La Penilla de Cayón, Spain. This system, featuring a heat pump that utilizes residual energy from the factory's cold production plant, is expected to reduce energy consumption by almost 5% and decrease CO₂ emissions by nearly 2,000 tons annually tracking across its global supply chain to monitor equipment, shipments, and parts in real time, optimizing inventory turnover and reducing logistics delays.



According to the **World Economic Forum**, IIoT-driven resource optimization can lower total operational costs by

10-25%

while also helping manufacturers meet environmental, social, and governance (ESG) targets.³



³ <https://www.weforum.org/stories/2022/01/8-innovations-advanced-manufacturing-support-esg-reporting/>

IIoT Use Cases in Smart Manufacturing



Predictive Maintenance

By equipping equipment with sensors that monitor vibration, temperature, noise, and electrical consumption, manufacturers can predict potential failures before they occur. Predictive maintenance reduces unplanned downtime, extends asset life, and minimizes repair costs.



Asset Tracking and Inventory Management

IoT-enabled tags and GPS trackers provide real-time visibility into the location and status of tools, parts, raw materials, and finished goods. This enables just-in-time inventory, reduces losses, and enhances workflow.



Quality Control

Connected cameras, environmental sensors, and AI algorithms can inspect products during and after assembly to detect defects instantly. Deviations trigger alerts or automatic corrections.



Process Automation

IIoT enables machines to adjust settings dynamically based on live data from sensors, resulting in automated, adaptive processes. This improves throughput, consistency, and safety.

Key Challenges in Scaling IIoT

01

Coverage Limitations

IIoT deployments span diverse environments, from climate-controlled clean rooms to outdoor construction zones. Ensuring continuous connectivity across indoor and remote locations, and across countries, is challenging.

02

Network Stability and Uptime

IIoT systems rely on constant, real-time data transmission between devices, machines, and control systems. Any network disruptions or downtime can lead to delayed decision-making, halted production lines, and data loss. In industrial environments, poor connectivity can further compromise reliability, making it a significant challenge to maintain seamless operations.

03

Integration Complexity

Legacy equipment often lacks built-in connectivity. Integrating modern IoT platforms with old systems, across different vendors and protocols, requires deep expertise and tailored solutions.

Pilot-to-scale failure rate:

~70% of initiatives fail to scale due to complexity.⁴

04

Security Risks

With every connected device comes an expanded attack surface. IIoT environments are vulnerable to malware, data breaches, and sabotage if security is not embedded from device to cloud.

04

Operational Management

Managing thousands of devices globally, including SIMs, firmware updates, data plans, and diagnostics, is highly complex without a centralized, automated management platform.

⁴ <https://www.verifiedmarketreports.com/product/industrial-iiot-market/>

Scaling Industrial IIoT: Requirements for Enterprise Deployment

Moving from IIoT pilot projects to full-scale enterprise implementation requires addressing a complex set of technical and strategic challenges. Successful scaling hinges on five key pillars:

Reliable, Global Connectivity



Enterprise-wide IIoT relies on ubiquitous, secure, and high-availability connectivity. Manufacturers need network coverage across indoor facilities, outdoor environments, and international sites. This includes support for cellular technologies like LTE-M, NB-IoT, 5G, and resilient roaming across hundreds of carriers. Reliable connectivity also enables predictive maintenance, which reduces unplanned downtime, extends asset life, and minimizes repair costs.

Unified Device and Connectivity Management



Managing thousands or even millions of IIoT devices requires centralized orchestration. A robust Connectivity Management Platform (CMP) allows companies to:

- Activate, monitor, and troubleshoot SIMs remotely
- Automate firmware and software updates
- Track usage and cost across sites
- Integrate via APIs into existing IT/OT systems

This streamlines operations and ensures uniform policy enforcement globally.

End-to-End Security



Scalability must not come at the expense of security. From device authentication to secure data transport and network segmentation, IIoT systems must be designed with layered, zero-trust security. With industrial cybercrime risks rising, encryption, identity management, and ongoing threat detection are essential.

Key considerations include:

Device authentication	Use strong, unique credentials or certificates for each device.
Data encryption	Encrypt data both in transit and at rest to prevent interception or tampering.
Secure boot and firmware	Ensure devices start from a trusted state and receive verified software updates.
Network security	Segment IoT devices from other systems and monitor for unusual traffic.
Access control and audit logs	Limit who can interact with devices and monitor all interactions.

Legacy Integration and Interoperability



Most factories contain legacy systems and equipment that lack native IIoT compatibility. Scaling IIoT means ensuring seamless integration between new edge devices and existing machinery, using protocols like Modbus, OPC UA, and MQTT. Scalable architectures must accommodate hybrid environments with multiple vendors and data formats.

Global Scalability Infrastructure



IIoT deployments must work across different countries, compliance regimes, and industrial environments. Scalable solutions require:

- Multi-country SIMs and eSIM/eUICC technologies
- Compliance with local or regional regulations such as GDPR
- Infrastructure built to support millions of endpoints with high availability and low latency

Scaling IIoT is not just a matter of adding more sensors; it requires foundational infrastructure that delivers connectivity, control, security, and compatibility at enterprise scale. Manufacturers that invest in these capabilities early can unlock the full value of smart manufacturing and gain a decisive edge in a globally connected industrial future.

The Need for Reliable Connectivity

97% of connected businesses⁵ suffer some form of outage or disruption of service every month.



This translates to £900/hour average loss for SMEs – and tens of thousands per hour for enterprises running large-scale IoT deployments.”

At Pelion we believe that is just not good enough. Your business shouldn't be paying the price for inconsistent connectivity.

Comparison of service levels and downtime

Service Level	Downtime	Daily	Weekly	Monthly	Yearly
99%	1%	14m 24s	1h 40m 48s	7h 12m	3d 15h 36m
99.9%	0.01%	1m 26s	10m 5s	43m 12s	8h 45m 36s
99.995%	0.005%	4s	30s	2m 10s	26m 17s

Key Connectivity Requirements for IIoT

Ubiquitous coverage	Devices must stay connected regardless of their location – inside a facility, across multiple sites, or in transit.
High availability	Downtime in IIoT systems can halt production, damage equipment, or cause revenue losses. Ultra-high uptime (99.995% or better) is crucial.
Security	Industrial environments face increasing cybersecurity risks. Secure data transmission, authentication, and network segmentation are non-negotiable.
Low latency & high throughput	Time-sensitive applications like robotics or machine vision need minimal delay.
Scalability	A single network must support thousands to millions of devices without performance degradation.

Conventional networks often fall short. Manufacturers require an IIoT connectivity solution that is global, secure, flexible, reliable, and future proof.

⁵ <https://www.rsim.com/news/human-cost-of-outages>

Key Takeaways

1 The need for digital transformation in manufacturing is accelerating the adoption of IIoT

Manufacturers are shifting from traditional, reactive operations to proactive, data-driven models. Digital transformation enables them to respond faster to market changes, customize production, and optimize resource usage. IIoT acts as the digital nervous system of smart manufacturing, facilitating real-time monitoring, control, and optimization of every process, from the shop floor to the supply chain.

3 Scaling IIoT comes with challenges including connectivity, integration, security, and operational complexity

As IIoT moves from pilot to production, organizations encounter barriers like inconsistent network coverage, legacy system compatibility, data fragmentation, and cybersecurity risks. Managing thousands of devices across global facilities with varying compliance requirements adds additional complexity. Without the right infrastructure, these challenges can stall or even derail digital transformation efforts.

5 Deploy IIoT confidently at scale across borders, technologies, and use cases.

Leveraging global connectivity, future-proof SIM technology, and an integrated management portal allows manufacturers to manage devices anywhere in the world with consistent visibility and control. Whether implementing predictive maintenance in a European factory, asset tracking across North America, or automating processes in Asia-Pacific, this approach ensures a seamless, secure, and scalable IIoT experience, paving the way for smarter, more agile manufacturing operations.

2 Reliable, secure, and scalable connectivity is essential to realize the benefits of IIoT


The full value of IIoT, such as minimizing downtime, automating quality checks, and enabling predictive analytics, can only be unlocked when devices are reliably connected. Connectivity must not only be high-availability and low-latency but also secure from edge to cloud. This ensures continuous data flow, uninterrupted automation, and resilient operations even in mission-critical environments.

4 Address challenges with a globally consistent, secure, and cost-effective platform

A comprehensive IIoT connectivity and device management solution eliminates fragmentation and simplifies deployment. With features like global SIM coverage, centralized device management, robust security protocols, and flexible data plans, the right Connectivity Management Platform (CMP) streamlines operations and reduces overhead. Its infrastructure is designed to handle industrial workloads with carrier-grade resilience and minimal downtime.

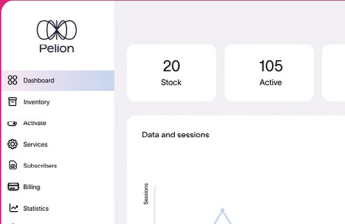
How Pelion Delivers IoT Connectivity

Pelion is a global IoT connectivity and management provider, supporting 500+ customers across sectors. With 600+ network partners in over 160 countries, Pelion offers secure, scalable SIM solutions (including eSIM/eUICC) and a unified platform for connectivity, billing, and analytics.




IoT SIMs - Global Coverage

Multi-network IoT SIMs that allow your devices to connect locally and globally to the best carrier signal across 600+ networks in 150+ countries.



Powerful Platform

Manage all your SIMs in one place with the Pelion Portal. Get visibility and insights for remote monitoring and over-the-air updates.



Deep IoT Expertise

Tap into 20+ years of know-how. Our managed service delivers expert guidance, 24/7 support, and enhanced SLAs..

IoT Security

Flexible security solutions designed to secure endpoints and expanding attack surfaces.

Get in Touch



[Pelion.com/talk-to-us](https://pelion.com/talk-to-us)



linkedin.com/company/pelioniot

Trial Pelion IoT SIMs for Free.

- 30 Day free trial
- Get 5 eUICC Enabled SIMs
- 50MB monthly data allowance per SIM
- Full Pelion Portal Access
- Connect to 600+ networks



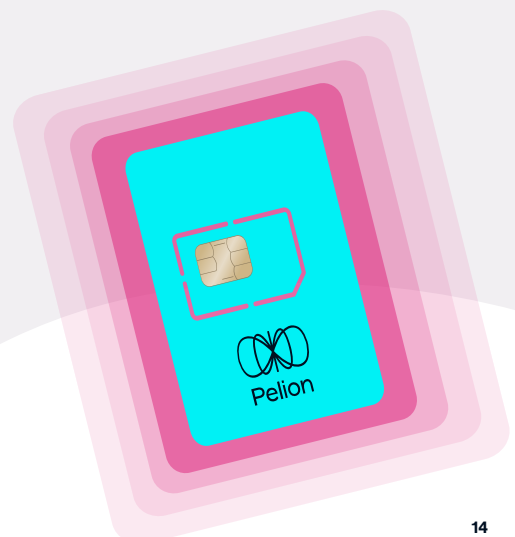
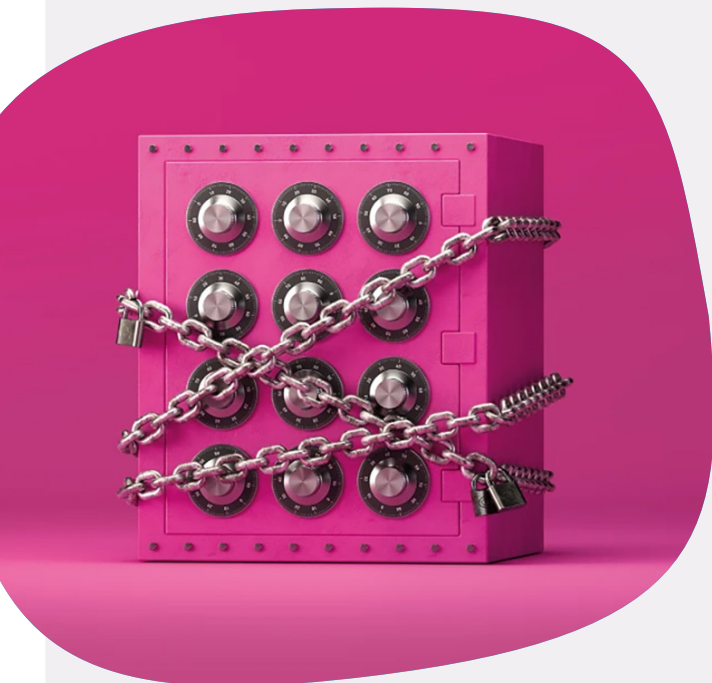
Conclusion

As digital transformation becomes a boardroom priority, IIoT is no longer viewed as a niche IT initiative or experimental project. It has evolved into a strategic enabler of competitive advantage, unlocking value across cost, quality, speed, and innovation dimensions.



Manufacturers that effectively harness IIoT not only improve operational performance but also gain the agility and insight needed to meet evolving customer demands, comply with regulations, and differentiate in a rapidly shifting global market.

By leveraging reliable global coverage, a unified connectivity management platform, future-proof SIM technology, and enterprise-grade security, manufacturers can confidently scale their IIoT deployments. As the industry advances toward intelligent, connected operations, having a strategic connectivity partner is essential to bringing that vision to life.



IoT Connectivity Made Effortless



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