

Boost Uptime and Revenue with Well-Integrated Predictive Maintenance

Asset optimization and predictive maintenance reduce manufacturing costs while increasing production and competitive advantage

This solution brief describes how to solve business challenges and enable digital transformation through investment in innovative technologies.

If you are responsible for...

- **Business strategy:**
You will better understand how a predictive maintenance solution will enable you to successfully meet your business outcomes.
- **Technology decisions:**
You will learn how a predictive maintenance solution works to deliver IT and business value.

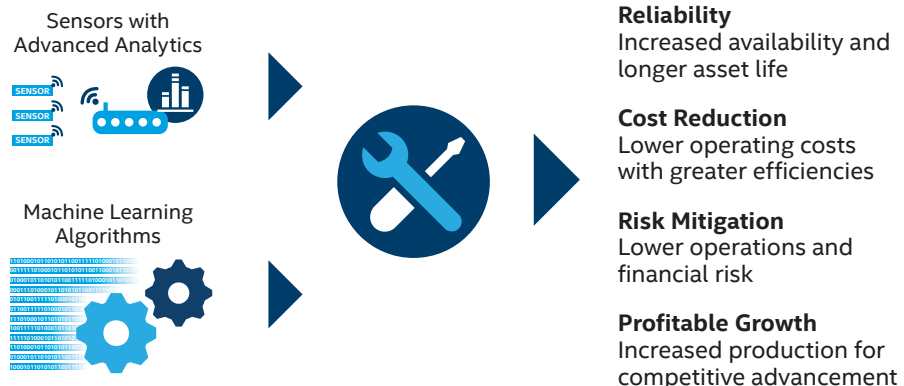
Executive Summary

Unexpected downtime and product failure is costly. Without visibility into the health of equipment and the parts they make, manufacturers cannot accurately forecast failure, capacity, quality, or delivery delays. This produces a cascading effect on the supply chain as inventories become unbalanced and orders are delayed, risking customer satisfaction and brand loyalty. Across the globe, manufacturers are aggressively pursuing digital manufacturing strategies to address these issues.

Predictive maintenance and quality is increasingly used in Industry 4.0¹ solutions to predict equipment failures and product quality. With Industry 4.0 solutions, Intel's factories, one of the closest examples of Industry 4.0,² cut costs by 20 percent and reduced maintenance time by 50 percent.

Using sensors connected to gateways and the data center/cloud with advanced analytics and machine learning algorithms, manufacturers can make the digital transformation to predict when equipment, inventory, or finished goods will fail and to improve supply chain management. The benefits include reliability, cost reduction, risk mitigation, and profitable growth.

Predictive Maintenance Benefits



Intel Solution Architect

Ted Connell

Worldwide Manufacturing Solution
Architect, Industry Solutions Group

Figure 1. Sensor data combined with advanced analytics and machine learning can help manufacturers gain visibility into asset health.

Business Challenge: Poor Asset Visibility and Integration Is Costly

Manufacturers often lack visibility into the health of their assets. A recent study found that manufacturing companies experience up to 800 hours³ of unscheduled downtime annually, 30 percent (or approximately USD 1.3 million) of which is unexpected. For example, the average cost of downtime for an automotive manufacturer is USD 22,000 per minute, yet only 14 percent of manufacturing companies use analytics to address this problem.⁴ Without visibility, companies are unable to accurately forecast downtime and expenses.

Limited machine and process integration also adds to poor asset performance and harms organizational agility. Without integration and visibility, it is impossible to predict outages and costs across different parts of an organization. Opportunities to save money in the supply chain are lost due to redundant manual processes and information sources. Organizations also struggle with the increasing complexity of supply chains, increased customer demands, material cost volatility, and numerous compliance standards—all of which combine to make it more difficult than ever to remain competitive and respond to changes in the market.

Predictive Maintenance Improves Product Quality

Predictive maintenance helps organizations maximize the life of equipment, reduce unforeseen costs associated with failure, and ultimately gain a competitive advantage. Manufacturing companies only make money when their factories are producing what customers want. But equipment or part failure during a critical production run disrupts that. The use of predictive maintenance helps companies identify potential failures before they happen and rework schedules in advance to accommodate it.

The Intel® IoT Platform was developed as an end-to-end reference architecture for extracting and transmitting trusted data from things to network and cloud delivered through ecosystem solutions from IBM*, Accenture*, GE*, SAP*, ADLink*, Dell*, and others.

With advanced analytics and machine learning algorithms, manufacturers can make the digital transformation for predicting when equipment, inventory, or finished goods will fail and improve supply chain management, as shown in Figure 2.

Third-party solution providers using the Intel IoT Platform help manufacturers use predictive maintenance and quality solutions to increase factory uptime, yield, and product quality, improving the following phases of product manufacturing:

- **Design.** During market analysis and product design, predictive quality solutions identify materials, components, and suppliers that will perform best. Predictive warranty solutions provide insights into product performance under various conditions and the rates of wear and replacement. This helps organizations better understand product costs, including estimates for warranty accruals.



REDUCE

- Risk exposure
- Failures
- Downtime
- Maintenance costs

OPTIMIZE

- Asset availability
- Asset life
- Workforce productivity
- Operational performance

IMPROVE

- Product quality
- Customer satisfaction
- Safety and compliance
- Employee productivity

Figure 2. Operations technology data and sensor data aggregated and then analyzed using advanced analytics and machine learning lead to actionable information that reduces costs and increases quality.

- **Production.** During manufacturing, predictive quality solutions can be used in the ongoing assessment of material, component, and process quality analysis. Predictive maintenance helps identify machine failures before they occur, reducing unplanned downtime and improving product quality and throughput.
- **Support.** During the ongoing support process, predictive maintenance can identify pending product or asset failures in the field, and underlying causes, as well as proactive resolutions.

Solution Value: Dynamic Processes Create New Opportunities

Industry 4.0 is characterized by the use of dynamic business and manufacturing processes and systems that enable smart machines to make smart products, just-in-time production changes, personalized and local production, and mass customization, as well as the ability to create new business models and grow services revenue.

Industry 4.0 uses dynamic business and manufacturing processes and systems that enable smart machines to make smart products, just-in-time production changes, personalized and local production, and mass customization. It also has the ability to create new business models and grow services revenue. In a recent survey 72 percent of manufacturers predict improvements in customer relations resulting from data analytics, 86 percent expect to reduce costs and improve revenue, and 35 percent of those manufacturers expect revenue gains to exceed 20 percent in five years.⁵

Predictive maintenance and quality is a relatively easy, high return-on-investment step toward the promise of Industry 4.0 offering the following benefits to manufacturers:

- **Increased product quality.** Quality problems are identified early in the production cycle when they are less costly to correct. Specific quality issues can also be identified across multiple factories or locations before they appear.

- **Increase uptime, productivity, and throughput.** Having production equipment available when scheduled, with employees actively doing value-added work, increases the capacity of a factory and decreases cycle times.
- **Reduced inventory costs.** Scrap is reduced by identifying quality issues early. Manufacturing schedules remain tight due to predictive analytics enabling lean management of the supply chain.
- **Reduced warranty claims.** Assurance of quality reduces the number of warranty issues from the field. Predictive maintenance enables business to proactively service clients before failure occurs, which helps maintains customer satisfaction and contains costs.
- **Reduced manual rounds and readings.** By connecting equipment and managing it from a central facility with advanced analytics and machine learning algorithms, manual rounds and readings can be eliminated.
- **New business models.** Assets as a Service (AaaS) as well as other service transformation opportunities create new business models that predictive maintenance brings to the market.
- **Improved financial processes.** Better insight into asset health helps Finance forecast available capacities, warranty, and replacement costs.
- **Improved employee productivity.** Reduces unscheduled maintenance, rework, scrap, and other work that does not add value.

Solution Architecture: Achieve Predictive Maintenance and Quality Using the Intel® IoT Platform

Intel's ecosystem partners' preintegrated and validated solutions for predictive maintenance and quality are designed for the Intel IoT Platform. Predictive maintenance and quality deliver end-to-end business value quickly, as shown in Figure 3.

With Intel® architecture and technology, as well as third-party solutions, manufacturers can gain pre-integrated computing infrastructure with software solutions that target their specific needs. These solutions provide the following:

- **An open platform.** The Intel IoT Platform enables flexible IT cost structures with products and services that are available from a variety of independent solutions providers and OEMs.

The Future Is Now at Intel's World-Class Industry 4.0 Factories

Intel wafer factories are the world's closest example of Industry 4.0. These factories use Internet of Things (IoT) technologies to fully automate manufacturing with pervasive robotic material transport and equipment standardization, advanced manufacturing execution solutions, real-time excursion control, advanced process control and adjustment, predictive and adaptive maintenance, and advanced inventory control and tracking. Each of these processes is controlled and optimized with big data analytics.

Intel worked with Dell* on an IoT-centered infrastructure platform to implement a private cloud for data analytics in one of its assembly and test factories. Intel wanted a solution to support big data analytics and required high performance and the ability to scale by hundreds of gigabytes. Key performance metrics included:

- Yield losses due to test and assembly manufacturing inefficiencies reduced by 25 to 50 percent⁶
- Spare parts costs reduced by 20 percent
- Maintenance time reduced by 50 percent
- Classification of defects completed 10 times faster

The factory automation solution helped production lines run for longer periods of time as maintenance times were reduced. The results also showed that the solution was capable of predicting up to 90 percent of failures faster than traditional monitoring technology. As a result of the automation system, Intel saved millions of dollars in a single factory through better decision making.

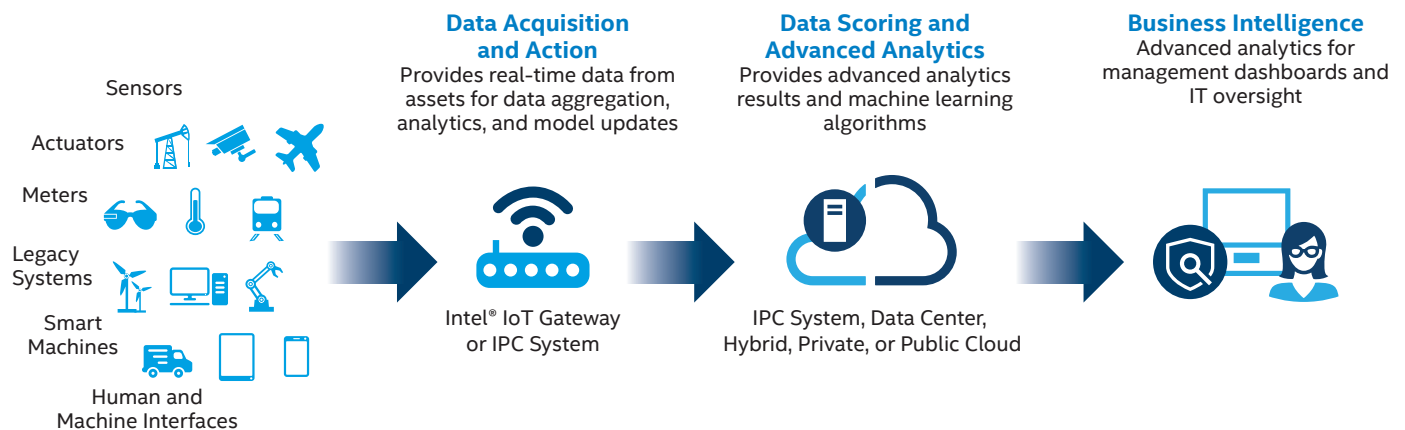


Figure 3. Internet of Things technologies are the backbone of end-to-end predictive maintenance and quality solutions. They help billions of assets talk to each other and share valuable information for a clear view into the health of assets, materials, and processes.

- **Interoperability.** Intel architecture ensures each new generation maintains backward compatibility with hardware, software, and software development tools.
- **Performance at the edge.** Predictive maintenance provides options for high performance at the edge through hybrid cloud or industrial PCs on the factory floor.
- **A robust, scalable, and secure network.** Many networking performance and security issues are solved with Intel IoT Platforms and Intel® Gateway Technology, which have been optimized for more efficient device manageability and data protection.
- **Fast return on investment.** With existing implementations already in the field, actual benchmarks can be modeled into client-specific proof of concepts and pilots that demonstrate real-world business results in the factory.

A number of solution providers such as IBM, Accenture, GE, SAP, ADLink, Dell, and others are using Intel® technology to provide IoT solutions for predictive maintenance. These technologies include:

- **Intel® IoT Gateway.** The gateways connect industrial infrastructure devices and secure data flow with the data center or cloud.
- **Intel® Quark™ processor.** Low power consumption, integrated security, and scalable architecture for devices and gateways enable IoT to cloud computing.
- **Intel® Xeon® processors.** Intel Xeon processors provide higher core counts, faster memory speeds, and improved performance-per-core for edge, industrial PCs, and data center computing.⁷
- **Intel® Xeon Phi™ product family.** Intel Xeon Phi coprocessors boost speed for data center computing.
- **Intel® Solid State Drive (Intel® SSD) Data Center Family.** Intel SSDs for the data center offer unequaled performance and reliability in the world's most demanding data environments.

Conclusion

Manufacturers and other industrial organizations have historically relied on manual processes, which lack visibility into the health of equipment, work-in-process inventory, and materials. This lack of visibility makes it difficult to accurately



¹ en.wikipedia.org/wiki/Industry_4.0

² youtube.com/watch?v=-KTKgOY1snQ

³ "Downtime Costs Auto Industry \$22k/Minute – Survey." news.thomasnet.com/companystory/Downtime-Costs-Auto-Industry-22k-Minute-Survey-481017

⁴ Ibid.

⁵ "Industry 4.0 Is Enabling A New Era Of Manufacturing Intelligence And Analytics." forbes.com/sites/louiscolumnbus/2016/08/07/industry-4-0-is-enabling-a-new-era-of-manufacturing-intelligence-and-analytics/#4d523314794f

⁶ "The Internet of Things optimizes factory floor operations." http://i.dell.com/sites/doccontent/corporate/case-studies/en/Documents/2015-intel-penang-10022395-converged-infrastructure.pdf

⁷ "Joining IoT with Advanced Data Analytics to Improve Manufacturing Results." IT@Intel white paper. 2015. intel.com/content/www/us/en/it-management/intel-it-best-practices/joining-iot-with-advanced-data-analytics-to-improve-manufacturing-results-paper.html

All information provided here is subject to change without notice. Contact your Intel representative to obtain the latest Intel product specifications and roadmaps. Cost reduction scenarios described are intended as examples of how a given Intel- based product, in the specified circumstances and configurations, may affect future costs and provide cost savings. Circumstances will vary. Intel does not guarantee any costs or cost reduction. Intel technologies' features and benefits depend on system configuration and may require enabled hardware, software, or service activation. Performance varies depending on system configuration. Check with your system manufacturer or retailer, or learn more at intel.com. No license (express or implied, by estoppel or otherwise) to any intellectual property rights is granted by this document. Copyright © 2016 Intel Corporation. All rights reserved. Intel, the Intel logo, Intel Xeon Phi, Quark, and Xeon are trademarks of Intel Corporation in the U.S. and/or other countries. *Other names and brands may be claimed as the property of others.

forecast equipment downtime, product quality, and warranty costs. When workers are scheduled but not efficient, or parts are not available, productive work cannot occur.

Predictive maintenance and quality provide fast business value and are an excellent place to begin transforming to digital manufacturing with Industry 4.0. The Intel IoT Platform gives manufacturers the flexibility to choose from multiple software and hardware solutions from IBM, Accenture, GE, SAP, ADLink, Dell, and others that are optimized to Intel architecture, bringing a wide range of solutions specific to individual needs.

Predictive maintenance and quality using IoT-based technologies helps organizations gain valuable insights into equipment health that maximize life cycles and reduce unforeseen costs associated with quality and failure. Digital manufacturing translates to a stronger competitive advantage.

Find the solution that's right for your organization. Contact your Intel representative or visit intel.com/content/www/us/en/industrial-automation/overview.html

Learn More

- Getting to Industry 4.0 with the Internet of Things eBook: intel.com/content/dam/www/public/us/en/documents/solution-briefs/industry-with-iot-ebook.pdf
- IBM White Paper: [Predictive Analytics - Maximize asset productivity and operational performance](#)
- Intel White Paper: [Improving Manufacturing with Advanced Data Analytics](#)
- Intel White Paper: [Using Big Data in Manufacturing at Intel's Smart Factories](#)
- Intel White Paper: [Joining IoT with Advanced Data Analytics to Improve Manufacturing Results](#)
- Intel White Paper: [Integrating IoT Sensor Technology into the Enterprise](#)

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