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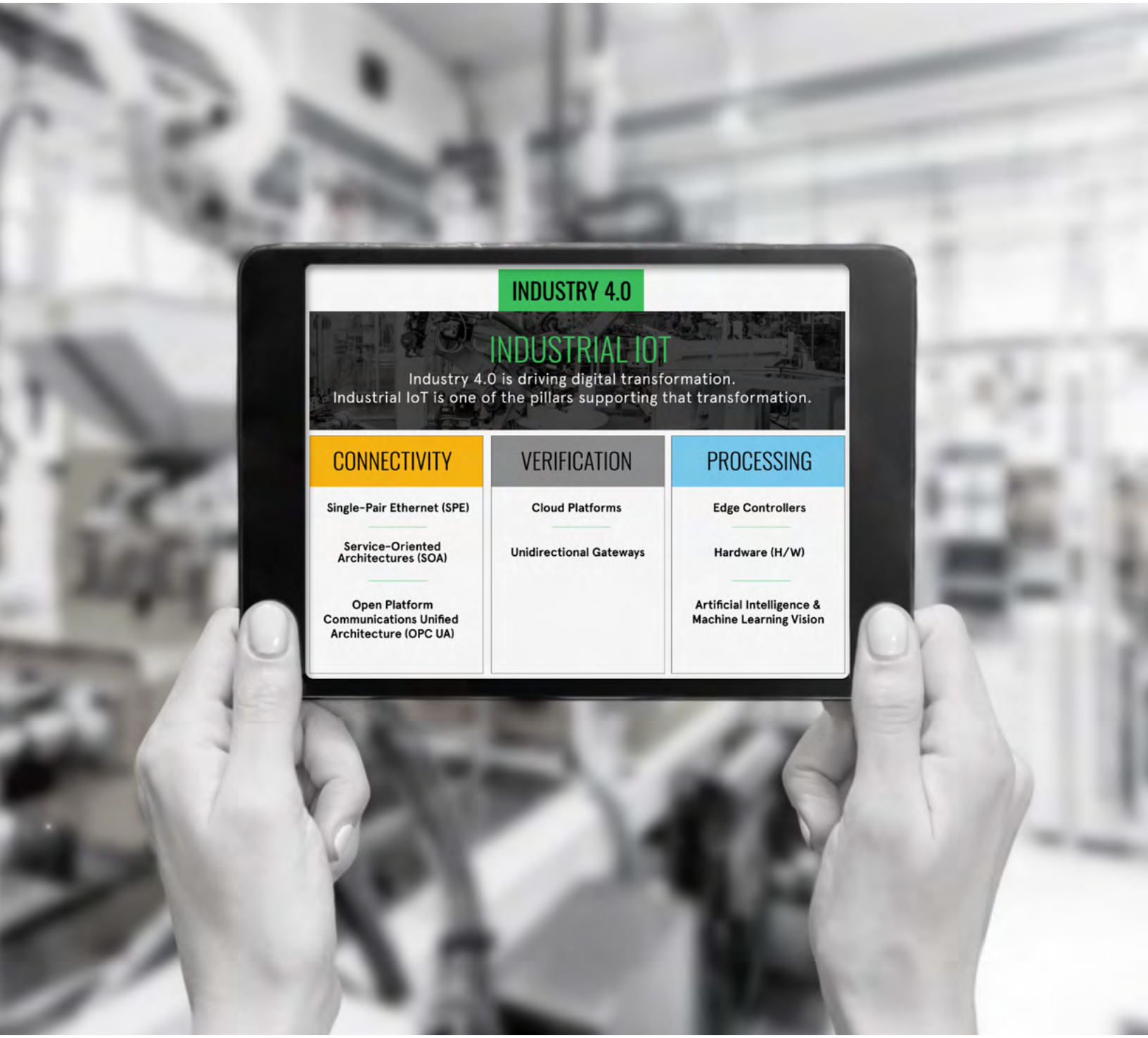

A TOP-DOWN ANALYSIS OF THE INDUSTRIAL IOT

New technologies are changing the industrial workspace, as the IoT brings the real and virtual closer together.

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EXECUTIVE SUMMARY

The Industrial IoT (IIoT) has been a topic of discussion for around a decade, after the term Industry 4.0 was coined at Hannover Fair in 2011. The number "4" refers to the fourth industrial revolution since the 18th century, which saw mechanization change the way people worked and, because of the impact that had on their working lives, the way they lived. We can expect a similar if less impactful shift as the IoT is adopted by industries.

The concept of Industry 4.0 is often attributed to the German government and the name to Professor Wolfgang Wahlster. Its global impact means it has been widely embraced and sometimes rebranded by other nations. As a concept (and like previous revolutions), Industry 4.0 has wider socio-economic implications and extends beyond the technology itself. However, for manufacturers looking to benefit from its potential, the IIoT is often their first waypoint.

While we have lived with the IoT for much longer, 10 years is a relatively short period of time in the industrial sector, so it's not surprising that there is still a long way to go. The pandemic accelerated the digital transformation of all industries, nations and markets. This aligns with smarter manufacturing and is enabled by the IIoT. Today, as we continue to adapt to a new normal, the IIoT paves the way toward a more connected world.

The landscape can be seen from two viewpoints, depending where an organization's journey starts. From the point of view of established manufacturers serving those vertical markets that rely on industrialized automation, the IIoT can still appear to be on the horizon. For other more agile and forward-focused manufacturers developing advanced automation solutions, the IIoT may be second nature.

Grouping all industrial markets under one homogenous term is part of the problem. Every vertical that relies on automation is different and unique. The fact that they each rely on similar enabling technologies is not always helpful when analyzing how the IIoT is influencing their continued journey toward complete digital transformation.

This whitepaper is part of a wider project from Avnet that looks at the current state of the IIoT. We look at it from the top down, commenting on everything from the business cases, prevailing trends, the enabling technologies and its implementation. Subject matter experts across our global organization provide insights, predictions and recommendations, complete with customer case studies.

— Phillip Ling, Avnet senior technology writer

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DRIVERS AND APPLICATIONS

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"The Industrial IoT is driving economic growth"

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The IIoT journey

In business, there needs to be a demonstrable return on any investment (ROI) made. In some cases, it is a simple case of measuring the cost of inputs against the revenue generated by outputs. The cost of capital expenditure (CapEx), such as investing in a new piece of automated optical inspection equipment, can be amortized against the increased production over a set number of working hours, while factoring in the operational expenditure (OpEx) of owning and operating the machine.

For the IIoT, the figures associated with CapEx and OpEx may be more obscure and abstract. This makes calculating an ROI more difficult. If the equipment used is IIoT-ready, then the expenditure is already incurred, but if the capabilities of that "readiness" are not fully utilized, it may seem like an unnecessary expense.

Manufacturers may already be convinced of the benefits of the IIoT and may be asking themselves, "What is stopping me?" The answer to that question will be complex. It will include the natural lifecycle of equipment, or the feasibility of retrofitting sensors and actuators to existing equipment. There will also be the considerable effort of moving the data generated by those sensors onto a platform that makes good use of the data.

Risk management

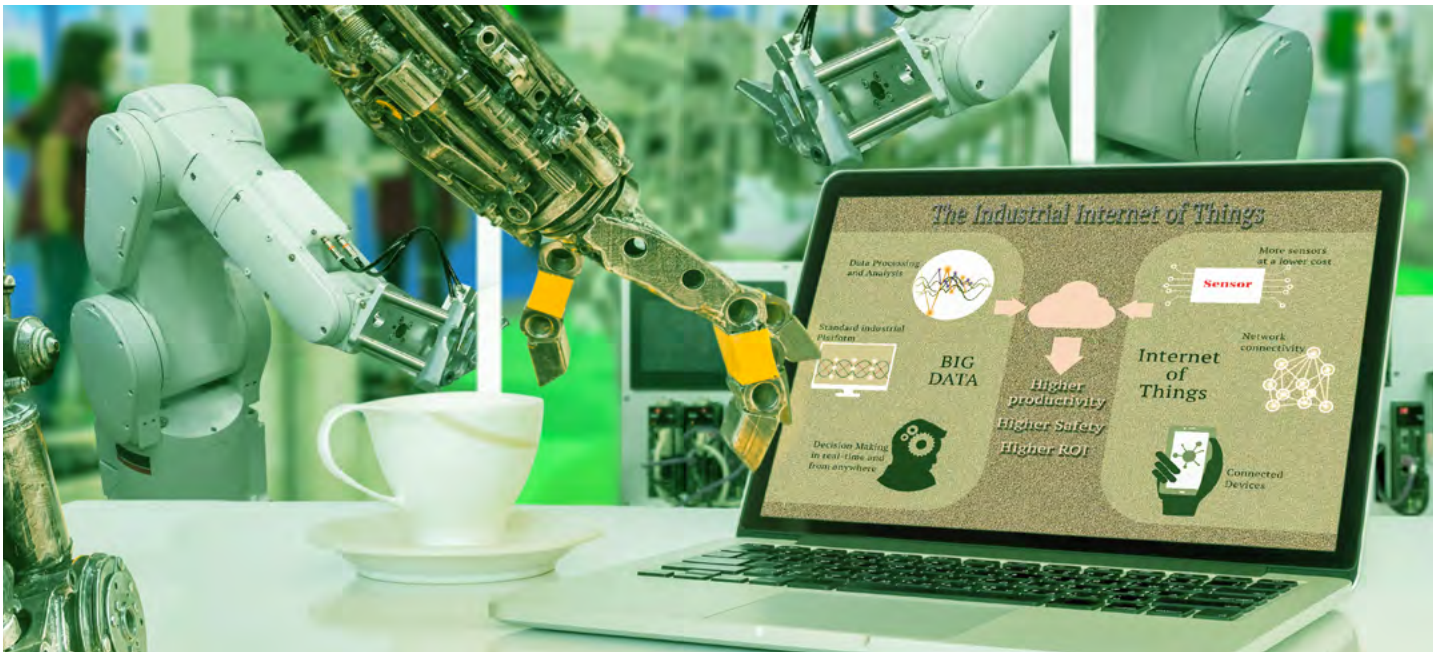
These factors can all be categorized as risk. Risk management is a recognized business discipline and so brings the conversation back around to familiar territory, even if the parameters used to assess the risk may still be unfamiliar. Reducing risk in the face of the unknown or unfamiliar can often mean avoiding those possibilities. However, in the case of the IIoT and digital transformation, inaction may be more of a threat than the unknown or unfamiliar. The competitive advantage that can be gained through increased productivity, delivered by the IIoT, is the ultimate return on any investment.

Data is at the heart of the IIoT. Information gleaned from operations can be used to improve processes, warn of impending failures and avoid downtime. This data is all around, but it needs to be gathered in a way that is useful.

This is the core enablement provided by IIoT solutions. And this is where the narrative often breaks. Some companies are already adept at mining good data from industrial processes or applying the intelligence that good data provides. Others are still trying to reach that point on their digital transformation journey.

Partnering with experienced solutions providers can make that journey easier.

MID- TO LONG-TERM TRENDS



Influencing trends

While every vertical built on automation is unique, similarities provide the economies of scale needed to form what is often simply referred to as the industrial sector. The technologies that cross the various verticals are common and all are moving toward the IIoT paradigm.

This will enable new ways of working, driven by global trends that will influence how each industry will evolve. One of the most pressing trends can be summarized as efficiency. Increasing efficiency, or reducing waste, is going to become even more crucial over the next decade as the entire world strives to combat the impact caused by two centuries of industrialization.

Economies of scale is particularly relevant here because modern industries are economically viable mostly because of the high volumes they produce. However, there is growing evidence to show that demand is shifting toward more diversity, rather than more of the same. In addition, the concept of on-demand manufacturing reduces the impact of over production.

Agile manufacturing

Moving to small and more agile production methods would create demand for approaches that are still efficient even when manufacturing in lower volumes. This has, in turn, given rise to the concept of micromanufacturing, or factories that are much smaller than traditional factories. These can be located closer to the source of raw materials, or the customer, which further reduces logistical costs and emissions.

Another trend that corresponds to a more agile manufacturing base is the concept of digital twins. The premise is to replicate complex processes in a virtual world, allowing changes to be implemented and evaluated without disruption to continuing processes. Digital twins will deliver higher efficiency and more agility, but it relies entirely on access to good data.

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"Three future Industrial IoT trends manufacturers should think about now"

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Case Study: "How smart water meters are using IIoT to improve resource efficiency"

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/ENABLING TECHNOLOGIES

Systems as services

Few areas of modern life remain untouched by artificial intelligence (AI). As a high-level concept, AI provides instant expansion of expertise. This allows that expertise to be applied to mundane activities, such as monitoring production lines for assembly errors.

A great strength of AI is that the exact same principles used to monitor physical objects on a conveyor belt can be applied to analyzing raw data stored on a server. That server can be located anywhere in the world. The concept of cloud-based data analysis means physical objects become data, the production line is a file stored on a server and the factory exists only in the cloud.

This is part of the theory behind cyber-physical systems (CPS), which is now synonymous with the IIoT. The aim of a CPS is to reduce or remove the barrier between physical systems and the electronic systems used to monitor and control them.

As we move down this road, we will also move more toward systems becoming services. The output of a system is a function, but the way that function is derived is less important than the action.

Cyber-physical systems

Today, CPS and IIoT approaches are intrinsically linked to the underlying hardware and physical implementations. Control extends all the way to the very edge of the system: the sensors and actuators. In a service-oriented architecture (SOA), access to and control of the data and actions may be devolved to the sensors and actuators themselves. They, in turn, will provide services that can be accessed remotely, without the subscriber needing to understand how.

Achieving this will require a move toward more standardized ways of exchanging and arranging data. Efforts to enable this include the Open Platform Communications Unified Architecture (OPC UA), protocols like message query telemetry transport (MQTT) and technologies including time sensitive networking (TSN). Standards for industrial data are also being developed, such as ISO/TC 184/SC 4.

SUGGESTED FURTHER READING

"Supporting a service-oriented approach in the IIoT"

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"How no-code design could accelerate Industrial IoT development"

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/IMPLEMENTATION

Making connections

At a high level, most connected industrial processes can be defined by just four functions. These include measurement and control at the front end, and communication and interoperation at the back end.

The technologies that implement these functions are changing, particularly in the IIoT. Automation and control have for many years been realized using the programmable logic controller (PLC) and it continues to evolve. The programmable automation controller (PAC) added the ability to interface more readily to enterprise networks. More recently, edge controllers have emerged to include powerful, localized processing able to execute AI at the network's edge.

The underlying hardware and software used in these devices are becoming more integrated and complex. Multicore processors and hypervisor technology enable a single device to run multiple operating systems, with real-time control sitting alongside network communications.

Sensors and analog front ends are also becoming more integrated, while delivering higher levels of performance at lower power. This combination of high performance and low power is critical in the IIoT, as we can expect more sensors to be used to collect more data.

Adding sensors to gather data is the primary entry point for OEMs experimenting with the IoT. One example of the value in this is predictive maintenance, which is closely coupled to condition monitoring.

Predictive maintenance

When combined with AI and machine learning, this can deliver valuable insights into the health and general performance of machinery. The main purpose here is to predict, with some accuracy, when a piece of machinery will need servicing. Using predictive maintenance can reduce unnecessary service calls while also avoiding unexpected failures.

Connectivity is at the core of the IIoT. Today, no single standard is used throughout the entire data path. In the field, established technologies such as CAN, Fieldbus and EtherCat still prevail. On the IT side, Ethernet is popular but so too are wireless technologies. Bringing all these disparate protocols together is the task of specialist equipment such as gateways, but the size, shape and profile of a gateway is open to interpretation.

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"Can edge controllers bring balance to the Industrial IoT?"

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"What does single pair Ethernet bring to the IIoT?"

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CONCLUSIONS AND FURTHER RESOURCES

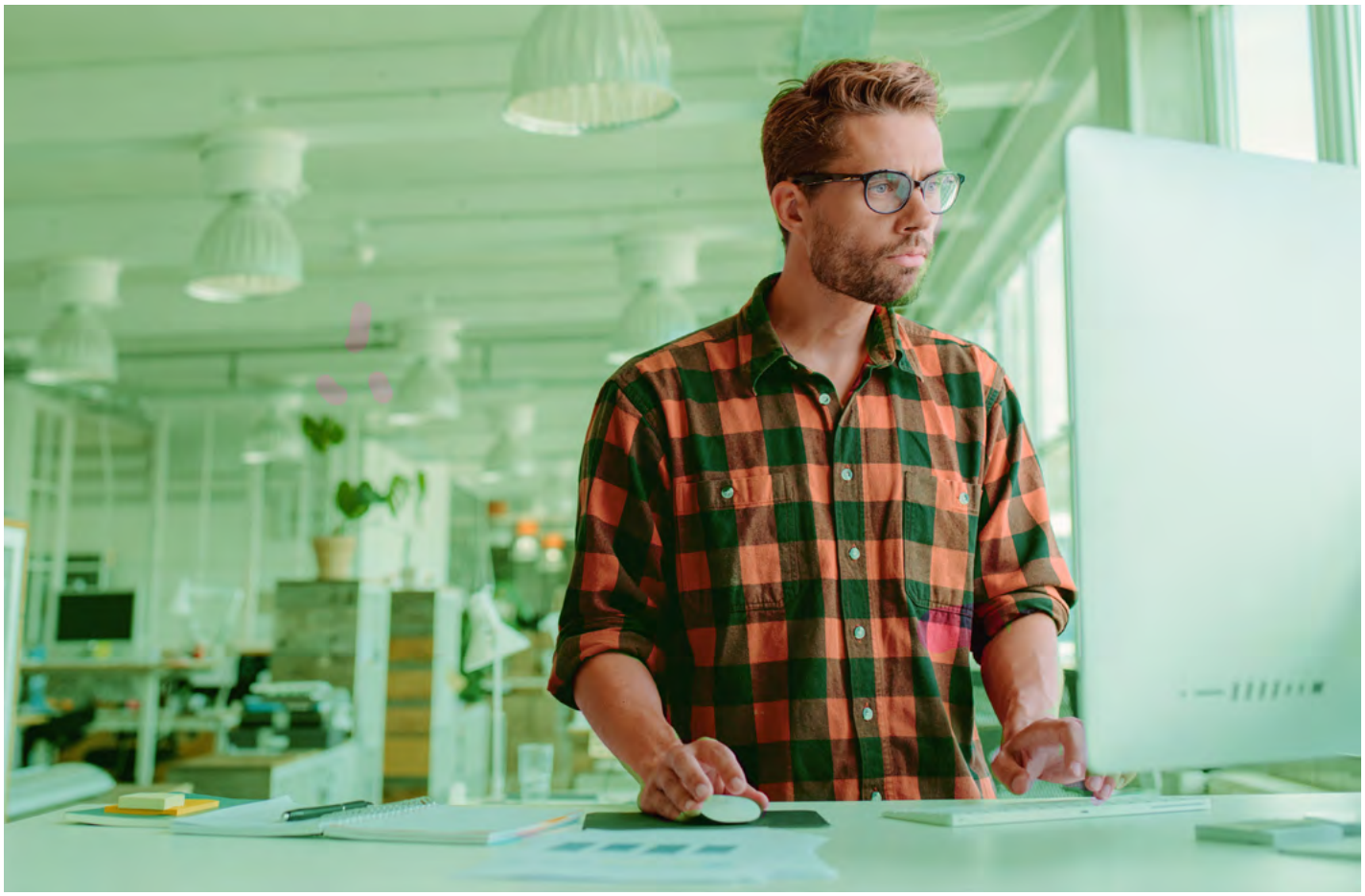
The idea of adding sensors to monitor a machine may be simple, but the IIoT is complex. Like an iceberg, most of that complexity is unseen. When embarking on a pilot project, choosing the best partnerships is essential.

But inaction is not an option. The competitive advantage that came with automation over 200 years ago is analogous to the benefits the IoT can bring manufacturers today. Failing to harness that will inevitably render some businesses unsustainable.

Most industrial manufacturers have yet to fully embrace the power of the IoT. The time to start is now, and while there is no obvious wrong way to do it, there are many right ways. Choosing the right way for you will be much easier if you choose to work with partners and solution providers that have already achieved success for other manufacturers.

Further resources:

- Infographic: The technology behind the Industrial IoT
- The Industrial IoT is driving economic growth
- Three future Industrial IoT trends manufacturers should think about now
- Case Study: How smart water meters are using AI to improve resource efficiency
- Supporting a service-oriented approach in the IIoT
- How no-code design could accelerate Industrial IoT development
- Can edge controllers bring balance to the Industrial IoT?
- What does single pair Ethernet bring to the IIoT?
- How to get to market with machine learning



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