451 Research

S&P Global
Market Intelligence

The Internet of Things, five years later: IT meets OT

Analysts - Ian Hughes

Publication date: Monday, April 26 2021

Introduction

This report looks specifically at the evolution of Industrial IoT in areas such as manufacturing over the past five years, as well as the changes that can be seen occurring in the application of emerging technology and the attitude toward these developments. It is part of a series of reports dedicated to specific vertical areas we have covered in depth in our IoT channel since 2015.

The 451 Take

The basics of IoT – with sensors, actuators, connectivity, data and processing – have evolved into an underlying component of a much larger ecosystem. The acronym IoT is now less prominent in industrial applications as connectivity (or the potential to connect) is considered the norm. IoT has not gone away, but has become part of the infrastructure powering significant outcomes, such as improving overall equipment effectiveness, reducing energy use and enhancing product quality. Industrial systems have an interesting challenge due to an inherent longevity – there will always be plants and systems, core assets for the manufacturers that may be decades old. The brownfield application of IoT to these is a voluminous and ongoing challenge. Over the centuries, industry has shown its ability to engage with, adopt and adapt technology to improve its outcomes. The current IT standards for virtualization, containers and services, combined with agile development processes, fit well with the OT world of today. Artificial intelligence operating alongside people in a loop powered by IoT data, connectivity and control, alongside descriptions such as Industry 4.0, is now often understood in the context of digital twins as the future of Industrial IoT.

Connected history

Industrial plants and machinery have often been considered a backwater of technology adoption by the fast-moving software industry, where the latter is not encumbered with the challenges of the physical world. Software can be patched and altered with no physical impact, but operating a processing plant or production line is a long-term investment that can evolve, often slowly but surely. However, the practicalities of fusing mechanical processes with control systems for safety and to improve manufacturing processes predate the software industry. Many computing students will have come across Joseph Jacquard's weaving loom of 1804, which was physically controlled by punch cards, an approach more commonly associated with computing in the 1960s and 70s. Manufacturing has continued to apply domain-specific solutions to problems that have tended to trail the general IT industry.

The initial interest in IoT in industry was focused not on changing the machinery, but on augmenting it with additional sensing capability, referred to as brownfield instrumentation. Data from these sensors needed to get from the machine to a place to be analyzed, leading to the development of IoT platforms to wrangle the data. Whether attempting to get just one temperature reading to a control center or a large number of sensor devices in place, this challenged the traditional insular concept of the self-contained and secure factory unit. To send data from the plant to the cloud brought concerns of security and intellectual capital breaches. This is where we tended to see the initial IT/OT clash occur in deployments, which in turn led to the formation of many OT-focused technology startups that could remove some of the concerns at the shopfloor and potentially bypass the perceived rigors or working with IT. Since IoT is primarily about data, that makes it a silo buster, so the conceptual differences between mechanical and software engineering, OT and IT, do not worry data. Hence, out of necessity, we are now seeing a more balanced approach, with OT needing challenges to be solved in a way that is scalable and supportable by IT functions. One key challenge is to improve overall equipment effectiveness across all forms of industry. According to our Voice of the Enterprise: IoT, The OT Perspective, Use Cases and Outcomes 2020, only 16.5% of 133 manufacturing respondents have an OEE over 80%, and 33% have an OEE of less than 65%.

The initial concerns over device-to-cloud have accelerated the acceptance and adoption of edge computing concepts in industrial use cases. Engineers are used to the dials and controls on machinery, so it is natural to consider processing any data locally at the edge. The decades of processing by SCADA systems are a further indication of edge and on-site computing in industrial plants already being the norm. Edge also has a significant place in providing low-latency responses to critical systems. It makes industrial use cases more edge-first environments, but that does not make it edge-only; instead, it sits across the continuum of processing and storage locations from edge to cloud. Where the best venue for data and processing is depends on the application. A prime example of a form of edge processing is the rise of AI-powered cameras. Computer vision provides an edge-based sensor that can have a machine learning model running on it for a number of local applications, such as product quality or worker safety, analyzing on the camera and then providing simple alert messages as problems are detected. If needed, it can switch to a full video stream to a control center, such as during an emergency situation.

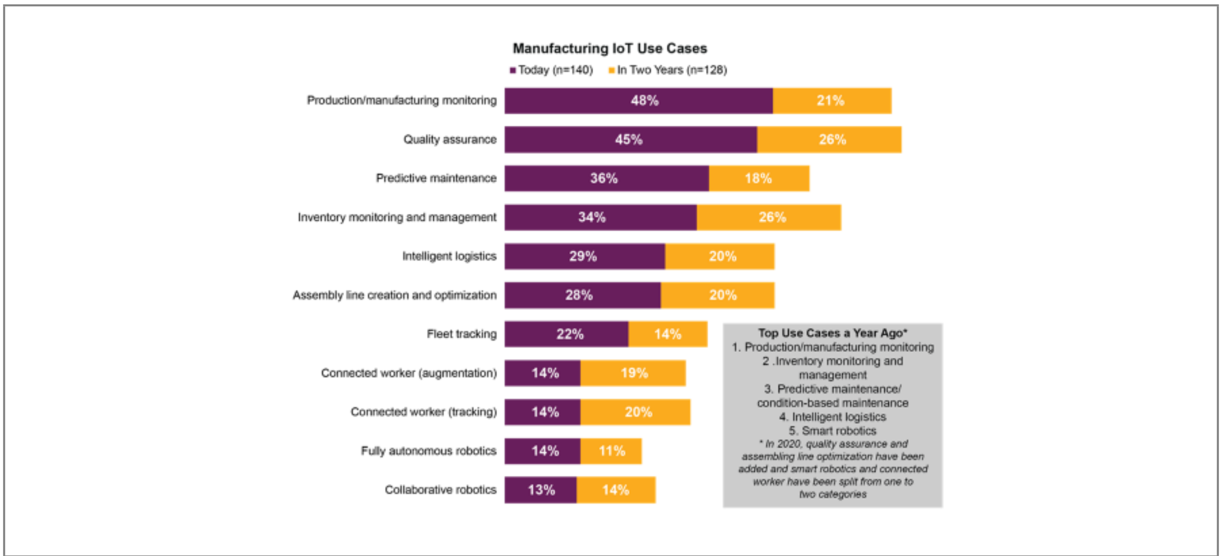
Emerging infrastructure

It is into the environment of a merged IT/OT world that the terminology of IoT is seeing a shift toward discussions of digital twins and digital thread. The adoption of emerging IT tends to follow a layering pattern, with today's innovations ballooning and then resolving into a common practice that is eventually 'business as usual' made part of core infrastructure. IoT, in the form of sensors, actuators, networking and the flow of data through IoT platforms, has become part of that infrastructure concept. We are tracking the ongoing growth of this IoT with forecasts of revenue, connected devices and data generation through our Industrial IoT Market Monitor.

The devil is in the details, and challenging industrial environments offer plenty, but few people are now surprised that useful IoT data can be gleaned from a manufacturing process. This understanding was well on its way to being the norm before the COVID-19 pandemic, but with that event the ability to remotely connect and control systems of all types became an absolute necessity. From a technology or engineering point of view, the complexity of connection and control is still a rich area for innovation, but the novelty of the concept has gone, replaced by terminology to try and help people understand what they can now gain from this infrastructure.

Digital twin is a term we have been using and tracking for some time, and it is now coming of age. When dealing with the physical world, as IoT does, the idea of having a digital copy of the instrumented asset (however the underlying technology achieves that) is much easier for many people to conceptualize. While not fully defined as a standard, a digital twin merging digital renditions of a physical installation with IoT data and information sits well in all conversations around digital transformation. Layering the history of that installation as its digital thread and applying concepts such as what-if simulation on that digital twin to explore its future also sits well. The twin concept can be wrapped around any layer in the stack – from a few sensors, to a machine, to an entire plant and then further, representing the full supply chain of an enterprise. IoT is an enabler for digital twins sitting alongside other emerging technology, such as 5G connectivity for more real-time data, AI and machine learning (ML) with no-code systems to manipulate and understand the twins and thread, and augmented reality as the user interface for IoT expressing the digital twin.

Manufacturing IoT Use Cases



Source: 451 Research's Voice of the Enterprise: IoT, the OT Perspective, Use Cases and Outcomes 2020
Q: Within your vertical, which of the following IoT use cases have you implemented today? In two years?
Base: All respondents

Enhanced automation and AI

In our Voice of the Enterprise: IoT surveys, covering both IT and OT, we track the advance of Industrial IoT from the basics of production monitoring offered by early IoT implementations to the application of that data to identify problems before they happen with predictive maintenance. In the figure above, the top manufacturing use cases now and in the next two years are represented, and more in-depth analysis can be found in our Voice of the Enterprise: IoT, The OT Perspective, Use Cases and Outcomes 2020 Advisory Report.

Predictive maintenance is the starter application, introducing AI and ML to industrial systems. While some predictive maintenance may simply involve the basic triggering of alerts as thresholds are approached, its real power comes from looking at a wide range of data to spot anomalies and trends. Going back to the history of manufacturing systems, for many decades data has been collected in logging databases, known as Historians, for retrospective investigations of processes. Now this Historian data can provide a valuable training resource for AI and ML models, again indicating the depth of technology already in play in industrial processes.

Robotics has been a significant part of manufacturing lines for some time, but standard industrial robots, while advanced in their physical abilities, have (like most manufacturing equipment) acted as a single-function repetitive device with a fixed role. Robot cells combine several large devices, such as welding arms, to operate in a programmed sequential way to produce a component delivered along a production line. The areas they operate in are fenced off from any of the shopfloor staff since the devices are not typically aware of their surroundings, although there will be some safety cutoffs. The flexibility of these robot arms and similar mechanical devices is now being enhanced with more IoT, AI and ML connected applications to create more autonomous and flexible robots for tasks that previously were difficult to automate. Hence, we see warehouse robots being coordinated to move products and resources around – but aware of people and the surroundings – and the emergence of true collaborative robots designed to help the workforce perform tasks, not replace them. Our nine-level classification of autonomous robots in industry explores this future further.

The importance of people

The past year has seen the OT world focus increasingly on its people, in part triggered by COVID-19. For a while, the sentiment of many automation providers and of the IT industry was that people were not a significant part of IoT. This is understandable since the core IIoT concept was, as described previously, about the sensors and the data. It has also been the case that the great crew change, the demographic loss of the retiring industrial workforce without the requisite new blood arriving to learn from them, has been known about and discussed for decades, but it required a technological and cultural shift to begin to address this. IoT rollouts, leading to digital twin approaches, have started the technology shift, and the pandemic-related urgency for remote connectivity could be seen to have caused the cultural jolt needed for that, as we covered in a recent report.

Many IT providers are now focused on delivering AI solutions with an OT focus, to augment the skills of the workforce with AI and ML. Tooling such as augmented reality helping a worker perform a task works best as part of the digital twin and digital thread loop, where IoT data and predictive suggestions help get the work done. No-code and low-code now can be used as part of an entire system, to let experts explore the mass of data and curate insight. Digital systems can capture information for tasks, such as shift handover, and then form part of the overall instrumentation of a plant, feeding predictive maintenance models and enhancing digital twin simulation for improvement. Helping people with AI does not only sit in the everyday operation, but can also assist in curated industrial design, the initial creation of a digital twin. People are now being understood to be a key part of the entire digital transformation process.

Conclusion

In looking back at the past five years of IIoT, it is worth noting a few of our key findings from a report in 2017 on the Industrial IoT state of play, where we noted that people are important to OT companies. Despite the apparent drive for automation also seen across IT projects, OT companies see deep value in people in their processes. OT has a slower adoption curve than IT due to cultural differences.

The rigors and quirks of the physical world, combined with the impact of any failure in a dangerous (or expensive) industrial process, means industrial engineers are culturally different from software engineers, having an alternate expectation around change and technology. This still holds true, but as we head deeper into 2021, the newer layers of IoT and a global attitude change get us closer to better industrial solutions. With an increased drive for all enterprises to consider their environmental, social and governance responsibilities, embracing these solutions can help greatly, such as using less power and fewer resources to safely and sustainably make products that share these attributes.