Making Machines More Connected and Intelligent

Overview

It's no secret that technology is dramatically transforming the manufacturing arena. We're witnessing a new industrial revolution, led by a dynamic set of trends and pushed forward by digital disruptors. The ground is shifting beneath manufacturers - and the companies that build the machines they use.

One new emerging area that promises to deliver powerful new capabilities to both manufacturers and to the machine builders that supply them is connected machines. Connected machines use Internet of Things (IoT) technologies to connect machines and factory robots beyond the plant floor, all the way to the machine builders that created them.

Sharing data with people who know the machine best can create new opportunities for machine builders as well as manufacturers. Companies can set up and install machines more quickly. Manufacturers can partner with machine builders to spot problems before they occur, so they can schedule maintenance before operations are interrupted. And if an issue does emerge, manufacturers and machine builders can track down the source of the problem faster and repair it more quickly.

In this paper, we'll talk about how the rich Cisco® portfolio of solutions can help manufacturers and machine builders move forward on the connected machines journey. We'll explore some of the trends shaping manufacturing digitization and the value that machine-embedded solutions offer. We'll also discuss some of the business outcomes that organizations can realize along each stage of the connected machines path.

Drivers Accelerating Machine Connectivity

As the industrial landscape transforms, manufacturers are facing several new challenges. They're not only grappling with new technologies, but with new market challenges and changing customer expectations. Some of the top trends include:

Convergence

Driven by trends such as Industry 4.0 and organizations such the Industrial Internet Consortium, manufacturers are reconsidering how they think about the value chain. IP networking is enabling closer integration between machines and factories, and the line between factory networks and enterprise networks is also becoming more indistinct. Manufacturers are moving beyond a traditional siloed approach to processes and are looking for ways to bring their operations together under a single network platform.

> By some estimates there are 60 million machines in factories throughout the world and 90 percent are not connected. Meanwhile, 70 percent of the machines are more than 15 years old.[*]

[*] IHS 2014 Machines Report for Cisco, PWC Internet of Things in Manufacturing 2015, McKinsey Disruptive Technologies 2013 Report
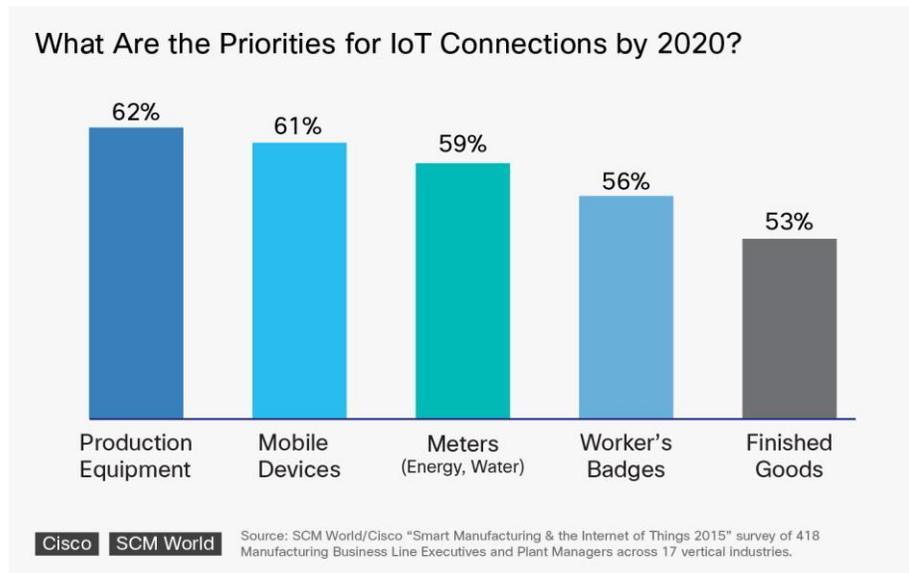
Data-Driven Manufacturing

Big data is changing the face of every industry, and manufacturing is no exception. The IoT is emerging, bringing with it a flood of data from machines, sensors, people, and places. Manufacturers want to put all that data to use with total quality management (TQM) for real-time quality control and support for inline rework. They're looking to OEMs to help them improve operator visibility with proactive overall equipment effectiveness (OEE) alerts. And they're exploring ways to support more flexible cell manufacturing and rapidly retool when their needs change.

Secure Operations and Machines

The threat landscape has evolved, and robust security is more important than ever for manufacturers. As the factory floor and business processes align more closely, security issues are extending beyond the enterprise and can impact machines and operations. To stop them, manufacturers are turning to new business and partnership models to build more effective security strategies. They're looking more closely at the boundaries of their organizations, and developing frameworks to scale security across their organizations and across the supply chain.

The digital manufacturing transformation is already well underway and is picking up speed. In a recent survey[1], SCM World asked plant managers and business line executives what "things" they were connecting now and in the years ahead. Production equipment was listed as a top priority, with 62 percent planning to connect these resources by 2020.

Figure 1.   SCM World Priority Responses

What Are the Priorities for IoT Connections by 2020?

Source: SCM World/Cisco "Smart Manufacturing & the Internet of Things 2015" survey of 418 Manufacturing Business Line Executives and Plant Managers across 17 vertical industries.

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Improving Technology, Lower Costs

Low cost availability of new technologies, along with more intelligent machines, is also driving the migration to more connected factory devices. New technologies are creating conditions for scaled, automated, and platform-based machine connectivity, monitoring and optimization. In this evolved technology state, machine operations can be viewed as part of a global system instead of an isolated point system. In the past, machines were connected, but the unit cost of those efforts was very high. Today, the unit marginal cost of connecting a machine is plummeting, led by convergence trends and the efforts of innovators like Cisco.

OEMs Focusing on New Priorities

Original equipment manufacturers (OEMs) are facing new business imperatives, as well. They're focusing on providing a better customer experience, enabling both OT and IT support models. They're also focusing on secure machines, and, increasingly, on after-sales services. As customers demand the highest possible availability and uptime, OEMs are striving to become more agile and proactive. They're looking for solutions to enable zero-touch deployment and provisioning. They're also exploring ways to control support costs with remote connectivity and monitoring. And they are taking more control of the aftermarket for parts and tools. It's all adding up to a new form of strategic partnership between machine builders and their customers- one based on sharing gains and risks together. Connectivity and remote access are essential capabilities to enable new machine-as-a-service (MaaS) business models.

> "Product designers must now consider an expansion of form, fit, and function to include connectivity and intelligence to be able to leverage the IoT environment. The factories that manufacture these products, in turn, will have to be designed to take advantage of smart connected devices, machinery, systems, and business processes. In many cases, these smart "connections" will extend well beyond the factory walls to value chain partners."
> **—"Connected Smart Machines," ARC Advisory Group**

Value of the Machine-Embedded Solution

Why would you embed network, computing, and security capabilities in the machine - or near it? Bringing these advanced features to the network edge lets machine builders and manufacturers themselves unlock several different benefits.

Controller offload - Embedding rich capabilities on the machine can reduce resource utilization on a machine controller. Features can be easily added or updated without impacting the control software and configurations. And employing a shared Ethernet backplane to integrate peripherals is not invasive, enabling plug-and-play operation.

Scalability - Robots and machines are becoming less isolated, and more systemic. An externalized network architecture helps them scale more easily.

Integration - Attaching a network device to machines makes it easier to handle addressing, identity, security, discovery, topology, and computing services.

Security - An attached network device can proxy security services on behalf of the robot. These security services can include identity, encryption, fingerprinting services, and data communications. The proxy approach allows the robot to remain isolated but still pass data securely.

Easier development - An embedded switch with an open architecture enables faster focused development on core functions related to robot or CNC control. With an open architecture, manufacturers can use a more modular, flexible software, security, and computing model.
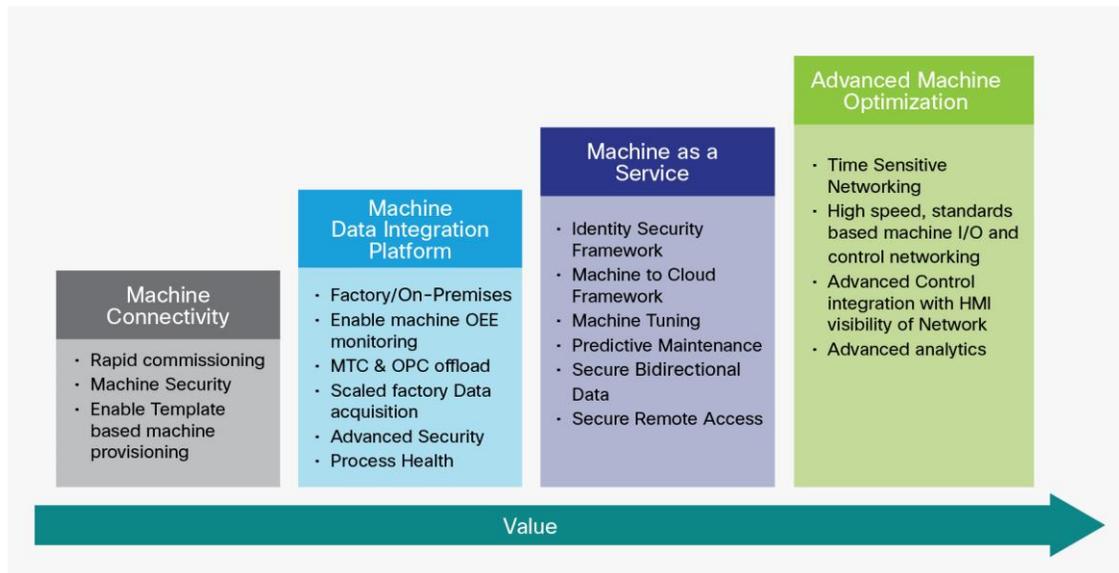
The Connected Machines Journey

As their business imperatives change, large and small manufacturers are increasingly focused on improving their agility. They are concentrating on maximizing quality, improving production efficiency, and putting more predictive maintenance processes in place. And they are looking to more services-based approaches and risk sharing with strategic partners. It all adds up to new opportunities for manufacturing machine builders.

Sharing data with the machine builders who know the machine best can enable both organizations to significantly improve machine performance. Machine builders can partner with customers to improve how their machines are purchased, consumed, and used. Machine builders can also develop their business models business models to move beyond a simple capital sale, toward a services model that can give customers more value.

Every manufacturer is different, and the connected machines evolution is a journey.

**Figure 2.** The Connected Machines Journey

Machine Connectivity: Foundation for Growth

The first step on the connected machine journey focuses on securing manufacturing machines and optimizing the customer's experience with them. It has a major impact on how machines are sold, manufactured, and provisioned. Machine connectivity can enable:

- Rapid commissioning
- Machine security
- Template-based machine provisioning

Figure 3.   Enabling Rapid, Standards Based, Repeatable Machine, Control, and Global Factory Integration.
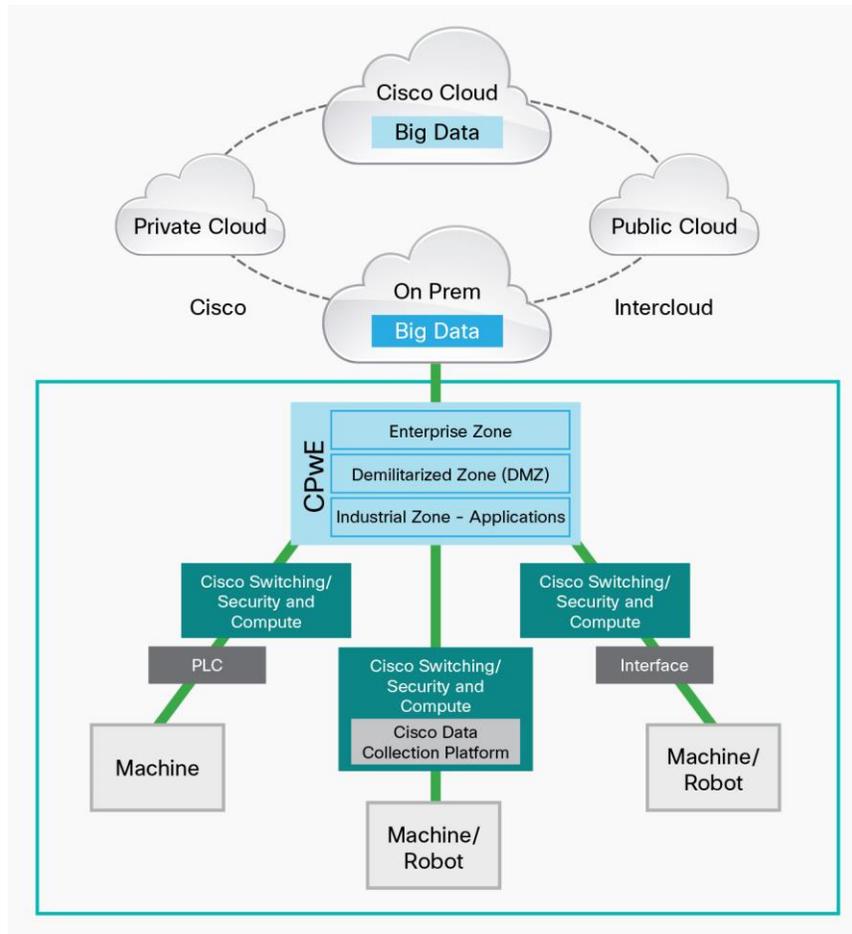
Machine Data Integration Platform: Analytics and Intelligence

Providing machine connectivity is only the first phase of the journey for machine manufacturers. The machine integration platform phase extends connectivity beyond the factory floor and lets manufacturers take advantage of the wealth of data created by IoT manufacturing. It's about connecting the machine to all the factory systems, the data systems, and systems used to visualize performance, efficiency, and quality.

In this phase, machine builders work with their partners to integrate the machine with the manufacturing environment. An open approach is essential, because different industries and geographies employ different standards and technologies. At the machine integration platform stage, manufacturers can improve OEE and take advantage of:

- Integration at the factory and on premises
- Machine OEE monitoring
- MTC and OPC offloading
- Scaled factory data acquisition
- Advanced security compliance and policy
- Process health
- Platform readiness for future advanced capabilities like MaaS, cloud monitoring, and remote access

MaaS: Closer Partnerships, More Capabilities

At the MaaS stage, machine builders move from a plant-level value proposition to a global, companywide value proposition. They can help manufacturers manage not just plant or factory-specific needs but manufacturing needs. In this risk-sharing model, the machine builder participates in the business with their customer. They offer predictive maintenance, higher quality, process optimization, and other capabilities. See the FANUC case study on page 7 for additional details.

Using their connected machines platform, machine builders and their customers can pull compelling data off the machines in real time, continuously. This helps them gain real-time insight into a machine's health and enables them to optimize the machine and its operations on a continual basis. Manufacturers can become aware of an issue before it occurs, and get advice from their machine builder on how to mitigate the issue. They can take proactive steps, instead of finding out about an issue from report at the end of a shift, week, or quarter. This level offers:

- An identity security framework
- Machine-to-cloud framework
- Machine tuning
- Predictive maintenance support
- Secure bidirectional and scalable data acquisition
- Secure remote access
- Advanced capabilities such as cloud machine health monitoring, predictive maintenance, remote upgrade, and analytics

Advanced Machine Optimization

The highest stage of the connected machine journey provides easy access to advanced analytics and rich capabilities enabled by the intelligent network. It enables manufacturers to take advantage of time-sensitive networking and other benefits:

- High-speed, standards-based machine I/O and control networking
- Advanced control integration with human machine interface (HMI) visibility of the network
- Advanced analytics

Flexible, Scalable Foundation for Connected Machines

The new Cisco Connected Machines solution lets machine builders position themselves to take full advantage of the new opportunities in digital manufacturing. It gives machine builders and end-user manufacturers machine-embedded or near-machine switching, security, and computing technologies. The solution enables edge and cloud analytics that support predictive machine monitoring and maintenance.

Designed as a foundation that scales to encompass the entire connected machines journey, the Cisco solution is based on open standards and technologies, and interoperates smoothly with existing manufacturing environments. With a flexible Cisco Connected Machines platform in place, machine builders can:

Drive customer value

- Monitor machine system health
- Enable continuous tool and process optimization
- Improve productivity and downtime avoidance

Commission and service more efficiently

- Enable predictive maintenance
- Offer remote commissioning, monitoring, and response
- Enable a global footprint with virtual services

Optimize security and integration

- Employ repeatable machine templates
- Enhance machine security and secure access
- Support standards-based plug-and play-connectivity

Unlock additional revenue streams

- Take control of MRO business
- Add value with MaaS offerings
- Provide remote expert capabilities

FANUC Minimizes Downtime to Save Millions

FANUC Robotics America has long been an innovator in applying connected machines solutions to its own operations. In 2014, the firm partnered with Cisco on a12-month zero downtime (ZDT) pilot project with major automotive manufacturers to decrease downtime and boost OEE.

After a successful pilot, FANUC is moving forward to extend the deployment and connect its manufacturing robots. The system proactively detects and informs of a potential equipment or process problem before unexpected downtime occurs. This lets FANUC and its customers schedule and perform maintenance during a planned outage window, so operations aren't disrupted.

Applying Big Data for Real-Time Insight

At the heart of the FANUC and Cisco solution are big data analytics at the network edge and in the cloud. FANUC robots contain sensors that constantly gather data on temperature, cycles, machine operator activities, and other metrics. This data is then dynamically analyzed to predict wear on parts such as bearings or transducers.

In the past, these types of maintenance issues could only be identified if a component failed and was manually checked by a technician. With the ZDT solution, robots are connected through a secure Cisco network and then into a Cisco edge compute data collector in the plant. The solution forwards relevant maintenance data to the Cisco cloud where an analytics engine captures out-of-range exceptions and predicts maintenance needs. The cloud app alerts FANUC service personnel and its manufacturing customer about the need for replacement part. The part is automatically shipped to arrive at the factory in time for the next scheduled planned maintenance window.

This kind of proactive, planned maintenance can unleash dramatic savings. One automobile manufacturer estimates unplanned downtime costs thousands per minute in lost production. FANUC is helping this customer save an estimated $40 million in downtime.

"Preventing unplanned downtime is a huge savings for our customers and makes the FANUC robots with ZDT a tremendous value," says Rick Schneider, North America CEO at FANUC Robotics. "With Cisco, we are helping our customers access this new value and also reimagining our go-to-market strategy for after-sales service and support."

Learn More

As a leader in digital transformation, Cisco is an ideal partner to assist manufacturers and machine builders with the next wave of manufacturing. Cisco focuses on connecting the silos, processed data, and communications bringing it together in an integrative fabric and design - all at once. To fully realize the true potential of digital manufacturing, companies turn to Cisco as their trusted partner in this journey. For more information, visit http://www.cisco.com/go/connectedfactory.

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