

The Cisco Connected Factory: Powering a Renaissance in Manufacturing

Cisco Manufacturing White Paper

Gearing Up for the 21st Century Revolution

Industrial enterprises around the world are retooling their factories with advanced technologies to boost manufacturing flexibility and speed, achieving new levels of overall equipment effectiveness (OEE), supply chain responsiveness, and customer satisfaction in the process. This renaissance reflects very real pressures industry players face today. For years, traditional factories have been operating at a disadvantage, impeded by production environments that are “disconnected”—at the very least strictly gated—to corporate business systems, to supply chains, and to customers and partners.

Managers of these traditional factories say the feeling is akin to flying blind. These are operations where plant floors, front offices, and suppliers operate in independent silos, where managers have only hazy visibility into downtime and quality problems, and where the root causes of inefficiencies are rarely understood or addressed.

To get ahead, modern manufacturers are adopting new plant architectures that enable a portfolio of enhanced and new capabilities. These include plant network topologies that converge factory-based operational technologies (OT) with global IT networks, increasing visibility and intelligence within operations and across the global supply chain. This is what we call the connected factory. Advantages include:

- **Production Flexibility.** Factories retool quickly to meet demand and cut down on costly downtime (Fact: more flexible factories can reduce inventory cost by 50%.)
- **Global Visibility.** Executives and operators respond intelligently and instantly to changing conditions on the plant floor—and in the marketplace—to increase efficiency and save money (Fact: manufacturers lose 5% of production and 33% of profits per year from downtime.)

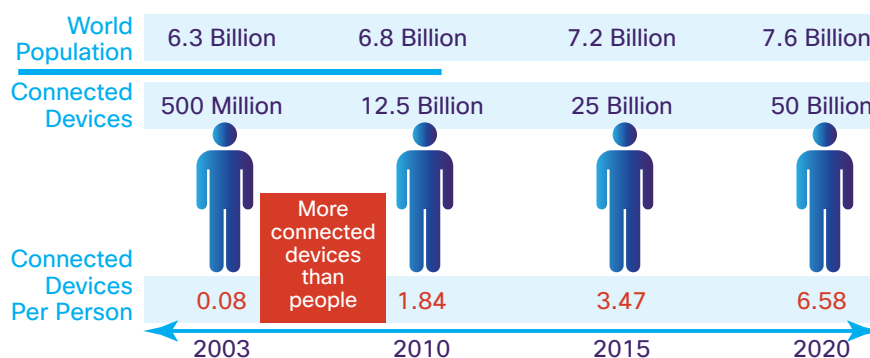
“Cisco has been extending its networking expertise from IT into manufacturing and energy for several years. Convergence across automation, controls, and business networks will help industrial companies better manage their operations and stay competitive, especially as the Internet of Everything becomes more important.”

Harry Forbes, Senior Analyst, ARC Advisory Group

- **Enlightened Mobility.** Workers and supervisors make decisions faster, avoid unnecessary travel, and instantly tap remote expertise (Fact: 63% of manufacturers allow staff to bring smart phones onto plant floors to access needed information and collaborate internally and with partners.)
- **Defense-in-Depth Security.** Companies effectively protect against growing cyber-threats (Fact: Cyber attacks against manufacturers have increased 32% in the last 6 months.)

In the evolving landscape of manufacturing, more plant-floor machines are being outfitted with sensors that connect to the cloud or enabling communication with other machines and their human operators in real time (Figure 1). Already this has led to many innovations, from making supply chains more traceable to boosting throughput and OEE by 10% or more in some instances.

Figure 1. Rise of the Connected Machine



The coming revolution will see deepening connections between the plant floor and the business and to the ecosystem surrounding the manufacturer, enabling tighter collaboration between contract manufacturers and headquarters-based engineers, managers, and executives. The basis of this change is the increasing adoption of secure Ethernet-based networking technologies, typically incorporating new communications and collaboration capabilities that link the plant floor to the wider world of business decision makers, contractors, and other factories and supply chains feeding the

What Pains Manufacturers Today

- Customer and market opportunity pressures to accelerate new product and service introductions
- Inability to increase plant throughput, production velocity, quality, uptime (OEE)
- High unplanned downtime (wasting, on average, at least 5% of production)
- Securing factories from cyber threats
- Volatile energy costs, including high peak energy charges
- High cabling and re-cabling costs (60% of deployment costs)
- Scaling network capacity for huge growth in new Ethernet devices
- Continual push for more productivity and cost reductions
- Responding to fragmented and varying customer needs, shifting supply chains from build-to-stock (BTS) to more build-to-order (BTO), configure-to-order (CTO) and engineer-to-order (ETO)
- Costs and inefficiencies of running dedicated networks for individual plant floor applications
- Needs for continual worker productivity and safety improvements

How the Internet of Everything (IoE) Impacts Manufacturing

No longer a thing of the future, the Internet of Everything (IoE) has arrived—and it's making waves throughout the world of manufacturing. Across industries today, there are some 50 billion connected “smart objects,” enabling billions of things to light up and be utilized via the Internet (Figure 2). The Cisco® Connected Factory is engineered to help firms capitalize on the rise of intelligent machine networks that make up the core of IoE. Cisco estimates the opportunity for IoE-based value creation at more than \$19 trillion over 10 years, with more than 20% of that total available to manufacturing enterprises and ecosystems.

Figure 2. The Internet of Everything



manufacturing process. According to the Aberdeen Group, 70 percent of manufacturing executives are focusing on plant-floor data initiatives to drive operational and business excellence, faster time to market, and immediate access to data from machines on the factory floor.

Greater network convergence and connectivity will help manufacturers address challenges they have been striving to overcome for decades. These include eliminating recurring supply chain disruptions, filling skilled worker shortages, neutralizing cyber threats, and boosting asset utilization.

In the years ahead, we will see deepening connections, not only between the plant floor and the business, but also with the broader ecosystem surrounding the manufacturer. We will see closer collaboration between headquarters-based engineers and contract manufacturers and component and service suppliers located continents away. Greater network convergence with intelligent machine connectivity will help manufacturers address challenges they have been working to overcome for decades. These include eliminating and minimizing supply chain disruptions, matching production to demand volatility with greater supply flexibility, preventing data breaches before they happen, and boosting asset utilization, quality and ultimately customer satisfaction. In many cases, the mix of data streams are pulled together in dashboards that present plant and business data in a single, secure view – a “pane of glass” that can be tailored to the information needs and access of individual users.

The Road to the Connected Factory

By converging industrial and enterprise networks, manufacturers can advance business agility and build a unified enterprise-to-plant architecture while increasing visibility, improving troubleshooting, and lowering costs. To get there, many manufacturers are turning to Cisco, which has assembled a portfolio of validated IP-networking technologies, scalable architectures, and capabilities called the Cisco® Connected Factory.

The connected factory provides a clear set of architectural guidelines and products that tie together factory automation systems, enterprise applications, and the wider ecosystem of supplier and partner solutions (see Figure 3). Key components include:

- Common, scalable architecture for ruggedized Industrial Ethernet and enterprise networks
- Standards-based Industrial IP Ethernet switching and security services
- Cisco enterprise-level technology delivered on an industrial platform with scalable, secure, real-time performance
- Integrated Cisco, Rockwell Automation, and other partner solutions and roadmaps— an ecosystem supporting a converged plant floor and enterprise network
- Comprehensive support and service network, including lifecycle services, five-year product warranty, 10,000 academies in 165 countries, and financing options to optimize cash flow

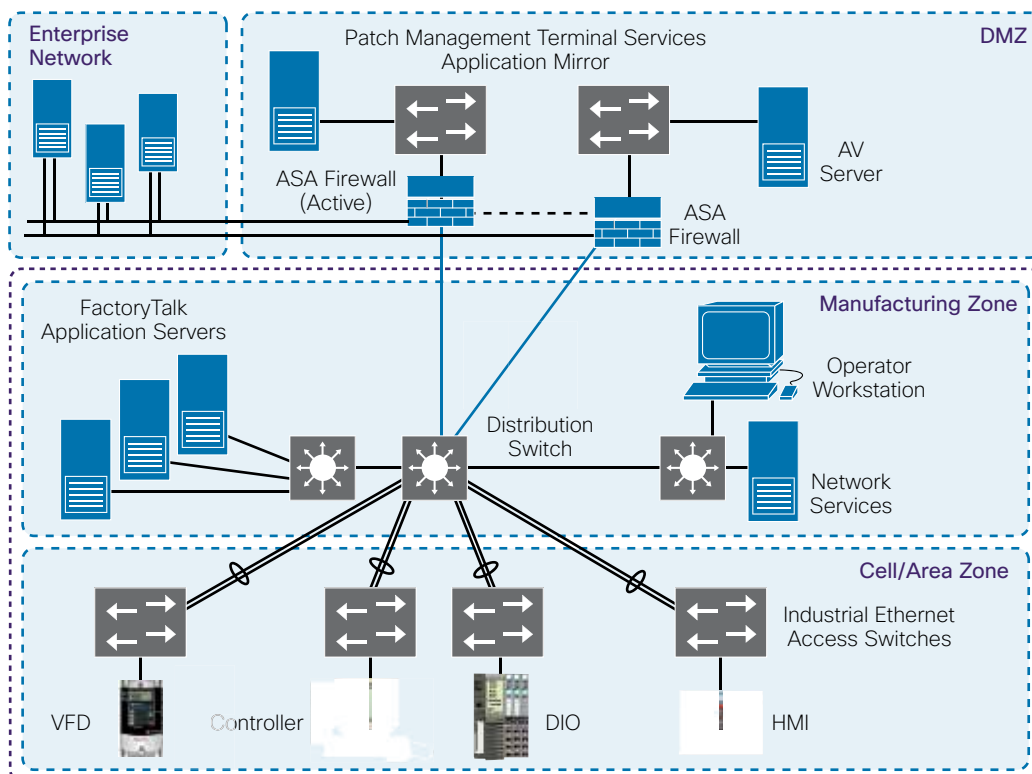
Benefits of the Cisco Connected Factory

How does a connected factory give manufacturers an edge? Industrial firms report a range of benefits that result from solutions that connect machines, integrate IT and OT, and bridge “islands of automation.” These include:

Less Downtime and Higher OEE

Connected factories support a new class of operating assets characterized by embedded sensors that are “self-aware” and capable of communicating with other machines without human intervention. These networks of intelligent machines adjust automatically to changing conditions and alert operators to maintenance needs in advance of breakdowns (from a “break-fix” to a “fix-before-break” model).

Figure 3. Cisco Connected Factory Architecture



“Anglo Platinum’s cost of ownership fell to one-half the industry average after the Cisco deployment. Now, we can ensure the availability of systems and support from a central location and have comprehensive visibility and reporting.”

Theo van Staden, head of infrastructure (IT), Anglo Platinum

Consequently equipment efficiency increases and the risk of downtime declines. Meanwhile, costs are controlled automatically through proactive maintenance programs that rely on devices, informed by sensor data, communicating across industrial networks.

Faster New Product Introductions

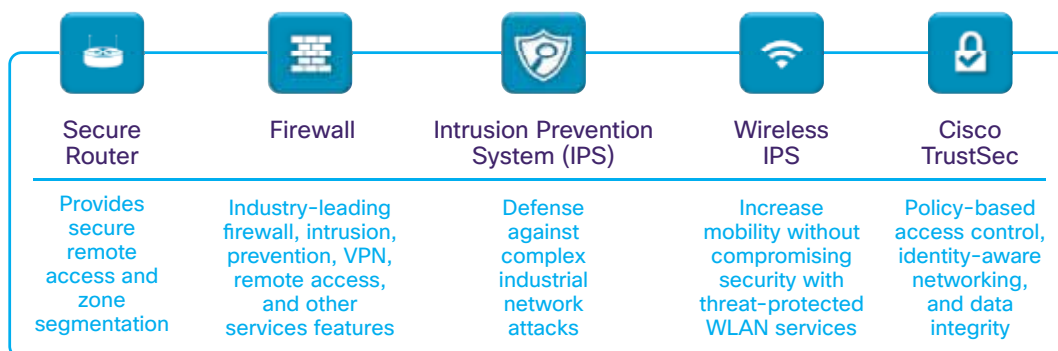
Connected factories reap benefits by opening up information flows between plant systems and business applications. As these information silos disappear, disconnects between the floor and the business go away. For example, R&D departments are now working in tandem with manufacturing planners, streamlining the introduction of new products. Using dashboards and mobile devices, managers and engineers react immediately to shifting production needs, operational issues, and market scenarios. The result, managers say, is like having an “enterprise-wide decision engine” that enables them to speed new products to market and execute supply chain adjustments faster than before. Likewise, new-generation flexible control systems and automation networks dramatically reduce costly setup and production changes over time.

Strengthening Security

Security-conscious manufacturers are embracing the Cisco Connected Factory solution because it is a validated, rigorously tested architecture with capabilities for role-based identity services that offer ultimate protection against cyber threats and data breaches. Cisco currently secures network operations at organizations ranging from NASDAQ to government agencies handling classified intelligence.

Similar security protections are increasingly essential in industrial environments. “Gaining visibility into this world of previously undetected cyber-threats helped reassure our team that we were doing the right thing by adding intrusion prevention technology across our industrial network,” says Charles Harper, the director of national supply and pipeline operations at Air Liquide, the world’s leading producer of gases for industry, health and the environment. Figure 4 shows the range of security capabilities that are built into the Cisco Connected Factory platform.

Figure 4. Cisco Industrial Security Portfolio



Promoting Innovation

Innovation may be hard to define, but manufacturers have found that breaking down walls between operational domains—and the data silos they hold—promotes collaboration and creativity. Manufacturers say that forging links between different teams of workers—including plant floor engineers, remote experts, and partnering firms—is one of the most valuable byproducts of a connected factory. Already, companies are using the Cisco platform to launch new machine-service models that send out alerts when predefined conditions are met and automatically launch collaboration and troubleshooting sessions involving the appropriate mix of experts.

Leveraging the Internet of Everything Data

The latest generation of converged networks will give manufacturers more opportunities for capitalizing on the Internet of Everything. In the years ahead, sensor-embedded, Internet-ready machines will become increasingly commonplace, but tapping their potential will require better networking and analytical platforms capable of processing and securing vast new streams of industrial data. This is precisely what the Cisco Connected Factory is designed to do.

Creating the Connected Factory of the Future

Industrial enterprises are searching for technology platforms that will drive growth and profitability in an increasingly fast moving, interconnected, and mobile marketplace. In this world, legacy technology architectures that carve up manufacturing operations into factory and business silos are becoming outmoded and uncompetitive. Forward-thinking manufacturers are embracing converged networks that securely integrate factory floors with business systems, seamlessly link to partner solutions, and exploit networks of intelligent machines.

Cisco's Connected Factory has been specifically designed to help manufacturers thrive in this converged environment. The new solution gives manufacturers greater speed and flexibility, real-time visibility across factories, equipment, and supply chains, and immediate access remote expertise.

Connected Is Better

Comparison between best-in-class adopters of converged networks and lower-rate adopters.

Converged Network Benefits

Best-in-Class Manufacturers Top 20%

- 8 hours of downtime per year (99.91% Uptime)
- 11% total cost of ownership reduction for industrial network
- 90% Overall Equipment Effectiveness (OEE)
- +25% operating margin vs. corporate plan

67% Converged Industrial Ethernet Adoption Rate

Middle 50%

- Downtime: 36 hours/year
- OEE: 80%

Bottom 30%

- Downtime: 135 hours/year
- OEE: 60%

67% Converged Industrial Ethernet Adoption Rate

Source: Aberdeen Group

Connected Factory in Action

Connected Factory Automation: By converging sensors, machines, cells and zones—“islands of automation” that are usually siloed on separate networks, Connected Factory Automation gives customers the ability to integrate manufacturing systems and business systems and bring everything online on a single network. A converged network gives manufacturers the flexibility they need to adapt to changes quickly, whether it is new product introductions, planned product line change-overs, adjustments due to component supply and/or shifts in the mix of product demand. Each affected zone, from the enterprise to the plant floor, is alerted of changes in real time through mobile devices, video monitors and HMIs that communicate over the converged network. The real-time information is also linked back to the entire supply chain, so that each step in the manufacturing value chain from supply through to distribution can quickly respond as needed.

Connected Factory Wireless: Connected Factory Wireless creates new flexible communication opportunities between things, machines, data bases and people located throughout the plant. From asset tracking to visibility of automation controls and Human Machine Interfaces (HMI), a wireless network environment in the shop floor can increase productivity and production speed. By adding wireless technology to your converged network architecture, you create new flexible communication opportunities between machines and people located throughout the plant. A unified plant wireless infrastructure can provide the reliability and performance needed for mission critical plant floor applications (like wireless torque tools) and is also a platform for additional industrial global applications ranging from WIFI asset tags to increase output and productivity by finding production assets and inventory faster to using mobile HD video cameras for troubleshooting and collaboration.

Connected Factory Security: Cisco Connected Factory Security solutions leverage Connected Factory Automation networks to add plant security for both digital and physical assets. Cisco can improve security through granular control of plant network access by user, device, and location. A defense-in-depth strategy and architecture allows the manufacturer to define security levels for all employees and contractors in a plant. For example, a plant manager can limit access of a remote or onsite expert to just the machines they support. Identity and policy is further enforced in Cisco’s ruggedized switches in a centrally configured, automated manner, rather than switch by switch.

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It is helping industrial enterprises go to market faster by speeding installation new machines, and reducing costs by flattening and simplifying plant networks. What’s more, the connected factory provides a foundation to support new services to meet future plant infrastructure needs. Not least, the connected factory provides unprecedented industrial security and threat prevention across every converged network.

For manufacturers ready to take the lead, Cisco’s Connected Factory solutions are rapidly deployed, thanks to their validated, pre-tested designs. Moreover, the underlying architecture plugs into a rich ecosystem of partner solutions, forming the foundation of a broadly applicable and versatile industrial platform. In a converging world, Cisco offers a proven portfolio of network technologies that equip manufacturers to take on the opportunities ahead.

Connected Factory in Action (continued)

Connected Factory Remote Monitoring and Response: Connected Factory solutions enable manufacturers to buy Machines as a Service (MAAS) from industrial machine builder partners, such as robot makers, who are enabled to monitor, control and support their machines remotely. Enterprise leaders continue to face fierce global competition in a very cyclical industry and are looking for ways to innovate faster and shorten time to market, while the growing demand for custom individualized products and lower total cost of ownership (TCO) is chipping away at their margins.

Connected Factory Energy Management: Energy Management enables intelligent IoT applications, such as analytic engines that communicate with machine sensors, to stream detailed operational data between the plants and higher-level systems. This provides real-time visibility into valuable energy use information. For example, instead of consuming power when not in use during breaks and weekends, automated controls can be triggered to power machines only according to production schedules sent to HMIs, helping to cut plant energy use by 10-20%. Plant Managers can also manage energy load profiling to reduce penalties for peak loads and overall energy use, via adjusting variable speed drives, load shedding, selective use of co-gen, and other measures. Energy management solutions such as Cisco Energywise can help capture, aggregate, display, and analyze real time energy use across both factory machines and IT systems.

CASE STUDIES

Big Data Means Big Control for Global Food Processor

While manufacturers have been generating lots of data for years, companies have had limited ability to store, analyze and effectively use it. New big data processing tools are enabling real-time data stream analysis that can provide dramatic improvements in real time problem solving and cost avoidance. Big data and analytics underpin competitive capabilities such as forecasting, proactive maintenance and automation. A good example is a global food processor that makes 800 different kinds of flour. The company uses predictive tools and services to forecast pricing, capacity requirements, and customer demand. This allows the company to maximize revenues through improved margin decisions and to increase production capacity utilization by 5%.

Harley-Davidson Revs Up Production with Automation Networks

Until recently, plant networks have been isolated from each other and from local and distant business networks. Today, manufacturers can use IoT and IP networks to connect everything within a plant and share information across multiple locations and business networks. Once machinery and systems are connected within the plant, manufacturers can use this information to automate workflows to maintain and optimize production systems without human intervention.

“What used to take hours or days to triage and troubleshoot problems now takes minutes,” said David Gutshall, infrastructure design manager at Harley-Davidson Motor Company. Moreover, another goal is to be able to add machines to the line much easier. “When we bring a new machine online, it essentially works with the network out-of-the-box,” Gutshall said, yielding greater flexibility and significantly reducing new model cycles and time to market.*

*For more information about Harley Davidson’s implementation, see “Building Smarter Manufacturing With The Internet of Things” by Lopez Research LLC, January 2014, and Mfg.net webinar.

“With the help of the Cisco and AeroScout Industrial solution, we are well on our way toward realizing a virtual warehouse and fully connected factory, with complete visibility and traceability.”

-Gary Frederick, chief information officer, Stanley Black & Decker Industrial Division

General Motors Deploys Standard IP Network to Cut Downtime

Because manufacturers need ultra-reliable networks that can cope with harsh factory conditions, many have long relied on proprietary systems. That has changed with more factories deploying standardized IP-centric networks that enable all devices within a plant to communicate with both operational and enterprise business systems. A standard IP network also makes it easier to connect and collaborate with suppliers and customers to improve supply chain visibility. For example, General Motors implemented a standards-based network architecture, called the Plant Floor Controls Network (PFCN), to create a uniform design for each plant network and establish a single engineering team that monitors and troubleshoots network operations globally. PFCN helped GM reduce network downtime by approximately 70%.

Leading Tools Manufacturer Goes Mobile

Improving plant-floor visibility was a top priority for Stanley Black & Decker when it looked at overhauling its Mexican manufacturing facility, which makes a wide selection of hand and power tools. The plant was already outfitted with a Cisco Unified Wireless infrastructure, but managers wanted to expand its potential by implementing a real-time location system (RTLS). The key was using AeroScout Industrial RFID tags that can be attached to almost any part to transmit real-time information to plant managers. Cisco access points installed across the plant enabled mobile access directly from a manager's tablet or smart phone.

Combining a dashboard solution from Cisco's partner AeroScout, the facility now keeps production floor managers continuously updated. By integrating the Wi-Fi tags with the programmable logic controller (PLC), for example, all floor managers maintain constant awareness of production conditions, allowing them to identify and immediately address bottlenecks in material flow. “We now have products and machines talking to the Internet, and we are able to monitor and control production almost automatically,” said Plant Manager Mike Amaya. Greater visibility has also helped the company improve labor utilization rates as well as product quality. Moreover, real-time inventory views have boosted customer service by enabling accurate deliver schedules and order updates.

Learn More

Cisco is committed to helping manufacturers enhance their factory for the future with integrated networking, wireless, security, video, compute, and communications designed for industrial environments. For more information, visit www.cisco.com/go/industrial.

