Industry 4.0

Topic: Industrial Internet of Things

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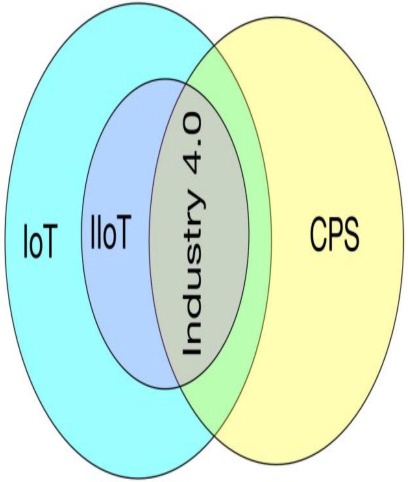
Introduction:

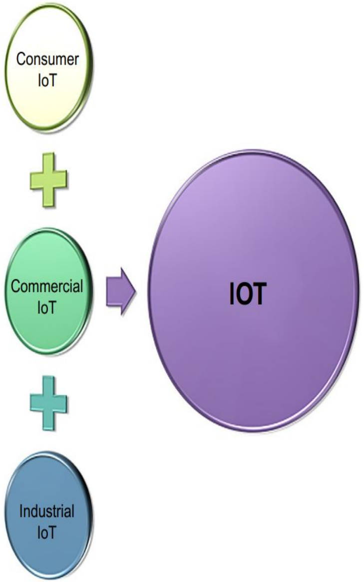
- Industrial Internet of Things(IIoT) is the application of different IoT-based technologies, such as M2M communication, AI, Machine Learning, Big Data technology, and various automation technologies, in the industrial sector.
- Primary focus of IIoT is to improve the manufacturing and production processes.
- Can also be referred to as a larger subset of IoT
- The key enablers of IIoT are smart sensor nodes, smart machines, automation, optimization, and real-time monitoring, which create industrial transformation
- Primary goal of IIoT is to improve operational efficiency and optimize the costs, thereby re-modifying the reference architecture and business models.



Introduction continued

- The industrial internet of things (IIoT) is the use of smart sensors, actuators and other devices, such as radio frequency identification tags, to enhance manufacturing and industrial processes.
- These devices are networked together to provide data collection, exchange and analysis. Insights gained from this process aid in more efficiency and reliability.
- IIoT is used in many industries, including manufacturing, energy management, utilities, oil and gas.
- IIoT uses the power of smart machines and real-time analytics to take advantage of the data that dumb machines have produced in industrial settings for years.
- The driving philosophy behind IIoT is that smart machines aren't only better than humans at capturing and analyzing data in real time, but they're also better at communicating important information that can be used to drive business decisions faster and more accurately.
- Connected sensors and actuators enable companies to pick up on inefficiencies and problems sooner, saving time and money while also supporting business intelligence efforts. In manufacturing specifically, IIoT has the potential to provide quality control, sustainable and green practices, supply chain traceability and overall supply chain efficiency. In an industrial setting, IIoT is key to processes such as predictive maintenance, enhanced field service, energy management and asset tracking.

- IoT can be divided into three categories, based on usage and clients base:
- **Consumer IoT**: includes the connected devices such as smart cars, phones, watches, laptops, connected appliances, and entertainment systems.
- **Commercial IoT**: includes things like inventory controls, device trackers, and connected medical devices.
- **Industrial IoT**: covers such things as connected electric meters, waste water systems, flow gauges, pipeline monitors, manufacturing robots, and other types of connected industrial devices and systems



Defination of IoT

- The IIoT is a network of physical objects, systems, platforms and applications that contain embedded technology to communicate and share intelligence with each other, the external environment and with people.

- The industrial Internet of Things (IIoT) refers to the extension and use of the Internet of Things (IoT) in industrial sectors and applications. With a strong focus on machine-to-machine (M2M) communication, big data, and machine learning, the IIoT enables industries and enterprises to have better efficiency and reliability in their operations.

Blocks of IIoT

- Things
- Gateway
- Data Lake/Storage
- Data Analytics

- **Things**: A “thing” is an object equipped with sensors that gather data which will be transferred over a network and actuators that allow things to act (for example, to switch on or off the light, to open or close a door, to increase or decrease engine rotation speed and more).

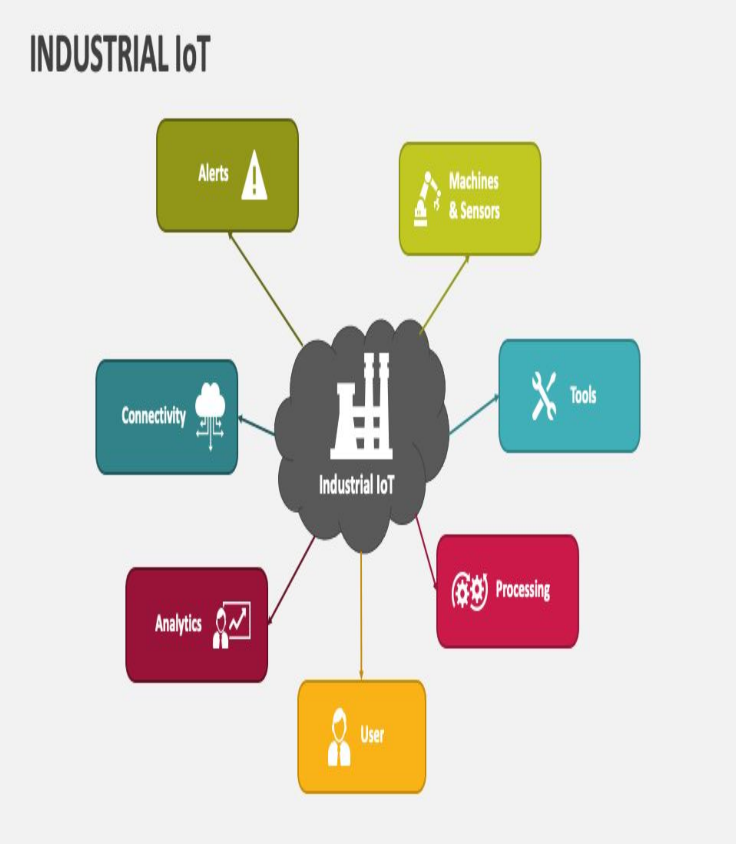
- **Gateways:** Data goes from things to the cloud and vice versa through the gateways. A gateway provides connectivity between things and the cloud part of the IoT solution, enables data preprocessing and filtering before moving it to the cloud (to reduce the volume of data for detailed processing and storing) and transmits control command going from the cloud to things.

- **Data lake**: It is used for storing the data generated by connected devices in its natural format. Big data comes in “batches” or in “streams.” When the data is needed for meaningful insights it’s extracted from a data lake and loaded to a big data warehouse. Big data warehouse contains only cleaned, structured and matched data (compared to a data lake which contains all sorts of data generated by sensors).

- **Data analytics**. Data analysts can use data from the big data warehouse to find trends and gain actionable insights. The data can be visualized in schemes, diagrams, infographics.

A typical IIoT system comprises of:

- Smart equipment that measures, stores, and communicates information
- Public or private internet networks that serve as a data communication structure
- Analytical applications that process raw data into data insights for optimized processes
- Tools that help decision-makers and employees utilize data for better business outcomes
- Dataflow is crucial to ensuring that IIoT applications work optimally.
- The real-time processing and complex analysis of the data help to optimize various industrial processes such as predictive maintenance of machines, inventory management, and packaging of finished products.



Various requirements of IIoT:

- Security
- Interoperability
- Scalability
- Accuracy
- Latency
- Reliability
- Automation
- Serviceability

Comparison between IoT and IIoT

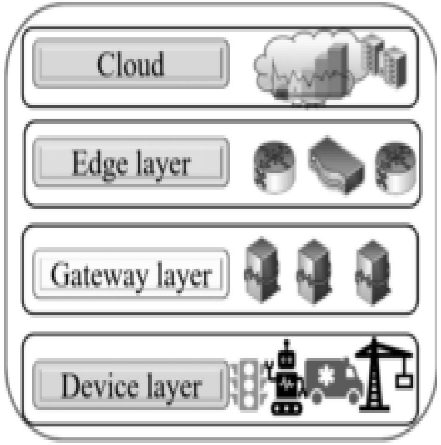
Features	IoT	IIoT
Focus	Devices are developed for the well-being of individuals	Devices are developed for the improvement of efficiency, safety, and security in industries
Interoperability	M-2-M communication possible in small scale	M2M communication, SCADA, and other manufacturing technologies are applicable in large scale
Scalability	Applicable in small scale, compared to IIoT, where things are interconnected through the Internet	Applicable in large scale networks, where seamless integration of devices are done in the industrial networks and IoT devices
Automation	IoT devices sense, process, and transmit data with limited or no human involvement	IIoT devices, in addition to the intelligence of the IoT devices, require control and automation logic, deep learning, and analytics
Emergency situation	In case any device fails, an emergency situation will not occur	Failure of any device may lead to a critical situation
Application	Consumer purpose	Industrial purpose

Comparison between IIoT and traditional automation.

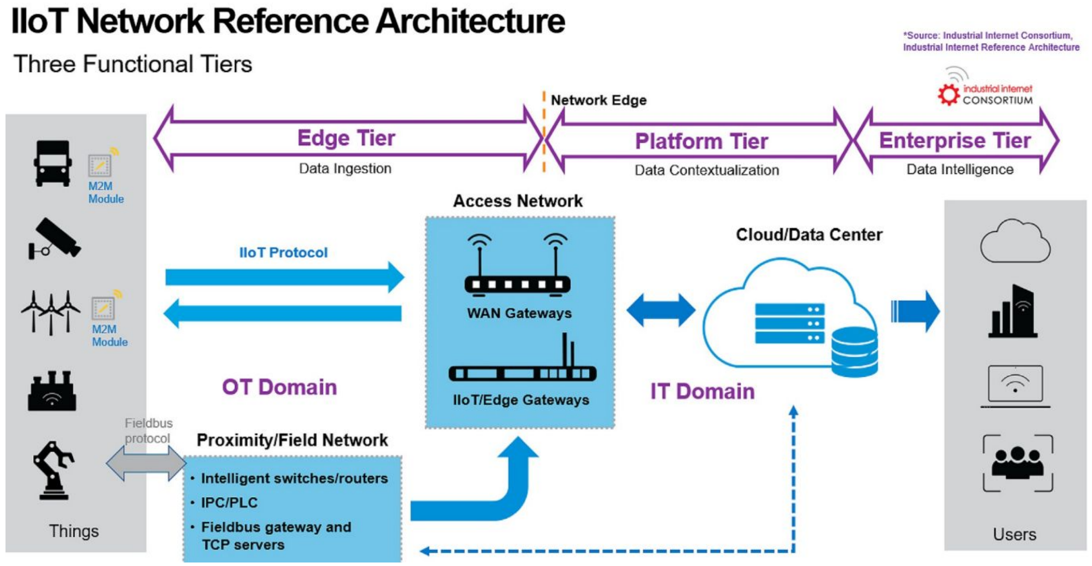
Features	IIoT	Traditional automation
Real-time communication	M2M communication is possible with minimum latency (dynamic). Better access and usage of the sensor nodes data.	Initially started with relay logic, with ladders and rungs. The development of Programmable Logic Controller (PLC) was a quantum leap in this direction, which replaced the relays and rungs.
Data model	Point-to-point data model	Broadcast-subscriber model
Data usage	The received data are translated into actionable information to improve operations, receive feedback, and execute accordingly.	To improve the operations, data are not directly translated.
Visualization	In order to optimize the entire production process, it can be visualized in a better transparent way.	Visualization of the entire production chain is semi-transparent.

IIOT Architecture

- ❖ The design of an IIoT architecture needs to highlight extensibility, scalability, modularity, and interoperability among heterogeneous devices using different technologies
- ❖ IIoT architecture is described as a three-layered infrastructure consisting of – device, gateway, and platform/middleware layer
- ❖ The device layer comprises heterogeneous type of smart sensor nodes which are deployed at various machines and devices.
- ❖ The sensor nodes sense and transmit data to the middleware layer through the gateway devices present at the gateway layer
- ❖ The gateway devices connect to the higher layers through infrastructures such as Wi-Fi and LAN, for further processing
- ❖ The edge layer and cloud together form the middleware layer and satisfy the requirements of analysis, storage, and processes data



- The architecture can also be divided into three tiers:
- Three tiers: sensor devices, gateways, and the data center or cloud IoT platform



Edge tier:

It focuses on gathering information via variety of sensors. Because sensors are so tiny and inexpensive, they can be embedded in many different types of devices, including mobile computing devices, wearable technology, and autonomous machines and appliances.

- They capture information about the physical environment, such as humidity, light, pressure, vibration and chemistry. Standards-based wired and wireless networking protocols are used to transmit the data from the device to the gateway.

Platform tier:

- The Platform Tier also known as Gateway Tier, acts as an intermediary that facilitates communications, offloads processing functions and drives action.

- Some sensors generate tens of thousands of data points per second, the gateway provides a place to preprocess the data locally before sending on to the data center/cloud tier.

- When data is aggregated at the gateway,summarized and tactically analyzed, it can minimize the volume of unnecessary data forwarded on. Minimizing the amount of data can have a big impact on network transmission costs, especially over cellular networks.

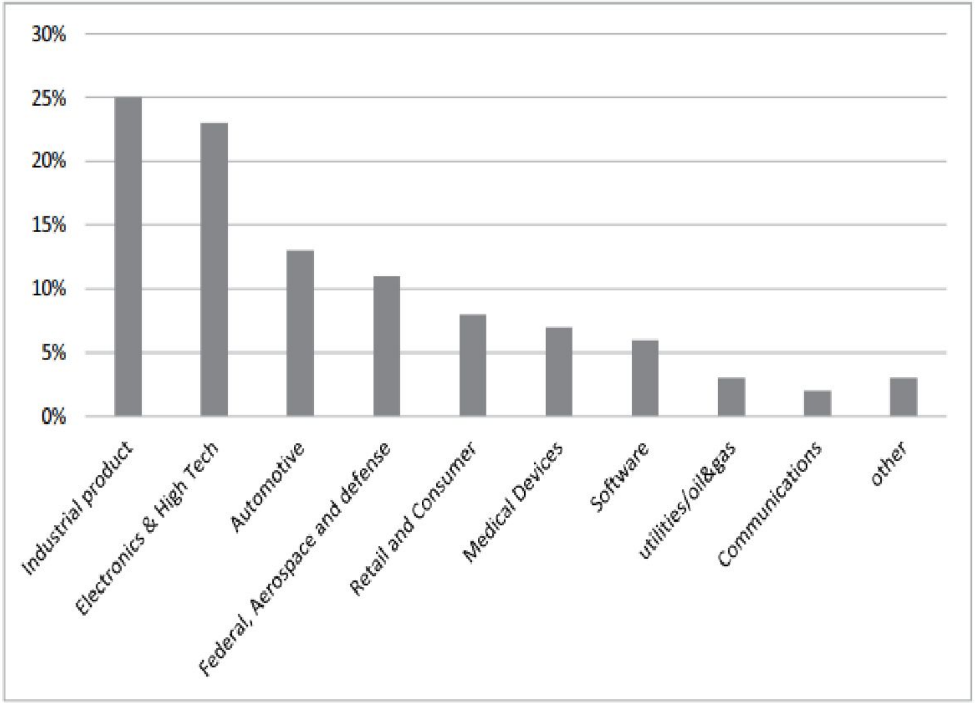
The data center/cloud tier:

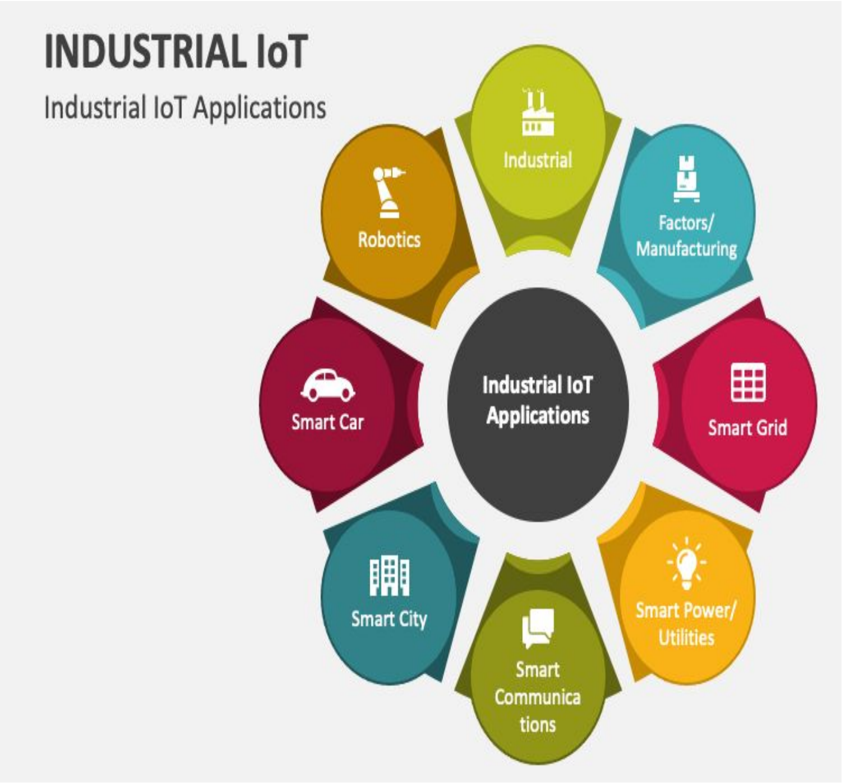
- performs large-scale data computation to produce insights that generate business value.
- It offers the back-end business analytics to execute complex event processing, such as analyzing the data to create and adapt business rules based on historical trends.
- It needs to scale both horizontally (to support an ever-growing number of connected devices) as well as vertically (to address a variety of different IoT solutions).
- Core functions of an IoT data center/cloud platform include connectivity and message routing, device management, data storage, event processing and analysis, and application integration and enablement.

Benefits of IIoT:

- Operational efficiency of the different industrial processes is improved.
- Product development and assembly line-related costs (operational cost) are reduced.
- Downtime of machines is reduced, and energy is conserved.
- The managers and other relevant officials can remotely monitor the factory operations.
- Improved estimation of available materials, work progress, and the arrival of inventory lead to the maximum utilization of the resources.
- Both customers' experience and cost of packaging the products have improved significantly.
- New business opportunities have been created.
- The real-time monitoring of the supply chain reduces inventory and capital requirements.

Application of IIOT





Examples of Application of IIOT in Industry

- Thames Water, the largest provider of drinking and waste water services in the U.K., is using sensors, and real-time data acquisition and analytics to anticipate equipment failures and provide fast response to critical situations, such as leaks or adverse weather events. The utility firm has already installed more than 100 000 smart meters in London, and it aims to cover all customers with smart meters by 2030. With more than 4200 leaks detected on customer pipes so far, this program has already saved an estimated 930 000 L of water per day across London.

- Precision agriculture powered by IIoT can help farmers to better measure agricultural variables, such as soil nutrients, fertilizer used, seeds planted, soil water, and temperature of stored produce, allowing to monitor down to the square foot through a dense sensor deployment, thereby almost doubling the productivity

Future of IIoT

- All industries are trying to modernize systems and equipment to meet new requirements, keep up with the market at an increasingly fast pace, and keep up with new technologies.

- Businesses that have implemented IIoT have experienced significant improvements in safety, efficiency, profitability, and expect the trend to be more and more businesses deployed.

- The term IIoT concept is commonly encountered in manufacturing industries.

- The Industrial Internet of Things will enable the creation of new business models by improving productivity, harnessing analytics to innovate, and transforming the workforce. It is predicted that the growth potential of implementing IIoT will generate $15 trillion by 2030 global GDP.

Challenges of IIOT

- Energy Efficiency
- Real-Time Performance
- Coexistence and Interoperability
- Security and Privacy
- Lack of standardization