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Importance of Industrial Internet of Things (IIoT) : Security Considerations and Challenges When Adopting IIoT

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ABSTRACT

The emerging Internet of Things (IoT) provides a wide range of platform to different technologies by connecting different devices and are automated by using sensors. It builds a platform and is responsible for functioning of various smart devices over a range. After installing IoT in devices they are able to communicate with each other without involving human and computer interaction, it is also being widely used in all the fields as no human intervention is required in any IoT based applications. IIoT helps in manufacturing to boost revenues by increasing production, Easy to achieve new growth approaches and reduced all over man work-force. In this paper we discuss IIoT, difference between IoT and IIoT, possibilities does IIoT create in the manufacturing industry and some aspects related to Security Considerations and Challenges When Adopting IIoT.

Keywords: IoT, IIoT, Industry 4.0, Security

I INTRODUCTION

The Internet of Things (IoT) describes the network of physical objects—"things"—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. These devices range from ordinary household objects to sophisticated industrial tools. With more than 7 billion connected IoT devices today, experts are expecting this number to grow 22 billion by 2025. The Fig 1.0 shows Internet of Things

Fig 1.0 Internet of Things

The term "Things" in the Internet of Things refers to anything and everything in day to day life which is accessed or connected through the internet. IoT is an advanced automation and analytics system which deals with artificial intelligence, sensor, networking, electronic, cloud messaging etc. to

deliver complete systems for the product or services. The system created by IoT has greater transparency, control, and performance.

1.1 Why IoT is important?

The Next Industrial Revolution which is going to change our lives in ways never imagined before, The last industrial revolution which is nothing but INTERNET the way we communicate and connect with people has changed like never before and also the Internet boom has improved our lives in many ways. Every time a Industrial Revolution happens there will be enormous changes in the economy create a whole new level of markets. Quick changes in IoT technology makes it a challenging task for the most experienced experts to anticipate the future of standardization in the field. For humanity, which is moderately clutter by nature, the IoT is an extraordinary advancement. On the other hand, for individuals who esteem their security, the Man to Man helps in interconnecting different electronic gadgets. IOT has arrived with a highly believable promise of giving individuals few more free hours by automating few tasks and boosting productivity of businesses by making better use of data. The IoT technology is more efficient due to following reasons:

1. Global Connectivity through any devices.
2. Minimum human efforts
3. Faster Access
4. Time Efficiency
5. Efficient Communication

1.2 Internet of Things(IoT) Market Size and Forecast

The Internet of Things (IoT) market is growing rapidly across industries due to the real-time data insights and automated responses that the technology can provide at scale at the user level. As network infrastructure continues to advance its bandwidth and low latency, IoT is also expected to become more effective and widely available.

1.3 Growth of IoT Networks

Many enterprises have been using IoT solutions for quite a long time and benefit from them. Nevertheless, the technology doesn't stand still. The Internet of Things continues its advancement due to the development of complementary technologies such as 5G connectivity, edge computing and artificial intelligence. As a result, IoT networks reduce or eliminate latency, becoming more efficient and secure.

1.4 Industry 4.0

Industry 4.0 refers to the fourth industrial revolution, although it is concerned with areas that are not usually classified as industry applications in their own right, such as smart cities. The Table 1 shows that evolution of industrial revolution.

Table 1 Industrial Revolution

Industrial Revolution	Meaning
First industrial revolution	the advent of mechanization, steam power and water power
Second industrial revolution,	which revolved around mass production and assembly lines using electricity
Third industrial revolution	electronics, I.T.systems and automation
Fourth industrial revolution	associated with cyber physical systems

1.4.1 Industry 4.0 Technologies

Generally-speaking, Industry 4.0 describes the growing trend towards automation and data exchange in technology and processes within the manufacturing industry, including:

- The internet of things (IoT)
- The industrial internet of things (IIoT)
- Cyber-physical systems (CPS)
- Smart manufacture
- Smart factories
- Cloud computing
- Cognitive computing
- Artificial intelligence

This automation creates a manufacturing system whereby machines in factories are augmented with wireless connectivity and sensors to monitor and

visualize an entire production process and make autonomous decisions.

Wireless connectivity and the augmentation of machines will be greatly advanced with the full roll out of 5G.

This will provide faster response times, allowing for near real time communication between systems. Figure 2.0 shows that Industry 4.0 growing trends.

Fig 2.0 Industry 4.0

The fourth industrial revolution also relates to digital twin technologies. These digital technologies can create virtual versions of real-world installations, processes and applications. These can then be robustly tested to make cost-effective decentralized decisions.

These virtual copies can then be created in the real world and linked, via the internet of things, allowing for cyber-physical systems to communicate and cooperate with each other and human staff to create a joined up real time data exchange and automation process for Industry 4.0 manufacturing.

This automation includes interconnectivity between processes, information transparency and technical assistance for decentralized decisions.

In short, this should allow for digital transformation. This will allow for automated and autonomous manufacturing with joined-up systems that can cooperate with each other.

The technology will help solve problems and track processes, while also increasing productivity.

II INDUSTRIAL INTERNET OF THINGS (IIoT)

Industrial IoT, or the Industrial Internet of Things (IIoT), is a vital element of Industry 4.0. IIoT harnesses the power of smart machines and real-time analysis to make better use of the data that industrial machines have been churning out for years. The Fig 3.0 shows that Industrial Internet of Things growing in various subsectors.

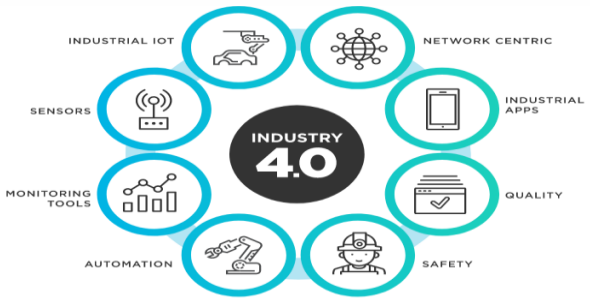

Fig 3.0 Industrial IoT

The principal driver of IIoT is smart machines, for two reasons. The first is that smart machines capture and analyze data in real-time, which humans cannot. The second is that smart machines communicate their findings in a manner that is simple and fast, enabling faster and more accurate business decisions.

IIoT is used across a range of industries from manufacturing, logistics, oil and gas, transportation, mining, aviation, energy, and more. Its focus is to optimize operations--particularly the automation of processes and maintenance. IIoT capabilities enhance asset performance and better manage maintenance. In the long run, it moves the industry toward a demand service model, increases customer intimacy, and creates new revenue streams--which all contributes to the digital transformation of industries.

The Industrial Internet of Things (IIoT) market is a growing subsector of the Internet of Things (IoT) that focuses on facilitating greater connectivity among equipment, software, and employees in an industrial environment.

These smart, sensor-based technologies use ultra-low latency connectivity, usually via cloud computing or edge computing, to collect data and make automated decisions across an industrial network. Although the Industrial Internet of Things

market is mostly tied to production-based solutions where automation is key to success, IIoT is quickly growing in capabilities and use cases.

2.1 IIoT Infrastructure

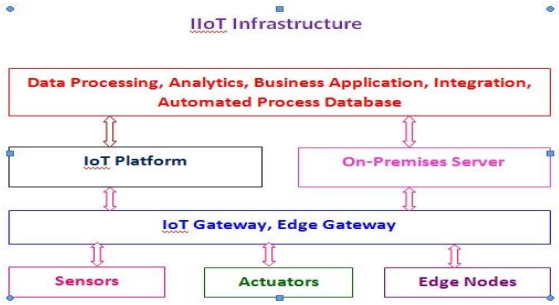

Fig 4.0 IIoT infrastructure components include the IoT or edge gateway, sensors, actuators and edge nodes

The Industrial Internet of Things (IIoT) is the internetworking of physical devices, automation controllers and other items-embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data. Fig 4.0 shows that IIoT infrastructure components include the IoT or edge gateway, sensors, actuators and edge nodes

2.2 Components that make up IIoT

Smart Machines

Machines are an integral part of any manufacturing or processing industry. Ordinary machines are programmed to do one thing, and they do it with high efficiency. Smart machines are an improvement over regular machines as they can communicate with other machines. IoT is all about the communication between devices, and IIoT applies it to the machines working in the industry. Machines can now send data about how well they are performing and if any part of it is undergoing undulating stress.

Sensors

Sensors are an integral part of both IoT and IIoT. Sensors detect the changes in the physical environment and convert them into electrical signals. These electrical signals are the data that helps us understand the physical quantity measured by the sensor.

Infrastructure

Infrastructure concerning IIoT is the network through which all the digital-communication happens. Without a secure and fast communication platform, data transfer will face obstructions that will make the entire setup futile. When it comes to storing and transferring data at a rapid pace, the cloud is the undeniable winner.

Software, Radios, and Controllers

An industry setup is very different from what we are used to with the traditional IoT. In industries, a piece of machinery receives support from many other devices to create a system. Hence, a machine will have controllers or radios, and they run over custom software. With IIoT, these subunits should also support IIoT standards.

2.3 How Does IIoT Work?

IIoT is a network of intelligent devices, via networks linked to databases, which monitors, collects, exchanges and analyses data. Typically, an IIoT system consists of:

- Intelligent equipment that can measure and store information about itself and communicate.
- A data communication structure such as public internet or individual networks.
- Intelligent applications that create useful information from raw data and utilize it to control and optimize processes.
- Interface and analysis tools that provide people with the opportunity to utilize the information for qualified decision-making.

The connected equipment sends information directly to the IIoT infrastructure, where it is transformed into useful information on the status or performance of a machine, a group of machines or the whole plant.

The information can then be used to optimize production and supply processes as well as foresee maintenance.

2.4 Difference between IIoT and IoT

The table 2 shows the differences between IoT and Industrial IoT

Table 2 Difference between IoT and IIoT

S.No.	IIOT	IOT
1.	It focuses on industrial applications such as manufacturing, power plants, oil & gas, etc.	It focuses on general applications ranging from wearables to robots & machines.
2.	It uses critical equipment & devices connected over a network which will cause a life-threatening or other emergency situations on failure therefore uses more sensitive and precise sensors.	Its implementation starts with small scale level so there is no need to worry about life-threatening situations.
3.	It deals with large scale networks.	It deals with small scale networks.
4.	It can be programmed remotely i.e., offers remote on-site programming.	It offers easy off-site programming.
5.	It handles data ranging from medium to high.	It handles very high volume of data.
6.	It requires robust security to protect the data.	It requires identity and privacy.
7.	It needs stringent requirements.	It needs moderate requirements.
8.	It having very long life cycle.	It having short product life cycle.
9.	It has high-reliability.	It is less reliable.

2.5 Industrial Internet Of Things Market

The IIoT market is one part of the greater IoT market, but because of its many use cases for industrial operations, the IIoT market alone is growing quickly.

The global IIoT market was valued at about $216.13 billion in 2020 and is expected to grow to about $1.1 trillion by 2028, according to Grand View Research.

Swift digital transformations happening as a result of the pandemic are some of the leading factors for the aggressive growth rate.

IIoT equipment manufacturers are increasingly finding more affordable and accessible ways to develop IIoT sensors and processors, meeting the demand for increased operational automation.

As a growing number of enterprises lean into automated assembly lines and operations as well as other “unified digital-human workforce” strategies, IIoT is expected to grow in virtually every global industry.

2.6 Benefits Of IIoT

IIoT connects different points of tools, data, and users across industrial environments, and it offers several key benefits once it’s implemented:

Automated Production

Automation is one of the core benefits that IIoT technology offers its users. IIoT is designed to collect and manage data in such a way that it can be trained, or train other tools, to perform manual labor typically performed by human workers on an assembly line. Industrial IoT automation limits the space for user error and decreases manual task work for a skilled workforce.

Maintenance And Safety

IIoT is often applied for automated predictive maintenance and safety monitoring in assembly lines. Through its low-latency, constant collection of performance data, IIoT sensors give companies the ability to analyze different aspects of performance and determine if equipment needs to

be updated or replaced or if a worker is coming into contact with dangerous working conditions. IIoT sensors can also track certain environmental factors, such as temperature and air quality, to ensure the safety of equipment and manufactured products in transit.

Real-Time Efficiencies

Because IIoT focuses on collecting as many real-time data points and insights as possible, it's often used as a precautionary tool that can prevent unnecessary downtime caused by equipment outages and other performance issues. Less downtime leads to greater workplace efficiency and overall productivity.

Workforce-Equipment Connectivity

In a more traditional factory or industrial environment, human workers operate equipment, and automated machines act on their own programming. IIoT is one of the few technical solutions that decreases silos between the workforce and their equipment. Users gain more direct insights from their tools and allow tools to learn from human intervention over time.

2.7 IIoT Use Cases

Most IIoT use cases are currently found in the manufacturing and supply chain industries. companies are relying on top IIoT providers to improve their real-time data knowledge and operational visibility:

"Huawei and DHL will collaborate on innovation projects focusing on cellular-based Internet of Things technology, which can connect large volumes of devices across long distances with minimal power consumption. The greater connectivity will deliver a more integrated logistics value chain, by providing critical data and visibility into warehousing operations, freight transportation, and last-mile delivery." -An SVP at DHL, a global delivery and logistics company, on Huawei IIoT

"We wanted to obtain quality data on a real-time basis and use the same data to analyze trends to help prevent defects before they occur. In addition, we want the person in charge to be notified immediately if any of the equipment malfunctions or if there is an outage, so that we might reduce the time the production line is down to a minimum." - An engineer in vehicle manufacturing, on Cisco IIoT

As connectivity innovations — such as multicloud environments, edge computing, and 5G networks — become more widespread and accessible, expect to see more applications of IIoT across global industrial markets.

III POSIBILITIES DOES IIoT CREATE IN THE MANUFACTURING INDUSTRY

In the IIoT, the combination of sensors and analytics allows real-time access to data that was previously unavailable.

The findings from this data are fed into the processes along the entire supply chain without delay. This makes it possible, for example:

- Optimization of processes (e.g. through remote monitoring)
- Greater flexibility of production processes
- Increasing degree of automation
- Increased operational efficiency and lower failure rates
- Faster detection of productivity weaknesses and problems
- More accurate predictions of machine condition and more efficient maintenance
- Cost savings by avoiding unnecessary repairs
- Better availability and fewer machine failures
- Improved quality control and reduction of the error rate
- Improved transparency through worldwide access to machine data
- Improved technical customer service
- Development of trend-setting business areas and models (e.g. supplementary services such as remote troubleshooting or predictive maintenance)

IV SECURITY CONSIDERATIONS AND CHALLENGES WHEN ASOPTING IIoT

The adoption of IIoT can revolutionize industries, but this increased connectivity can create additional security issues. Companies that work with

operational technologies understand the importance of worker safety and product quality. But with the integration of operations, the internet, automation, and smart machines, several challenges arise with availability, scalability, and security.

Most industries are well versed in managing availability and scalability since they are crucial to functioning and can easily integrate into an IIoT system.

Security is where most organizations tend to falter. Many businesses still utilize legacy systems and processes, and new technologies can complicate integration and end-to-end security.

The increase in smart devices, particularly employee devices used for work, give rise to a plethora of security vulnerabilities. Organizations are responsible for the secure implementation and setup for any connected devices. But device manufacturers also have to prove they can keep devices safe, which is not often the case.

Cyber-security issues are rising. Successful hackers can crack connected systems and potentially shut down operations. To handle these security issues, manufacturing companies need to approach IIoT like any IT company would--with a focus on the security of physical and digital components.

Another challenge with IIoT adoption is securely integrating industrial operations with IT. User data has to be in sync with global privacy regulations.

Gathering data is essential to generating essential insights for a company, but personal information needs to be separated and stored in encrypted databases. Storing personal data with business data can lead to serious risks of exposure.

Several other security problems are associated with IIoT. This could be exposed ports, a lack of sufficient authentication practices, or even the use of obsolete applications. All these small problems, in addition to having an internet network, can be dangerous for companies. Unsecured IIoT systems can result in operational disruption and financial losses.

The more connected an environment is, the higher the security risks:

- Software vulnerabilities are easy prey for hackers to attack.
- Devices and systems connected to the internet are publicly searchable.
- Hacking attempts increase, leading to targeted attacks and data loss.
- Operations are disrupted from system manipulation or sabotage attempts.
- System malfunction results in device damage, or worse still, physical damage to employees.
- Extortion attempts resulting from compromised operational technologies.
- Increased fines if private information is made public against regulations.

V CONCLUSION

One of the biggest benefits of the Industrial Internet of Things is its ability to reduce human error and manual labor. The two factors we mentioned are crucial to the purpose of IIoT: efficiency and cost reduction (in terms of saving money and time). These are the key factors that companies expect when implementing this type of technology. The ability to collect data, analyze it, and then take appropriate actions based on the results is essentially all that IoT does, whether for consumer or industrial purposes. The goal of IIoT is also not to completely replace human work, its goal is to enhance and optimize it. The future of IIoT will include more emphasis on predictive maintenance, enhanced device communication, and more affordable access for companies of all sizes to tap into the business benefits of the connected facility. Among those benefits are productivity gains, cost savings, immediate control, and quick detection of issues and opportunities.

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