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# Emerging Technologies on smart factory in Internet of Things (IoT) and cloud in Industry 4.0

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## Introduction/Overview

The emergence of technologies like the Internet of Things (IoT) and cloud computing has revolutionized the industrial landscape. They have enabled the creation of smart factories and connected devices, where machines, tools, and devices are interconnected through IoT sensors and communicate with each other to automate tasks and optimize processes. A smart factory can leverage these technologies to become more efficient, cost-effective, and productive. By using IoT sensors to gather real-time data on the health of machines and equipment, predictive maintenance can be performed, preventing unplanned downtime, and reducing maintenance costs. IoT sensors can also be placed on inventory items to track their location, movement, and usage, optimizing inventory levels, reducing waste, and improving supply chain efficiency. Additionally, IoT sensors can be used to collect data on production processes and product quality, allowing for real-time quality control. The data can be analysed using cloud-based software to identify defects and improve quality control. Smart factories can also leverage these technologies to monitor energy usage and identify areas where energy can be conserved, improving sustainability, and reducing costs.

Furthermore, IoT sensors can be used to track the location and movement of assets such as tools, equipment, and vehicles, improving asset utilization, reducing theft, and increasing productivity. Lastly, these technologies can also be used to monitor worker safety and identify potential hazards, improving safety protocols, reducing accidents, and ensuring compliance with regulations. In conclusion, by leveraging the power of emerging technologies like IoT and cloud computing, businesses can optimize their operations, reduce costs, and enhance productivity while achieving sustainability and safety goals. The proposed solutions on smart factory & connected device use cases using IoT and cloud offer significant opportunities for businesses to remain competitive in an ever-changing industrial landscape. The rise of emerging technologies like the Internet of Things (IoT) and cloud computing has revolutionized the industrial landscape. These technologies have paved the way for the creation of smart factories and connected devices that can communicate with each other, automate tasks, and optimize processes. In a smart factory, machines, tools, and devices are interconnected through IoT sensors and communicate with each other to improve efficiency, reduce costs, and enhance productivity.

## Business Case:

A smart factory with IoT and cloud technology can bring significant benefits to a business, including increased efficiency, productivity, and cost savings. In this business case, we will explore the advantages of implementing a smart factory with IoT and cloud technology.

## Overview:

The manufacturing industry is evolving rapidly, and businesses must adopt innovative technologies to remain competitive. One such technology is the smart factory, which uses IoT sensors and cloud computing to automate and optimize the manufacturing process. By implementing a smart factory, businesses can streamline their operations, reduce costs, and improve the quality of their products.

## Benefits:

**Increased Efficiency**: A smart factory with IoT sensors can collect real-time data from various manufacturing processes, providing insights that can help businesses identify

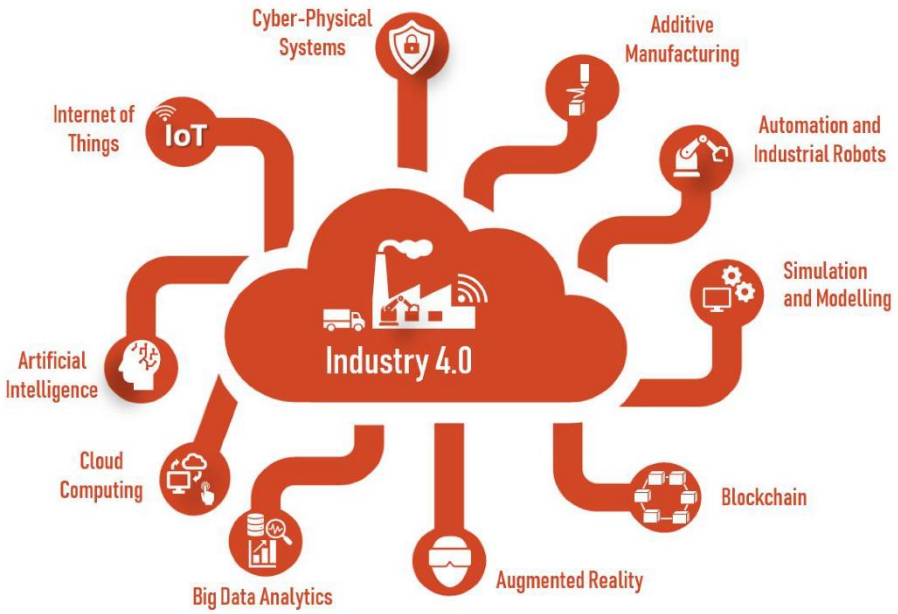
inefficiencies and improve their processes. This data can be used to optimize the use of resources, minimize downtime, and improve overall efficiency.

Improved Quality: By implementing IoT sensors in the manufacturing process, businesses can monitor production quality in real-time. Any anomalies or defects can be detected immediately, allowing for quick corrective action to be taken. This results in improved product quality, reduced waste, and higher customer satisfaction.

**Cost Savings**: Smart factories can help businesses reduce costs by automating repetitive tasks, minimizing waste, and optimizing the use of resources. Additionally, by utilizing cloud computing, businesses can reduce their hardware and maintenance costs, as the cloud service provider takes care of those aspects. Flexibility and Scalability: Smart factories can be easily adapted to changes in demand or production processes, allowing for greater flexibility and scalability. The use of cloud computing also enables businesses to quickly scale up or down their computing resources, depending on their needs.

**Challenges:** Security: The use of IoT sensors and cloud computing introduces new security risks. Businesses must ensure that their systems are secure and protected from cyber threats. Integrating IoT sensors and cloud computing into existing manufacturing systems can be challenging. Businesses must ensure that their systems are compatible and that there is no disruption to existing processes.

**Cost:** Implementing a smart factory with IoT and cloud technology can be expensive, especially for small and medium-sized businesses.




The following subsections will highlight the major pillars and enablers of Industry 4.0; cyber-physical systems, Internet of Things, Big Data, cloud computing, artificial intelligence, robotics, and Smart Factory.

**Cyber-Physical Systems**

The combination of physical and virtual spaces is referred to as cyber-physical systems (CPSs), and it aims to create a communicative interface between the digital and physical worlds by integrating computation, networking, and physical assets. While the definition

of CPS may vary based on perspectives and backgrounds, it is well-understood that the interconnection between the physical world is represented by hardware (e.g., sensors, actuators, robots) and cyber software (communication, networking and internet). CPS is at the core of Industry 4.0, and its success depends on the smart management of interconnected systems between its physical components and computational capabilities, utilizing state-of-the-art technology in both worlds

**Internet of Things (IoT):**

The International Telecommunication Union (ITU) defines IoT as "A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies". The infrastructure that allows devices and/or assets to connect to one another is known as the IoT. The term IoT has been deployed in many different fields, and it takes the name of the corresponding field; in Industrial internet of things (IIoT) Internet of Service (IoS), the merging of Robotics and IoT technologies gives birth to a new concept known as IoT-aided Robotics or Internet of Robotic Things (IoRT)

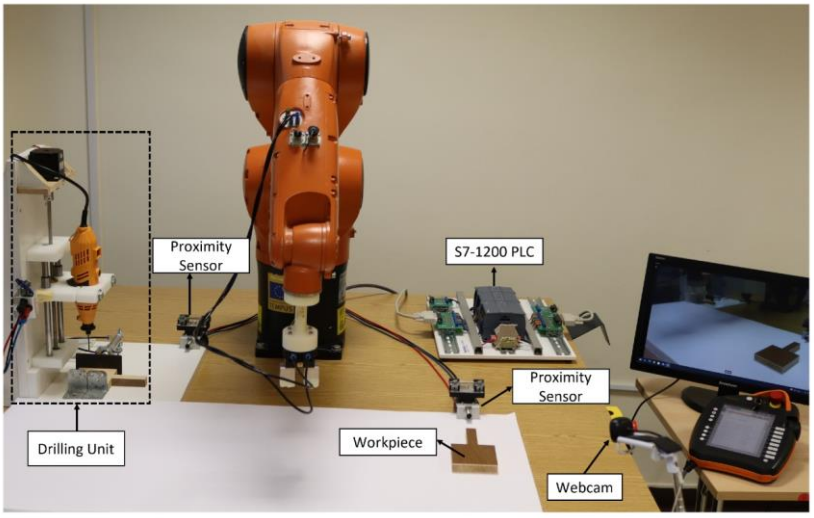
**Big Data Analytics:**

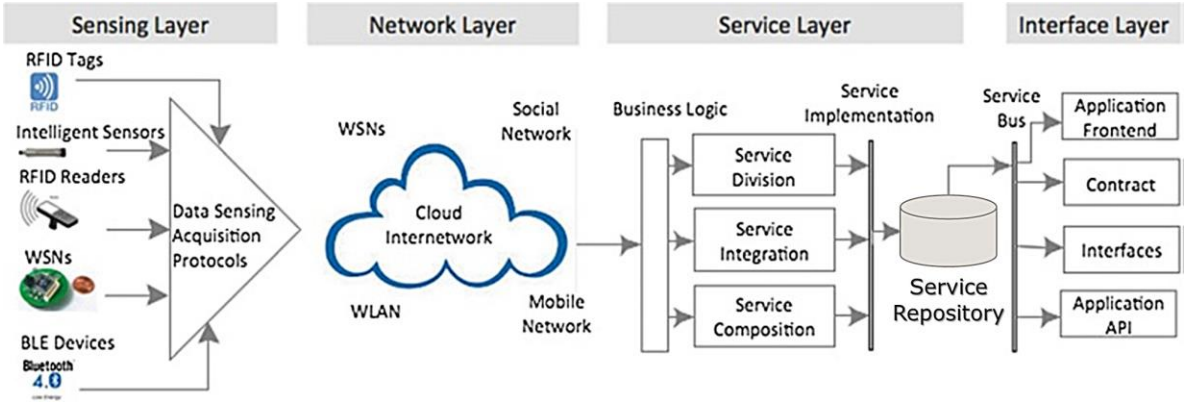
Within the framework of Industry 4.0, Big Data Analytics has the potential to provide global feedback and a high degree of coordination, both of which are necessary to achieve high production efficiency. Data acquired from a variety of resources and channels, such as sensors, actuators, network traffic, and log files, can provide statistical findings for direct supervision and control duties, as well as dynamic reconfiguration and optimization of the system and enterprises, thereby empowering businesses.

**Artificial Intelligence:**

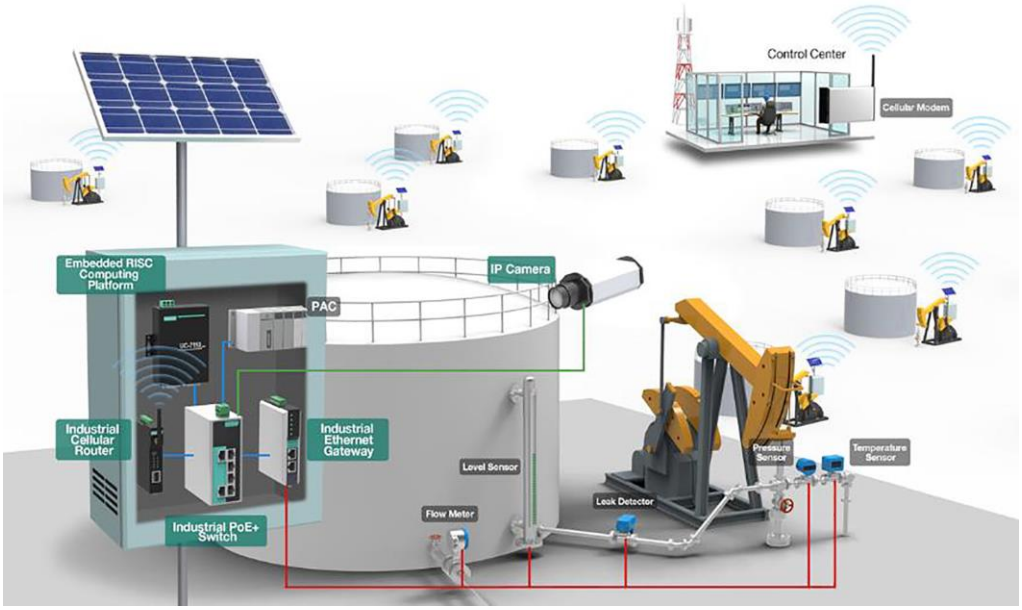
Because of Industry 4.0, today's industrial environments are not only more responsive and connected than ever before, but they are also more complex than ever before due to rising levels of interdependencies, nonlinearity, uncertainty, and data volume. The advancement of AI and the widespread use of Machine Learning (ML) and Deep Learning (DL)-based techniques across sectors are paving the way for these technologies to play a central role in the implementation of Industry 4.0.

Regarded as one of the key technologies for Industry 4.0, AI focuses on the design, validation, and implementation of a wide range of machine learning algorithms for use in manufacturing and automation, which leads to industrial artificial intelligence. AI-based approaches have an impact on Industry 4.0 by enabling intelligent devices to conduct functions such as self-monitoring, interpretation, diagnosis, and analysis autonomously, resulting in increased agility, productivity, and sustainability. Physical resources layer: it includes all manufacturing resources (machines, equipment, sensors, actuators).Network layer: data transmission and sharing between different layers (mainly between the physical resource layer and the cloud layer) requires advanced network technologies and communication protocols for high-speed and reliable real-time communication. It utilizes advanced networking technologies and protocols such as industrial ethernet, industrial wireless networks, Fieldbus, Profibus, Wi-Fi, Bluetooth, CAN, Cellular 4G/5G, TCP, OPC-UA, MQTT, JSON.

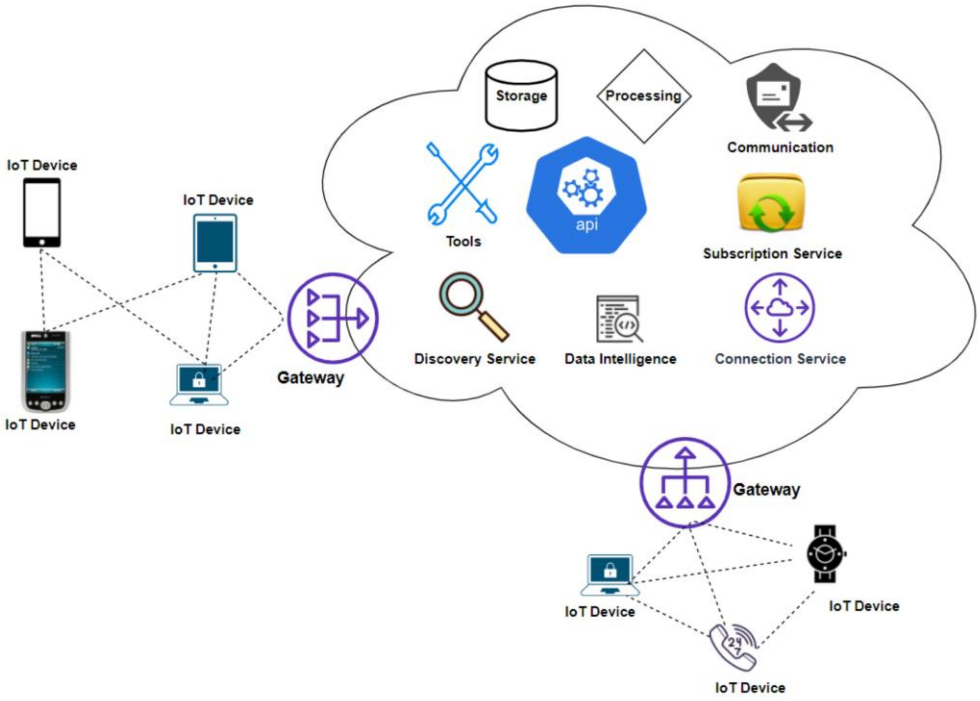


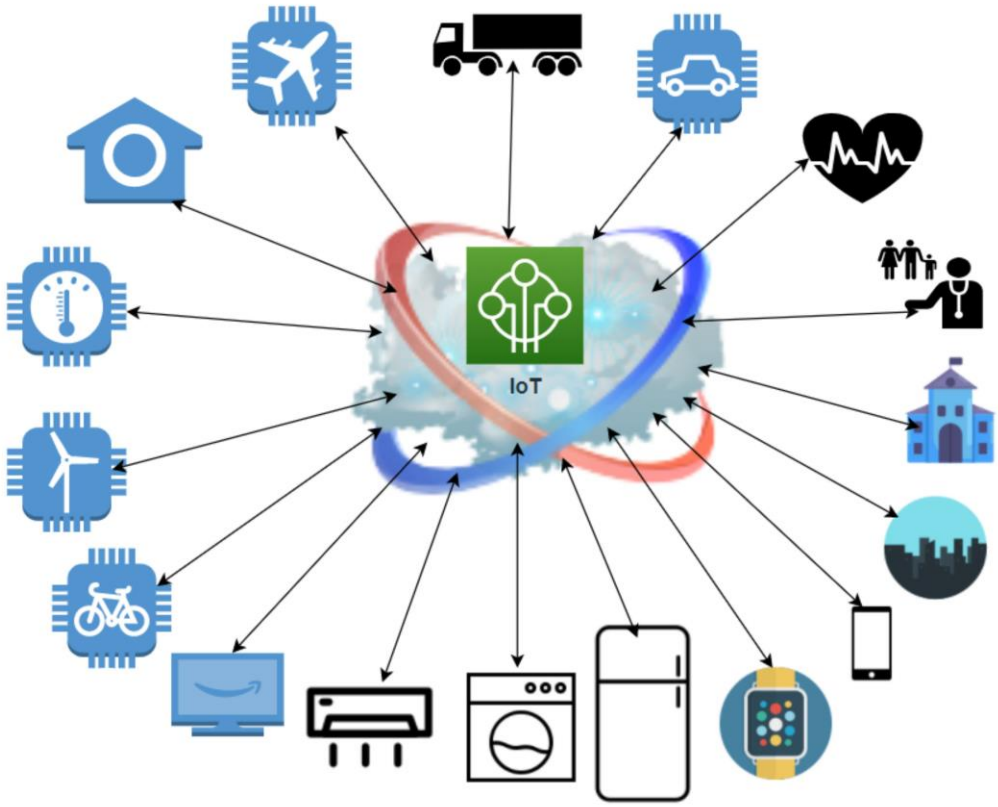

Generic Service-oriented Architecture (SoA) for IoT



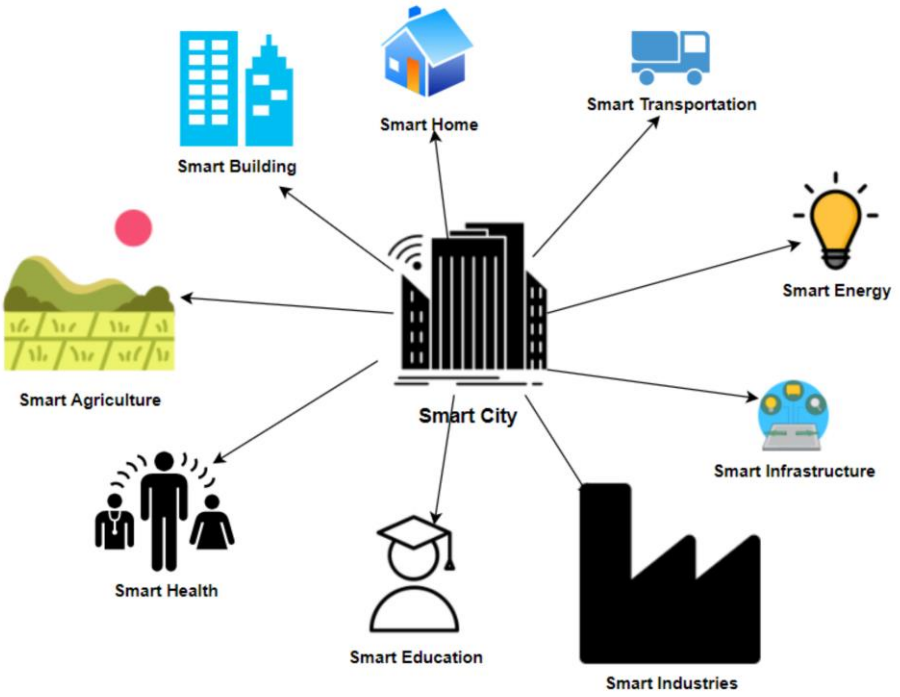

Typical IIoT network



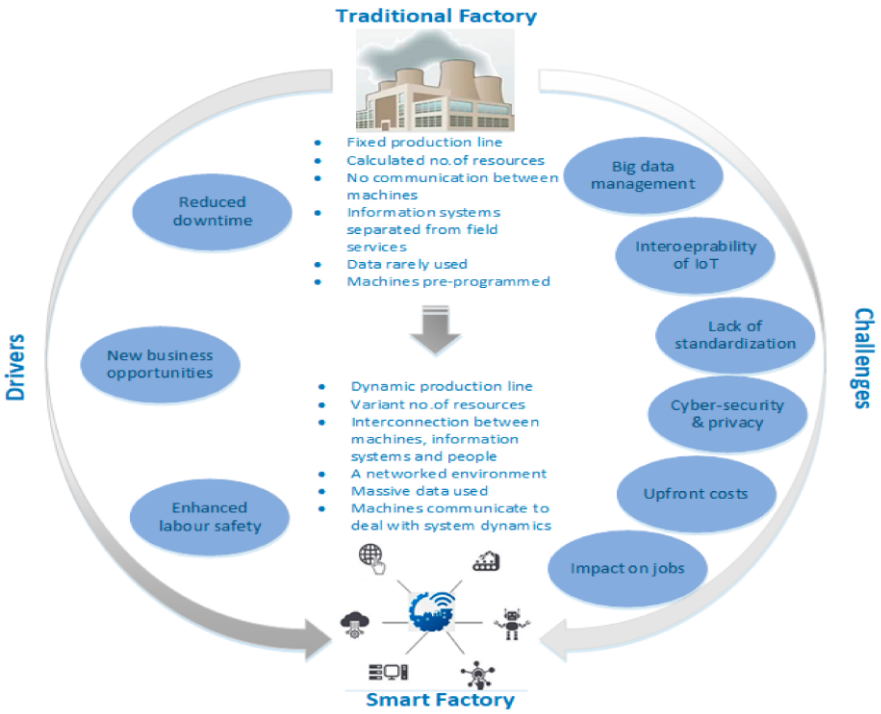

Cloud-based IoT System



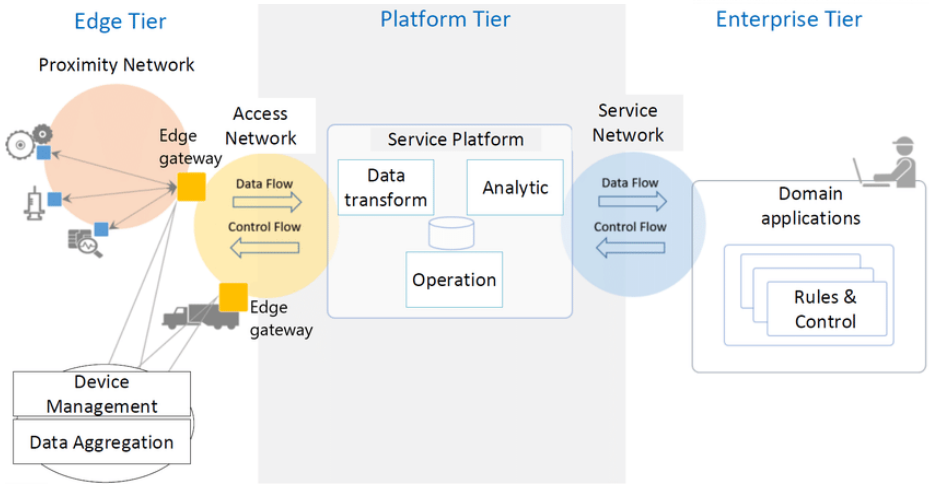

Cloud-IoT applications main areas.




Smart cities applications




Comparison of traditional and smart factories.




Three-Tier IoT system architecture of (IIRA) Industrial Internet Reference Architecture

## Problem Statement

The problem statement is to identify and address the challenges associated with the adoption of emerging technologies such as IoT and cloud computing in smart factories and develop effective use cases for connected devices to improve manufacturing efficiency, reduce downtime, and enhance product quality. With the rapid advancements in emerging technologies such as the Internet of Things (IoT) and cloud computing, the manufacturing industry is undergoing a transformation towards smart factories. However, the adoption of these technologies comes with various challenges, such as integrating existing systems with new technology, ensuring data privacy and security, and managing the massive amounts of data generated by connected devices. Additionally, there is a need for identifying and developing effective use cases for connected devices in smart factories to maximize the benefits of these technologies.

The use of IoT in smart factories has the potential to revolutionize manufacturing by improving operational efficiency, reducing downtime, and enhancing product quality. However, the deployment of connected devices also brings new challenges, such as ensuring device interoperability, managing data flows, and maintaining the security and privacy of sensitive data. Moreover, integrating the vast amounts of data generated by connected devices into existing business processes and systems is a significant challenge. Cloud computing provides a solution to some of these challenges by enabling efficient data processing and storage, real-time data analytics, and remote device management. However, cloud adoption in manufacturing is still in its early stages, and there is a need for developing effective cloud-based solutions that meet the specific needs of smart factories.

## Proposed Solution(s)

1. Smart factory and connected devices are transforming the manufacturing industry with the help of emerging technologies such as the Internet of Things (IoT) and cloud computing. These technologies enable manufacturers to create more efficient and flexible processes, optimize production, and improve product quality. Here are some proposed solutions on how to utilize these technologies to create smart factories and connected device use cases:

IoT-enabled Asset Tracking sensors can be used to track assets such as raw materials, work-in-progress, and finished goods as they move through the manufacturing process. This can help manufacturers optimize their production processes, reduce waste, and improve efficiency. Cloud-based analytics can be used to analyse the data collected by these sensors and provide insights into the production process. Predictive Maintenance:

IoT sensors can also be used to monitor equipment and predict when maintenance is required, allowing manufacturers to schedule maintenance before equipment fails. This can help prevent costly downtime and reduce maintenance costs. Cloud-based analytics can be used to analyse the data collected by these sensors and provide insights into equipment health.

Quality Control: IoT sensors can be used to monitor product quality throughout the manufacturing process. This can help manufacturers identify defects early in the process, reducing waste and improving product quality. Cloud-based analytics can be used to analyse the data collected by these sensors and provide insights into product quality. Smart Inventory Management: IoT sensors can be used to monitor inventory levels in real-time, allowing manufacturers to optimize inventory levels and reduce waste. Cloud-based analytics can be used to analyse the data collected by these sensors and provide insights into inventory levels and trends. Connected Devices: Connected devices such as wearables and smart tools can be used to improve worker productivity and safety. For example, smart glasses can provide workers with real-time information and instructions, reducing errors and improving efficiency. Cloud-based analytics can be used to analyse the data collected by these devices and provide insights into worker productivity and safety.

2. Emerging technologies like the Internet of Things (IoT) and cloud computing have transformed the industrial landscape by enabling the creation of smart factories and connected devices. In a smart factory, machines, tools, and devices are interconnected through IoT sensors and communicate with each other to automate tasks and optimize processes. In this way, the factory becomes more efficient, cost-effective, and productive. Here are some proposed solutions on how emerging technologies can be used in smart factory & connected device use cases using IoT and cloud. Predictive Maintenance: Smart factories can use IoT sensors to gather real-time data on the health of machines and equipment. The data can be analysed using cloud-based algorithms to predict when maintenance is required. This proactive approach helps prevent unplanned downtime and reduces maintenance costs.

## Introduction of Solution(s)

Additionally, IoT sensors can be used to collect data on production processes and product quality, allowing for real-time quality control. The data can be analysed using cloud-based software to identify defects and improve quality control. Smart factories can also leverage these technologies to monitor energy usage and identify areas where energy can be conserved, improving sustainability, and reducing costs. Furthermore, IoT sensors can be used to track the location and movement of assets such as tools, equipment, and vehicles, improving asset utilization, reducing theft, and increasing productivity. Lastly, these technologies can also be used to monitor worker safety and identify potential hazards, improving safety protocols, reducing accidents, and ensuring compliance with regulations.

In conclusion, by leveraging the power of emerging technologies like IoT and cloud computing, businesses can optimize their operations, reduce costs, and enhance productivity while achieving sustainability and safety goals. The proposed solutions on smart factory & connected device use cases using IoT and cloud offer significant opportunities for businesses to remain competitive in an ever-changing industrial landscape. The rise of emerging technologies like the Internet of Things (IoT) and cloud computing has revolutionized the industrial landscape. These technologies have paved the way for the creation of smart factories and connected devices that can communicate with each other, automate tasks, and optimize processes.

## Application of Solution(s)

1. The application of emerging technologies like IoT and cloud computing in smart factory & connected device use cases is vast and varied. Here are some examples of how these technologies can be applied:

2. Predictive Maintenance: IoT sensors can be used to monitor the health of machines and equipment in real-time. The data collected can be analysed using cloud-based algorithms to predict when maintenance is required. This proactive approach helps prevent unplanned downtime and reduces maintenance costs.

3. Inventory Management: IoT sensors can be used to track inventory items and their movement. The data collected can be analysed using cloud-based software to optimize inventory levels, reduce waste, and improve supply chain efficiency.

3. Quality Control: IoT sensors can be used to collect data on production processes and product quality. The data collected can be analysed in real-time using cloud-based software to identify defects and improve quality control.

4. Energy Efficiency: IoT sensors can be used to monitor energy usage and identify areas where energy can be conserved. The data collected can be analysed using cloud-based algorithms to optimize energy consumption, reduce costs, and improve sustainability.

5. Asset Tracking: IoT sensors can be used to track the location and movement of assets such as tools, equipment, and vehicles. The data collected can be analysed using cloud-based software to improve asset utilization, reduce theft, and increase productivity.

6. Worker Safety: IoT sensors can be used to monitor worker safety and identify potential hazards. The data collected can be analysed using cloud-based software to improve safety protocols, reduce accidents, and ensure compliance with regulations.

7. The application of emerging technologies like the Internet of Things (IoT) and cloud computing in smart factory & connected device use cases is vast and diverse. Here are some examples of how businesses can apply this solution to achieve operational excellence, sustainability, and safety:

8. Predictive Maintenance: By installing IoT sensors on machines and equipment, businesses can gather real-time data on their performance and health. This data can be analysed using cloud-based algorithms to predict when maintenance is required. This approach enables businesses to adopt a proactive maintenance strategy, preventing unplanned downtime and reducing maintenance costs.

## Future/Long-Term Focus

The future/long-term focus on emerging technologies on Smart factory & connected device use cases using the Internet of Things (IoT) and cloud computing is centred around advancing the capabilities and potential applications of these technologies to create more efficient, sustainable, and productive factories.

Here are some potential areas of focus for the future:

**Artificial Intelligence (AI) Integration**: The integration of AI algorithms with IoT and cloud computing can enable factories to become more autonomous, efficient, and predictive. By leveraging AI, factories can automatically detect patterns, make predictions, and optimize processes in real-time.

**5G Connectivity:** The introduction of 5G networks can enable faster and more reliable data transmission between IoT devices, cloud computing systems, and factories. This technology can facilitate the adoption of real-time applications that require low latency

and high bandwidth, such as virtual and augmented reality, and remote control of factory processes.

**Edge Computing**: The integration of edge computing can enable real-time processing of data at the edge of the network, reducing latency and improving reliability. This approach can enable factories to process data locally and send only relevant data to the cloud for analysis, reducing data transmission costs and improving overall performance.

**Blockchain Technology**: The adoption of blockchain technology can enable factories to create a secure and tamper-proof system for tracking products and data across the supply chain. By leveraging blockchain technology, factories can ensure product authenticity, reduce fraud, and improve traceability.

**Robotics:** The integration of robotics can enable factories to automate tasks that are dangerous, repetitive, or require high precision. By using robots, factories can reduce labour costs, improve safety, and enhance productivity.

In conclusion, the future/long-term focus on emerging technologies on Smart factory & connected device use cases using IoT and cloud computing is centred around enhancing the capabilities and potential applications of these technologies. By leveraging these technologies, factories can create more efficient, sustainable, and productive processes that enable businesses to remain competitive in a rapidly changing marketplace.

2 The future of emerging technologies in smart factory & connected device use cases using the Internet of Things (IoT) and cloud computing is promising. Here are some long-term focus areas that businesses should consider to stay ahead of the curve:

**Cybersecurity:** As factories become more connected, the risk of cyber-attacks increases. Businesses should prioritize cybersecurity by implementing measures such as secure communication protocols, encryption, and access controls. By adopting strong cybersecurity measures, businesses can protect their sensitive data and ensure business continuity.

**Sustainable Manufacturing**: As sustainability becomes an increasingly important issue, businesses should focus on sustainable manufacturing practices. This can include reducing waste, adopting renewable energy sources, and improving supply chain transparency. By adopting sustainable practices, businesses can reduce their environmental impact, enhance their reputation, and meet customer demand for sustainable products.

**Why Cloud-Based IoT Applications Are Essential for Smart Cities**

Cities have transitioned to IoT technologies and communication technologies for a variety of reasons.

1. The IoT systems enable sensors to detect data to manage appliance consumption, potentially resulting in significant cost savings.

2. Since installing and maintaining IoT applications is more accessible, the cost is a significant consideration when determining whether to go physically or online. Furthermore, the prices are decreasing, and communications' durability and power output allow for new circumstances that were previously not possible.

3. Efficiency is one of the most significant considerations. Service providers must physically go to the web page to examine and execute communications infrastructure for the most stressful solutions.

4. Reduced assistance is frequently the cause, as it should be, especially in operating situations and when smart road lighting and tracking equipment are repaired.

5. Wireless communication provides monitoring and control of IoT transmission through various analyses. This allows administrators to upgrade firmware and apply security solutions to all completed plans and get automatic alerts in the event of an issue.

## Conclusion

In conclusion, emerging technologies such as the Internet of Things (IoT) and cloud computing have the potential to revolutionize smart factory & connected device use cases. By adopting these technologies, businesses can achieve operational excellence, sustainability, and safety while gaining a competitive edge in the marketplace. These technologies enable businesses to collect and analyse data in real-time, providing insights into processes, assets, and products that were previously unavailable. This data can be used to optimize processes, reduce costs, improve quality control, and enhance safety protocols.

Furthermore, the long-term focus areas of AI, edge computing, 5G connectivity, cybersecurity, and sustainable manufacturing will ensure that businesses stay ahead of the curve in the rapidly evolving technological landscape. The future of smart factory & connected device use cases using IoT, and cloud computing is bright, and businesses that embrace these technologies will be well-positioned to succeed in the years to come. In conclusion, emerging technologies like IoT and cloud computing offer a plethora of opportunities for smart factories and connected devices. By leveraging the power of these technologies, businesses can improve efficiency, reduce costs, and enhance productivity while achieving sustainability and safety goals.

## Appendix

Abbreviations

The following abbreviations are used in this paper:

IoT Internet of Things

IIoT Industrial Internet of Things

ICT Information and Communication Technology

API Application programming interface

CapEx Capital expenditures

IaaS Infrastructure as a service

PaaS Platform-as-a-Service

SaaS Software-as-a-Service

WSN Wireless Sensor Networks

RFID Radio Frequency Identification

ML Machine learning

GPS Global Positioning System

SMEs Small and medium-sized enterprises

AI Artificial Intelligence

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