WHITE PAPER

The Future of Industrial Automation

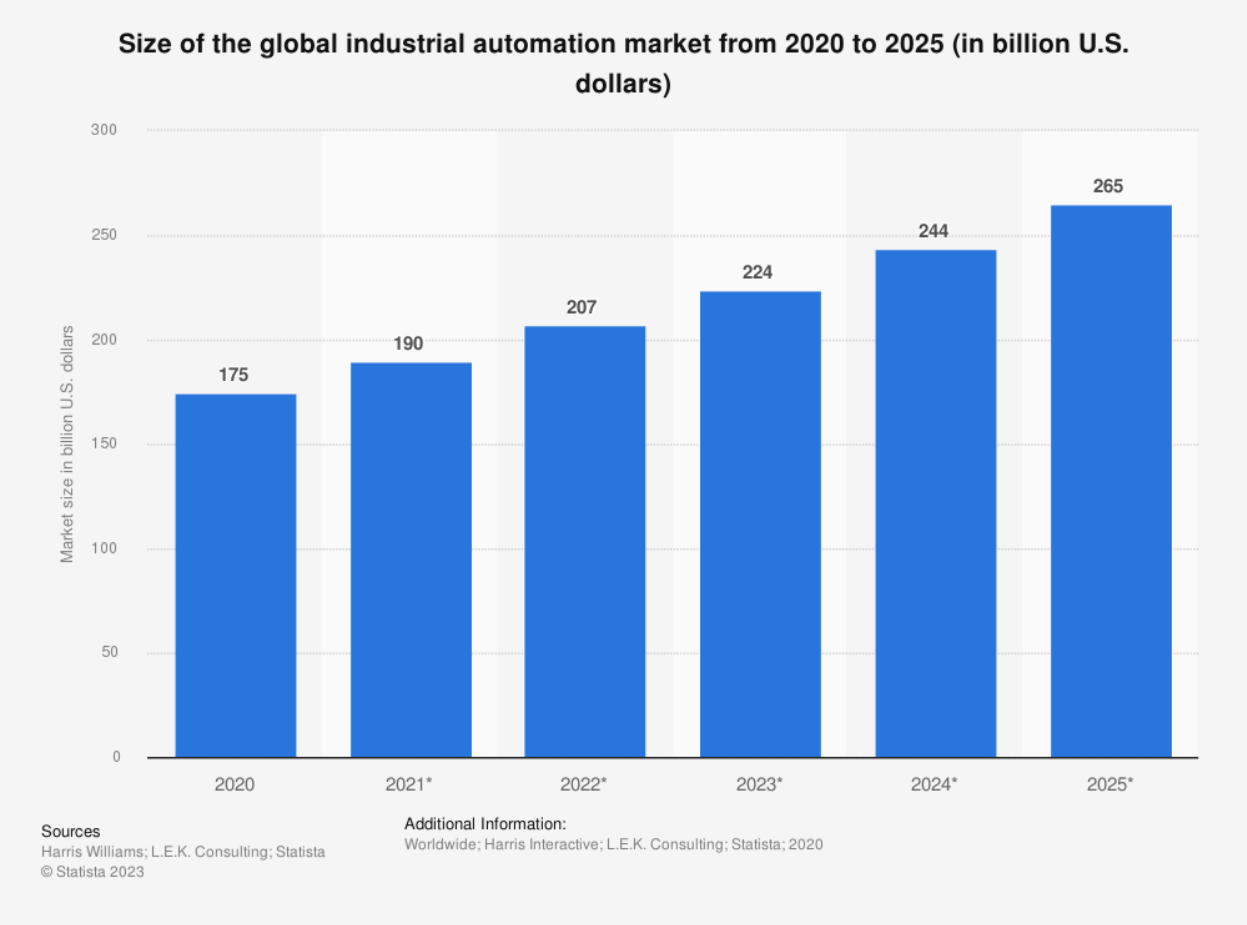
How IIoT is Revolutionizing the Manufacturing Industry

FIBERROAD

Introduction

The Industrial Internet of Things (IIoT) is changing the way the manufacturing industry operates by creating more connected, secure, and efficient processes. IIoT is a key component of Industry 4.0, which builds on the previous generation of machine-to-machine communication. Automation suppliers are innovating to meet the demand for more advanced technology, and IIoT is still growing in its potential. However, machine builders and end users can already benefit from introducing IoT features into their existing machinery. Upgrading existing machines with IoT features is a cost-effective approach that eases the transition for stakeholders who may not be ready to adopt new technology.

The extent of IIoT applications in the manufacturing industry is extensive, and comprehending it can be difficult, as it offers enhancements and resolutions to nearly every division of the enterprise. For instance, data collected from intelligent sensors can improve asset performance through analysis for maximum uptime, while smart devices can provide real-time user and machine data, benefiting workers by enhancing productivity, safety, and profitability. While some IIoT technologies can be incorporated into existing legacy systems, others necessitate time as original equipment manufacturers (OEMs) gradually integrate them into newer systems in accordance with international IIoT standards.



The IIoT vision involves smart connected assets operating as part of large systems in a manufacturing enterprise. Assets may have onboard intelligence for analyzing and decision-making via sensing elements. IIoT implementation in the manufacturing industry involves embedded intelligence, where systems are connected to cloud technologies providing secure access to process data and enabling advanced analytics tools, that can improve business values by providing improvement suggestions and early warnings to avoid possible downtimes due to any system component.

The IIoT is a technology that is causing significant changes in the way things are done. The IoT evolution involves multiple ecosystems and groups that overlap and interact with each other. These groups include hardware manufacturers, cloud providers, analytical experts, developers, and service providers who will offer remote solutions and value-added services. Currently, there are seven billion IoT devices in use, and this number is expected to increase to 22 billion by the year 2025[1]. The global market for IIoT in manufacturing is projected to reach $191.3 billion by 2028, with a compound annual growth rate of 21.4%[2].

Benefits of IIoT for Manufacturing Industry

The IIoT can provide numerous benefits to the actions in the manufacturing industry which can be understood by examining the core functionalities of the technology itself. IIoT is a group of networks that utilize networking technologies and standard Internet Protocol to connect machines, people, and processes, creating a cyber-physical system. There are lots of avenues IIoT is serving the manufacturing industry and assisting in solving challenges, the most common use cases in the industry are discussed here.

Operation Visibility and Remote Access

In order to maintain optimal functioning of the plant operations, machine operators should possess comprehensive knowledge regarding the status and performance of different machines. To facilitate this process, the IIoT helps present useful information about the processes on graphical displays which proves to be immensely helpful for operators on the ground, allowing them to take immediate action and receive alerts related to machines and processes. This information is logged and viewed in real-time simultaneously. Additionally, the utilization of remote access transfers the monitoring and diagnostic capabilities to both floor staff and managers, enabling them to view pertinent information from their offices, away from the factory floor. This approach allows for ongoing monitoring of the plant productivity, and the early detection and diagnosis of any potential issues, thereby preventing costly downtimes.

Process Optimization

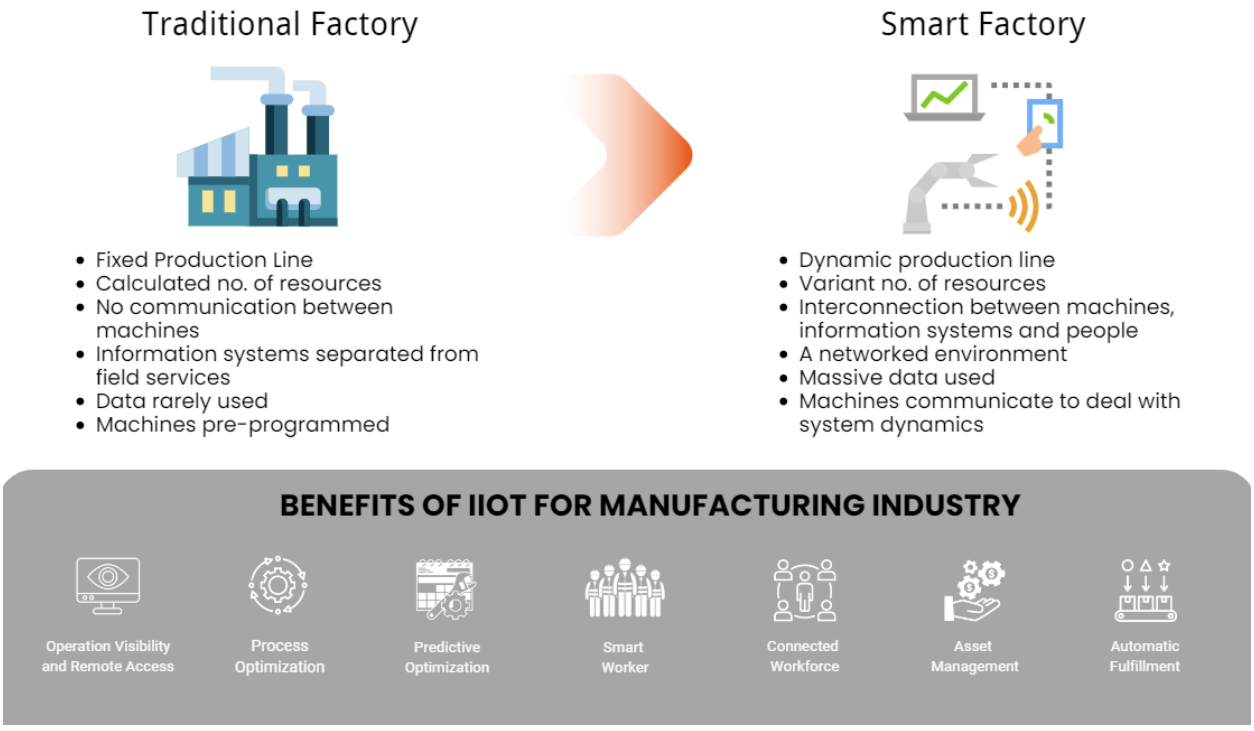
The implementation of the IIoT can optimize industrial processes. With the use of Industrial IoT sensors and data analytics, manufacturers can collect and analyze important performance-related data on their industrial processes, machines, plants, and logistics in real-time, thus making them transparent. This transparency allows manufacturers to identify inefficiencies and quickly take measures to reduce downtime, improve energy consumption, and optimize the utilization of resources. Furthermore, the IIoT enables real-time monitoring and control of manufacturing processes, allowing manufacturers to respond to changes swiftly and improve operations for maximum efficiency.

Predictive Maintenance

The IIoT technologies are replacing preventive maintenance with predictive maintenance. In the former traditional method, machine components were replaced at set intervals based on manufacturer recommendations. However, this often resulted in unexpected downtime and extra costs because some components would malfunction early or continue to perform well beyond the suggested replacement time. Predictive maintenance, on the other hand, uses logged and real-time data from machines across the plant to determine when and which machine demands maintenance. The sensors have the capability to furnish valuable data, such as temperature, vibration, and the machine's present power usage. This information can aid managers in scrutinizing the functioning of the machine as well as determining the health status of its components. Using historical machine data and prediction models, the IIoT can alert the management to machines that require maintenance, ensuring maximum uptime and machine availability while also controlling redundant costs.

Smart Workers

The implementation of IIoT in the manufacturing industry has the potential to revolutionize the way operators work. With the use of portable displays and process controllers, operators can access information from plant processes and make informed decisions in real time. The accessibility of data and information, such as analytics and augmented reality, through Internet Protocol (IP), will enhance the potential of portable wireless devices and their usefulness to machine operators. Dynamic QR codes are another technology being used to improve the experience by providing quick and easy access to information, enabling operators to complete tasks and troubleshoot issues more efficiently. By accessing information from enterprise systems, operators can improve productivity and profitability.



Connected Workforce

In a factory setting, it is not uncommon for managers and technicians to be needed on specific product lines. This can be quite disruptive as they often must visit each line multiple times to find workers needing assistance or for a worker to leave a workstation to call for assistance. However, with the advent of IIoT technologies, workers can use cost-effective internet-based wireless devices to quickly and easily notify the relevant personnel of their urgent needs. They may send an alert or get connected to them right away without having to leave their workstation. The streamlined communication approach will ensure that the respective personnel can easily identify which worker or production line requires assistance, resulting in a faster response time. It will enable different members to focus their energy on solving real problems, saving time, avoiding hindrances in workflow, and ensuring the safety of workers as well.

Asset Management

The IIoT provides a significant benefit to the manufacturing industry by enabling better asset management. With the help of positioning services, the location of vehicles and equipment can be easily monitored and traced, allowing for better tracking of materials, products, and equipment during transportation. This feature reduces the risk of errors or damage, enhances occupational safety, and improves logistics. Furthermore, the IIoT enables manufacturers to optimize shutdown procedures by monitoring and tracking the performance of equipment in real time. This ability optimizes asset utilization, improves overall equipment effectiveness, and reduces operating costs.

Automatic Fulfillment

One of the benefits of IIoT implementation in the manufacturing industry is the utilization of automatic fulfillment technology. This technology, which operates similarly to the Amazon Dash Button, allows for the monitoring and reordering of stock levels of materials, spare parts, and other necessary items. By relying on identification and localization to track inventory levels, automatic fulfillment technology can automatically reorder items as needed, optimizing the fulfillment process. This implementation reduces the risk of stockouts and ensures that necessary supplies are always available, improving productivity and reducing downtime.

Compliance Assessment

Another valuable use of IIoT technology is compliance monitoring, which can aid in adhering to regulations and guidelines. The features could include compliance with legal regulations related to environmental protection and occupational safety, as well as specific safety regulations such as access monitoring in hazardous areas. The implementation can benefit from monitoring compliance, minimizing the risk of non-compliance, improving safety and security, and avoiding costly penalties or legal consequences. Compliance monitoring is a vital aspect of IIoT application, ensuring that businesses operate within regulatory frameworks and maintain safe and ethical practices.

IIoT Integration at Different Levels in the Manufacturing

The adoption of IIoT represents a significant step towards building a smart manufacturing ecosystem. However, many companies perceive the concept of digital transformation as complex and struggle to plan their journey effectively. This section aims to break down the IIoT integration strategy for companies that are already familiar with the famous automation pyramid structure.

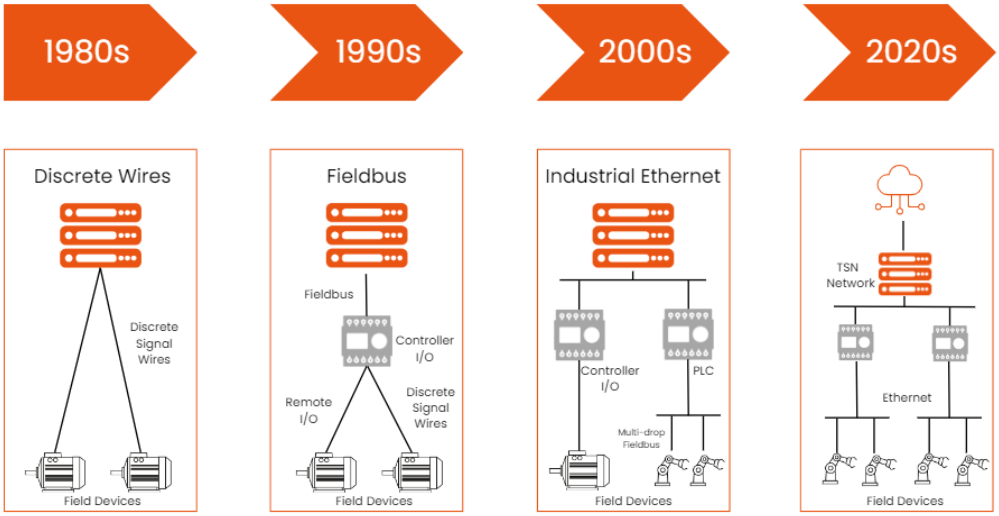


Figure 3: The evolution of Industrial Connectivity

Sensor Level

Sensors are crucial components of automation and IIoT technology. In an automation system, sensors acquire and transmit data from machines to Programmable Logic Controllers (PLCs) which are then fed to Supervisory Control and Data Acquisition (SCADA) system. This data can be accessed by the operator through a Human Machine Interface (HMI). Advanced sensors can directly transmit acquired data to software platforms, eliminating the need for a PLC and SCADA system. Collecting real-time data from hundreds of machines and processes is challenging due to the vast amount of data involved and the limitations of connected wired sensors and network bandwidth. However, wireless networks and lightweight IIoT protocols have enabled large-scale data collection and transmission. Collecting data from multiple sensors and performing sensor fusion can enhance the quality of data. Additionally, storing less important data can be helpful when running statistical and machine learning models for advanced analytics. These models can evaluate the dependencies and relations between various parameters that humans may not be able to discern just by looking at the data itself.

Control Level

PLCs are a critical component of Industrial Control Systems (ICS), but their current capabilities and features need to be redefined to meet the demands of Industry 4.0. To enable cooperation and seamless integration with IIoT devices, the proprietary nature of these controllers and networking

features must be made more flexible. This requires higher processing power, improved security protocols, and enhanced networking possibilities to communicate with IIoT devices and share information over cloud services. PLCs must also be able to communicate with systems and hardware from manufacturers offering IIoT solutions. Cloud services have attracted the attention of third-party service providers who are now interested in offering Infrastructure-as-a-Service (IaaS). With IaaS, end-users can access cloud services online without having to invest in hardware or software resources or manage the upkeep of the cloud services.

Supervisory Level

SCADA software provides plant supervisors with a graphical user interface for monitoring and controlling real-time plant data. While these software solutions provide valuable insight into plant processes, they have limitations when it comes to storing large amounts of data for advanced analytics and internet connectivity. Currently, the information can be viewed and stored on a local machine using a local network. Modern software providers are now offering web-based cloud solutions that improve supervisory experience and provide better data storage capabilities. The main objective is to transfer data visualization and storage to internet-based platforms while adding data intelligence through analytics. IIoT platforms are being developed on lightweight architectures such as Docker virtualization instead of containerized technologies, which enable plug-and-play features with low latency and big data analytics capabilities.

Operations Level

Many industrial companies currently use standalone software, such as Enterprise Resource Planning (ERP) and Manufacturing Execution System (MES), for decision-making. However, this software has its constraints. For example, they struggle to gather information from multiple sources, have their own data repositories, and lack open communication support, making them less future proof. This software is also proprietary, which often requires significant modifications and customizations to meet specific industry needs. Additionally, they lack the features of convenient visualizations and user interfaces and are not compatible with third-party planning modules, making them ill-suited to handle the demands of Industry 4.0. Companies like Microsoft and Amazon offer cloud services specifically tailored to the manufacturing industry. These services are compatible with web-based MES and ERP software, providing real-time decision-making and automating business decisions based on predefined rules. Cloud solutions eliminate the need for companies to invest in their IT infrastructure resources and management, and instead provide a platform-as-a-service (PaaS) that can be integrated with current systems, scaled up as needed, and offer state-of-the-art functionalities and safety features.

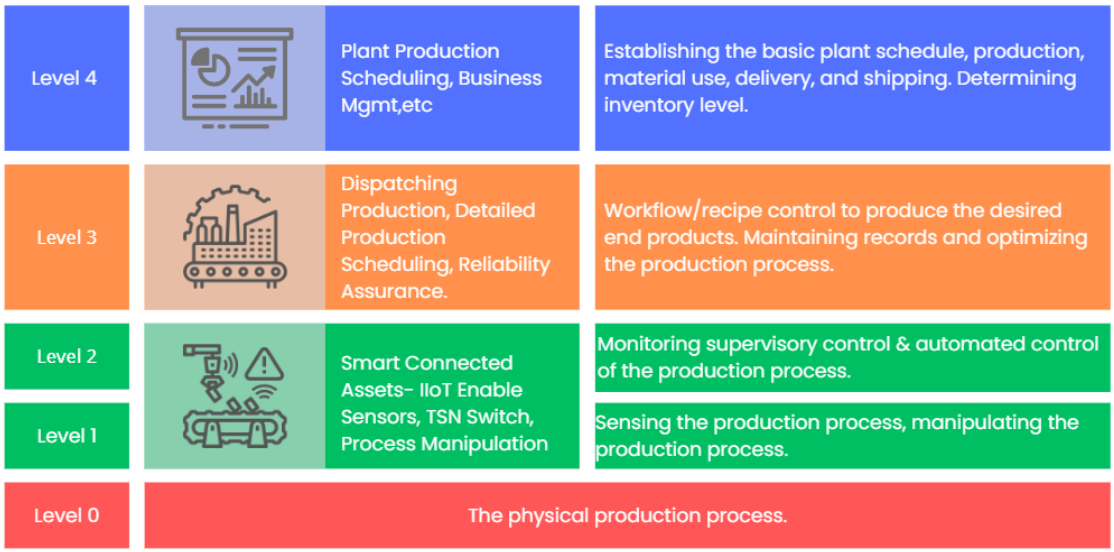
Major Challenges In IIoT Adoption

The adoption of IIoT in the manufacturing industry has the potential to revolutionize the industry. Nonetheless, there are significant hurdles that must be overcome in the implementation of IIoT technologies. Some of the major challenges and the ways companies are resolving them to realize the benefits of IIoT, are explored.

Standardization

The lack of standards in IIoT has been a significant challenge for its implementation. The hardware industry is highly fragmented as many embedded developers and designers have their own ways of doing things. However, standards are required for smart devices, and machines to interact seamlessly. Although there are standards available to address the needs of industrial automation, such as PackML, they may not fully cater to the requirements of the manufacturing industry. To bridge this gap, the Industrial Internet Consortium is taking steps to establish the necessary standards. Additionally, open-source frameworks for IoT firmware development are being created to ensure that designers adhere to standards. In 2016 and 2017, the Open Connectivity Foundation and the Institute of Electrical and Electronics Engineers (IEEE) are pushing for united protocols to create a universal language for IoT.

ISA95 Hierarchy



Cyber Security

As the IIoT gains traction, cyber security becomes even more critical in industrial control systems. Incorporating security measures into all components of IIoT systems is necessary due to their complexity. To ensure the security of both individual assets and larger systems, it is crucial to adopt industrial security standards and certification. This adoption is essential for the advancement of IIoT. Similarly, to safety certifications, adherence to these standards indicates that system elements have the key security building blocks and are combined securely by certified teams and operated securely by trained operators. However, adding complexity to IoT solutions by incorporating additional devices and networks poses additional security challenges, as illustrated by the Las Vegas casino hack and attacks on petrochemical and water treatment plants. A holistic approach to security, including physical device defense, risk-based vulnerability management, encryption of data-in-motion, and compliant data storage and consumption, is essential. When assessing the security of IoT systems, it is important to examine how data is stored, processed, and transmitted. To protect this data, a combination of hardware and software encryption methods, modern cryptography algorithms, and public and private infrastructure are recommended.

Execution Cost

When it comes to custom IoT solutions, there are a few technical considerations to keep in mind. One key factor is the hardware used to build the solution. A custom IoT solution will require specific hardware to meet the exact requirements of the project. Additionally, the software used to power the solution will need to be developed specifically for the hardware, as off-the-shelf software may not be optimized for the custom hardware. Another consideration is the communication protocol used to connect the devices within the IoT solution. Choosing the right protocol is critical to ensure that the devices can communicate effectively with each other and with any backend systems. The chosen protocol will also affect the security of the solution, as some protocols are more secure than others. Finally, the data generated by the IoT devices will need to be stored and analyzed. This requires a backend system that is capable of handling large volumes of data in real time. A custom IoT solution will likely require a custom backend system that is optimized for the specific needs of the project.

Conclusion

The adoption of IIoT technology in the manufacturing industry has been slow due to several reasons, including the reluctance of end users to replace their existing industrial automation and control systems with new technologies. However, visionary automation suppliers have been working towards the goal of IIoT for years, and the cost of connected sensors is dropping rapidly, making it easier for companies to phase in new technologies over time. It is essential for companies to develop a consistent holistic strategy to achieve optimal business results and fulfill their customers' needs while staying ahead of market trends. IIoT infrastructure can offer high visibility across the whole manufacturing industry, making it extremely valuable for both efficiency and process optimization from a business perspective. Additionally, IIoT-enabled digitization could lead to better environmental management, helping companies reach their sustainable development goals. Despite the challenges of adopting IIoT technologies, the market size of IIoT is rapidly expanding, and companies should not let these challenges become obstacles to innovation.