

Realize the potential of a connected factory

How to capitalize on the promise of Industrie 4.0 to improve visibility, reduce costs and transform operations



The digitization opportunity for manufacturing operations

It's no secret that digitization holds great promise for manufacturers and can fundamentally transform every aspect of a manufacturing business. From Industrie 4.0 in Europe to Made in China 2025, there are a growing number of initiatives globally that aim to help manufacturers embrace this potential. At a basic level, digitization efforts involve integrating digital and physical systems in order to improve visibility, increase efficiency, add flexibility, and lower costs.

As digital standards coalesce, it is becoming easier to capitalize on the promise of digitization by creating smart, connected factories. Standard protocols are being adopted, enabling firms to connect industrial equipment on plant floors.

With data from connected equipment, manufacturers stand to gain a new level of operational visibility across sites. This visibility is the foundation for major operational improvements, such as implementing predictive maintenance programs.

To be successful, a connected factory project must fit in with the current environment. Equipment can't simply be taken offline to add digital components, and mission-critical systems can't be completely redone or replaced. Employees cannot be asked to learn complicated new systems. Operations must continue normally and quotas must be attained. In short, core manufacturing operations cannot be impacted. It can also be difficult to know where to start, especially when there are a multitude of systems in place, as is the case in most manufacturing facilities.

But with the right technologies, connecting your sites can be a straightforward process that delivers value without disrupting operations.

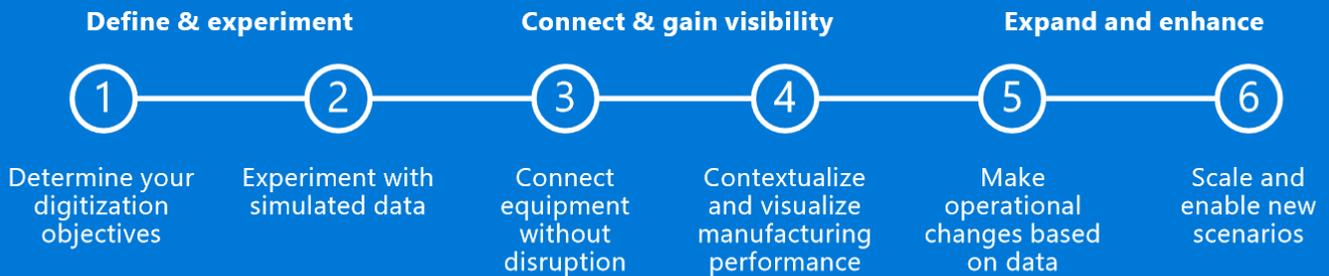
Benefits of using Microsoft Azure IoT solution accelerators for connected factory

Get started quickly on your Industrie 4.0 project with the Microsoft Azure IoT solution accelerators for connected factory. Azure IoT Connected Factory enables you to connect and monitor your equipment and gain visibility into operational data that was previously unavailable. It is designed for fast and easy set-up so you see results rapidly, and builds on your existing sensors, equipment, systems, and data. Your plant operations can continue as usual when you are rolling out the solution, ensuring no disruption to critical business processes. In short, with Azure IoT, you get a clear path to new levels of visibility and insight, and a strong foundation for driving transformational improvements.

A framework for getting started with a connected factory project

In this paper, we lay out a phased approach—one that helps you start in minutes, gain rapid insights, and expand when you're ready. While your connected factory project is unique to your business, this approach offers a starting point grounded in Microsoft's experience working with leading manufacturers to digitally transform their business

A framework for getting started with Industrie 4.0



1 Determine your digitization objectives

Digital technologies are transforming manufacturing. While you may not know exactly where you want to end up or what digitization means for your organization, it's important to identify the kinds of business objectives that digitization can support.

Digitization is all about transforming manufacturing operations using the latest technology—and it often starts with connecting factory floor equipment. Over the past few years, the cost of components that support connectivity has fallen dramatically. Consumables like RFID tags now cost very little to include in products. Sensors are becoming more affordable, increasing the amount of new equipment sold with sensor capabilities built in, while older equipment can be retrofitted, or IoT-enabled, at lower price points. At the same time, it is now possible to collect and analyze massive quantities of sensor and device-generated data, thanks to technologies like the cloud and advanced analytics.

Digital transformation means harnessing capabilities like these to gain insights that you can use to make your manufacturing operation faster, more efficient, and more flexible. Benefits of digitally enabled manufacturing can include:

- **Improved visibility across your manufacturing operations**—make more informed decisions with a real-time picture of operational status
- **Improved utilization**—maximize asset performance and uptime with the visibility required for central monitoring and management
- **Reduced waste**—take faster action to reduce or prevent certain forms of waste, thanks to insight on key production metrics
- **Targeted cost savings**—benchmark resource usage and identify inefficiencies to support operational improvements
- **Improved quality**—detect and prevent quality problems by finding and addressing equipment issues sooner

In addition to understanding the possibilities, it is important to determine target business objectives. This helps provide the foundation for a business case and serves as a benchmark for proving value. For example, let's assume that one of your objectives is to respond more quickly when certain equipment breaks down.



Your business objective influences the kinds of information you need to collect, the speed at which that information needs to be available, and the business processes that need to change in order to support faster responses. While an objective-based effort is important, it is also important to **stay flexible**. As you connect equipment and refine your approach, your objectives will likely evolve too as you learn more about what is possible for your business.

It is also important to **start small and identify a specific place to start**. When it comes to connecting plant floor equipment, that typically involves identifying a particular assembly line to connect, the pieces of equipment to connect, and the types of information needed from that asset (e.g. temperature, pressure, blade speed, vibration, etc.).

Whether you're connecting a plant floor, a section of pipeline, or another operational element, the key is starting with an area that can be discretely measured. That offers a well-defined scope for initial experimentation, and makes it easier to see results early on.



I have thousands of machines in factories all over the world. There has to be some way to harness my data, but where do I start?



2

Experiment with simulated data

Experimenting with a solution that allows for simulation gives you a no-risk way to see what digitization can accomplish. Simulations don't require connecting any of your actual equipment and won't impact your operations.

Even if it's clear that digital transformation holds great promise in theory, it can be challenging to pursue in practice. That's because the path forward is often unclear. It's common to think something like this: "I see the overall value of digitization and Industrie 4.0, and I know I need to make changes, but I'm not sure where to get started."

The good news is that getting started doesn't require an all-encompassing project scope, or a precisely optimal starting point. The key is simply to **get started somewhere with a focused initial project**, and to experiment and iterate. Connected equipment simulations can help you explore your options in a low-risk environment. A simulation gives you the freedom to explore how digital changes could offer value, such as better visibility, without affecting operations.

By exploring simulated interfaces and dashboards, you can get a sense of how equipment all over the world can be viewed holistically, including both an overall view of performance and detailed insight into the status of individual machines. Even if connecting operations around the globe is a much later step, **seeing the results of a simulation firsthand can help you refine your objectives and get a better sense of what's possible**.

When deciding on a solution to support this effort, it is important to select technology that enables **fast and easy set-up of both simulations and real-world assets**. For example, the Microsoft Azure IoT Connected Factory allows you to quickly generate a simulated environment, and can be deployed in minutes.

Armed with a better understanding of what's possible in theory, the next step is to experiment by connecting equipment in the real world.



This simulation shows data from factories running all over the world in real-time. Getting that kind of information would make a huge difference in our operations.



3 Connect equipment without disruption

Digitization doesn't have to be accomplished all at once. Connecting a specific set of equipment enables you to experiment on a small scale and at your own pace—all without disrupting operations. This creates a foundation you can build on and scale out across your organization when you're ready.

It's one thing to see simulated data, and another thing to hook up your own equipment and see real-time data and insights from your own operations. Fortunately, with the right technology, **this transition to connecting your own equipment can be a straightforward one.**

The same technology solution used for simulation should also offer a path for connecting your own equipment and processing the data that the equipment generates. Connecting equipment can be relatively simple – at a basic level, it involves:

1. Determining the communication protocol your equipment uses
2. Hooking up the equipment to a gateway device that consolidates data across machines
3. Connecting the gateway to the cloud to provide visibility into status and key performance metrics

From there, you're ready to start exploring real-time data from your equipment.

Keep in mind that a flexible, secure technology solution is critical to making this process painless and straightforward, minimizing potential risk and disruption. For example, Microsoft Azure IoT **Connected Factory uses the existing software on a machine to connect – there's nothing new installed** on the machine itself.

The right kind of solution also enables you to **connect equipment without taking it offline, and to connect individual pieces of equipment at your own pace**, with no need to connect everything at once. Want to experiment by connecting one machine now, and the entire assembly line starting next week? You should have the flexibility to do that. Want to connect everything quickly and start getting insights as soon as possible? Your technology shouldn't slow you down.

It's also important to carry the experimentation mindset forward as you connect equipment and start collecting data. What you learn through the simulation may play out differently in practice. In other words, after connecting equipment, plan on continued iteration as you identify what data is useful, what's missing, and what needs to be fine-tuned.



I can connect a couple of machines at a time to see how this works, and my operations aren't impacted. And I can connect more equipment when I'm ready. This feels doable.



Contextualize and visualize manufacturing performance

With connected equipment comes greater visibility into operational status, anomalies, trends, and other performance insights. This visibility is the foundation for making a wide array of operational improvements.

The value of connected equipment is the data it generates. Once machines are connected, you start to benefit from **real-time visibility** into key performance indicators. There are a number of insights that can quickly be gained, such as:

- What is the pressure and temperature of each component?
- How much current is being drawn, and has that increased or decreased recently?
- What is the equipment's current state? Is it online or offline?

These simple but critical data points can make a big difference, enabling a better understanding of operations, better decisions, and greater responsiveness. But it's not enough to have the data. **Insights must be easy to glean via intuitive, visual dashboards**, and must be readily available to the people that can act on them, such as shop floor technicians and plant supervisors.

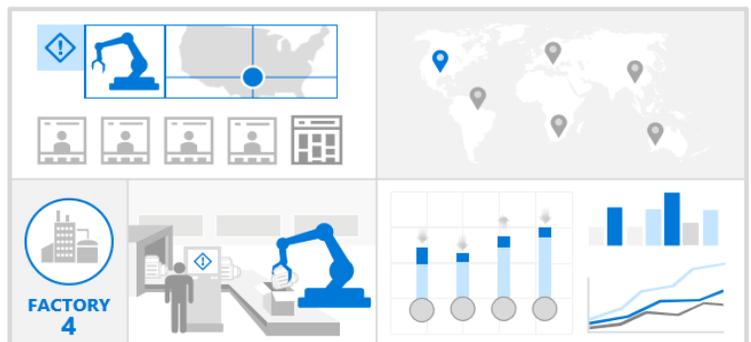
As in previous phases, it's helpful to experiment. With a robust technology solution, you can quickly identify the data points to collect for KPI calculations and root cause analysis. In some cases, you may find you are collecting data that isn't needed, or isn't providing insight, and adjust accordingly. **Cloud-based solutions make it easy to fine-tune the information you collect.** For example, with the Azure IoT Connected Factory solution, you can control the data that gets collected without having to physically send someone to a machine.

Data from connected equipment is also the foundation for **uncovering trends and patterns**. For example, collecting and analyzing historical data enables you to **establish your own performance benchmarks** across similar equipment and across plants. By comparing real-time data against benchmarks, you can constantly monitor whether a piece of equipment is operating within normal ranges, and identify subtle anomalies that emerge over time.

A digital approach to operational visibility offers tremendous potential value. A recent Automation World survey found that nearly three-quarters of respondents use plant-floor data at the corporate level, but a spreadsheet was cited as the most common reporting tool.¹ With a connected factory solution, operational intelligence is available automatically and immediately, enabling **better, faster decisions at the plant and at the corporate level**.



I can see the status of every machine at a glance. I've never been able to see our operational status so clearly, and I can dig even deeper to get details about a piece of equipment.



¹ Source: <https://www.automationworld.com/industrial-internet-things/are-executives-really-using-plant-floor-data>

5 Make operational changes based on data

Connected equipment is ultimately useful when it drives changes. Anomalies can be quickly detected and fixed. Maintenance schedules can be optimized to minimize disruption.

There's no limit to the kinds of data-driven improvements that become possible. The visibility you gain by connecting equipment adds value when those insights drive operational changes. Better visibility and insight makes it possible to identify issues and respond faster, make better decisions, and enact other operational changes.

For example, **detecting anomalies through real-time insights** gives you the ability to **intervene more quickly**. Take the example of a machine that is displaying signs of an impending failure, such as increased power consumption. With the ability to monitor performance via a live dashboard, you know immediately when those conditions occur, and can quickly dispatch a repair technician to address the issue.

Similarly, **monitoring against benchmarks enables an even more proactive approach**. Consider a scenario where bearing temperature in a piece of equipment is increasing. If you have established a benchmark provided by the equipment supplier, or by analyzing data from similar machines used for similar purposes, you can pinpoint when the temperature exceeds the normal range and schedule maintenance before failure occurs. Apply this benchmarking and monitoring approach across lines and sites, and your ability to preempt failures and reduce costs increases dramatically.

Another benefit of visibility is the ability to **identify under-performers and out-performers, and make corresponding improvements**. For example, one site may have particularly high utilization of a certain machine, while utilization at another is particularly low. With the ability to see performance side-by-side, you can more easily identify these outliers and investigate what's behind them. You may uncover issues like machines not being run or maintained optimally, or you may find utilization differences related to different operators. You may also discover best practices that you want to roll out more broadly. When you can compare performance across equipment and over time, these kinds of variations become more apparent, and easier to act on.

These are just a few examples of potential operational changes that connected factory visibility supports. Other types of changes may include **optimizing production processes** to reduce waste and bottlenecks, **adding or replacing equipment**, and **adjusting staffing or training procedures**. Once you start collecting data automatically and gaining visibility, finding operational improvement opportunities and making changes is a natural next step,



I can identify potential equipment issues and schedule repairs before anomalies turn into catastrophes. Unplanned downtime is becoming less and less of an issue for us.



6 Scale and enable new scenarios

Scale from a single assembly line to an aggregated view across your operations. Add new equipment and capabilities at your own pace. Use your solution as a starting point for expanding to scenarios like predictive maintenance..

By this point, you've built an understanding of what it takes to connect equipment and the insights you can gather. The next step is to expand your project—for instance, by moving from a connected assembly line to connecting the entire plant, and then to connecting multiple plants around the world. With a single consolidated view of your operations, you stand to gain better, faster insight into performance, and the **ability to compare performance across the organization**. You can also work with third-party contract manufacturers to connect their equipment and get insight not just into your own operations, but those of your partners as well.

Beyond scaling to more equipment and factories, you can also choose to **expand the capabilities and scope of your digitization efforts**. Visibility into current performance and historical data are a powerful foundation for other digital changes, such as predictive maintenance programs and an optimized energy management approach.

For example, a natural next step is to consider predictive maintenance. By applying predictive analytics to performance data, it becomes possible to not only identify when maintenance is imminently needed, but to accurately predict maintenance needs well ahead of time. This is an example of how layering on new capabilities can deliver additional value – in this case, using predictive analytics capabilities like machine learning to detect subtle patterns and changes in a set of historical performance data.

Similarly, you may choose to **integrate performance data into other business applications**, such as a field service system. In this case, if an anomaly is detected, a service alert could automatically be triggered and a technician automatically scheduled to look at the equipment with the potential problem.

Digital transformation can take many forms and mean many things for your operation. As you enable new scenarios and scale, the key is to continue experimentation using a phased approach, and to continue fine-tuning as your needs and environment evolve.



I can compare performance across not only our own plants, but at our contract manufacturers' sites too. We are finding and correcting problems, reducing maintenance costs and standardizing processes.



Getting started with Microsoft Azure IoT Connected Factory

Digital transformation is a journey, not an endpoint.

Microsoft can support you on every stage of your digital transformation journey, starting with the **Azure IoT Connected Factory**.

This solution is a starting point to connect your OPC UA and OPC Classic devices to the Microsoft cloud and get insights to help drive operational efficiencies. Additionally, it enables you to securely manage factory devices from the cloud. Working with Microsoft, you can:

- Experiment with simulated data and **connect equipment** at your own pace, **without disruption** or taking things offline
- **Detect anomalies** with Azure Time Series Insights and enact operational changes
- Connect with **experienced Microsoft partners**
- to customize your solution
- **Scale and extend the solution** to new scenarios, such as predictive maintenance.
- **Work with what you have** – no need to rip and replace anything
- Microsoft's approach is grounded on using your existing infrastructure: **your existing architecture, existing equipment, and existing systems**. We understand the need for continuity, and we support that while enabling you to transition to a digital-first approach.

Enabling robust security with an OCP based design.

Microsoft is committed to supporting digital transformation with a secure, extensible and open platform.

That's why our connected factory solution uses the OPC UA communication protocol and Microsoft Azure security end to end.

The German Federal Office for Information Security (BSI) verified that OPC UA architecture is secure by design.¹ Specifically, OPC UA enables secure communications when all settings are correctly configured.

With Azure IoT Connected Factory, OPC UA security components are activated by default, no new configuration required

¹ Source: <https://opcfoundation.org/security>

Microsoft's approach is grounded on using your existing infrastructure: Choosing Microsoft also means setting yourself up to tap into **a broader portfolio of solutions that deliver further advantages**. Our industry-leading offerings span from IoT to advanced analytics to business applications like Dynamics 365 and Office 365 to cutting-edge technologies like deep learning and augmented reality. This breadth of capabilities means that no matter how your digital needs evolve, we are positioned to support them.

The first step on your digital transformation journey can be your next step. Experience the power of digital transformation first-hand by trying out the Azure IoT solution accelerator for connected factory today.

www.microsoft.com/loT

© 2018 Microsoft Corporation. All rights reserved. This document is provided "as-is". Information and views expressed in this document, including URL and other Internet website references, may change without notice. You bear the risk of using it.

This document does not provide you with any legal rights to any intellectual property in any Microsoft product. You may copy and use this document for your internal, reference purposes. Some examples are for illustration only and are fictitious. No real association is intended or inferred.